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ELECTRON DISCHARGE DEVICE

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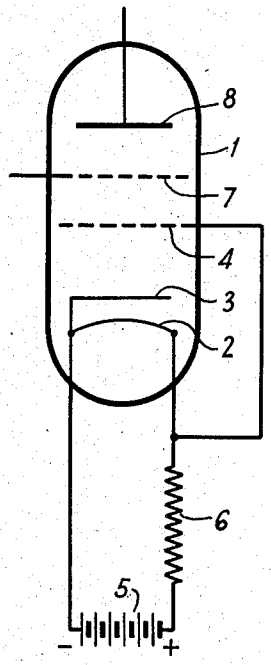


Fig. 1.

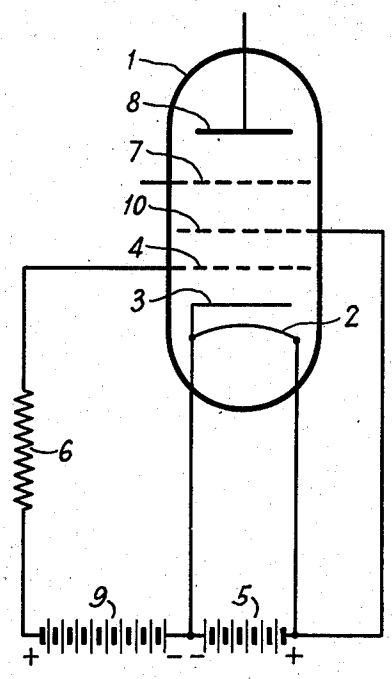


Fig. 2.

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ELECTRON DISCHARGE DEVICE

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8 Claims. (Cl. 250—27)

This invention relates to gas discharge tubes having an incandescent cathode as the electron source and especially to improvements for insuring stability and uniformity of operation of such tubes.

Such tubes sometimes have the disadvantage that the voltage drop of the gas discharge path changes owing to exterior influences. When using rare gases, such variation may take place because of gas consumption, and when using mercury vapor there may occur still much greater variations due to the dependence of the vapor pressure upon temperature.

It is the principal object of my invention to provide a gas tube which is stable and exhibits uniform characteristics during operation.

According to the invention, use is made of the fact that the voltage drop not only depends upon the gas or vapor density, but also upon the number of charge carriers produced per unit time.

In accordance with the invention, means are therefore provided which in proportion to the inner resistance, i. e., to the "gas current" of the tube, oppose any change in voltage drop in the gas discharge, and thus compensate for such changes.

This can be carried out in three different ways. First, the filament temperature can be increased, thereby enhancing the emission; second, an increase in the ionization in the gas chamber can be effected; third, the voltage at an electrode for instance that of the anode can be increased.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which:

Figure 1 is a schematic diagram of a gas tube and its associated circuit made according to my invention, and Figure 2 is a modification of Figure 1.

Figure 1 shows a tube and circuit employing a method of compensation by increasing the temperature of the cathode. Obviously the invention is not limited to this example. A gas filled tube is provided with an envelope 1, containing the heater 2, cathode 3, acceleration grid 4, control grid 7, and anode 8. The gas discharge is maintained between cathode 3 and the discharge grid electrode 4 which is connected to the positive pole of the heating circuit. The battery 5 supplies the voltage for both circuits, i. e., for the heating circuit as well as for the discharge current, that is the so-called gas current. Both have a common resistor 6 for the control. If the inner resistance of the gas paths increases, i. e., if the gas current decreases, then the voltage at the filament increases, and hence the temperature and the emission. This is explained by the fact that the total current through resistor 6 decreases, hence the drop across the resistor 6 decreases making available a higher voltage across heater 2. In addition, the grid 4 may become more positive. A corresponding action takes place in the reverse direction. The resistor 6 can be so chosen that its characteristic provides a linear compensation between the primary increase in resistance in the gas path and the secondary increase in the emission, so that the working point of the tube remains the same. Obviously this is not the case with a pure ohmic resistor. The invention is applicable to all cases where the variation in the resistance of the gas path is automatically so compensated by exterior influences that the cathodic functions of the entire gas path relative to the other electrodes are maintained constant or at least approximately constant.

A circuit and tube of modified form are shown in Figure 2. The numbers 1–8 designate the same elements as in Figure 1. But here the resistor 6 is no longer common to both circuits, and together with a second battery 9 it is inserted in the gas current circuit. Consequently it no longer influences the heating but produces an acceleration potential at grid 4 proportional to the increase in the gas current resistance. The auxiliary electrode 10 serves for maintaining constant the potential of the entire gas cathode relative to the other electrodes independent of the variations at grid 4. Where such necessity does not exist the auxiliary electrode may of course be omitted. As in the aforementioned method also in this case in place of the purely ohmic control, a resistance having a special characteristic may be employed, or simply a relay having a corresponding action.

With a constant voltage applied to the grid 10 with respect to the cathode and anode, the field distribution between the grid 10 and the anode is unaffected by changes within wide limits of the voltages between cathode 3 and grid 4. If the anode current is less than the saturation current that is maximum cathode current under given operating conditions, the voltage and current conditions will be unaffected by any changes between the cathode and the grid 10. The grid 10, therefore, acts as a shield between the cathode 3 and the anode 8 and may also be considered as the source of electrons for the tube. If the current between the cathode 3 and grid 4 decreases due to increase in the resistance of the gas discharge paths between cathode 3 and grid 4, the voltage on grid 4 increases as above described to maintain the current conditions the same. This change has substantially no effect on the field distribution between grid 10 and anode 8. Under extreme conditions if current between the cathode and the grid increases considerably and

if the grid 10 were not present the current to the anode would increase for given control grid and anode voltages, but with the grid 10 present, however, acting as a blocking grid the current to the anode would be unaffected except for those changes induced by the control grid 7. Thus the grid 10 cooperates with the grid 4 to maintain stabilized conditions in the tube.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention can be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What is claimed to be new is:

1. The method of operating a gas discharge tube having a thermionic cathode electrode, a discharge grid electrode, a control electrode, and an anode electrode, and comprising applying a voltage to said tube to establish a gas discharge between the thermionic cathode electrode and discharge grid electrode, utilizing variations in the internal resistance of the gas discharge path to control the voltage applied to said tube and impressing the resulting voltage between said thermionic cathode electrode and said discharge grid electrode to maintain the current to the anode substantially constant.

2. The method of operating a gas discharge tube having a thermionic cathode electrode, a discharge grid electrode, a control electrode, and an anode electrode, and comprising applying a voltage between said cathode electrode and the discharge grid electrode to establish a gas discharge between said cathode electrode and discharge grid electrode, utilizing variations in the internal resistance of the gas discharge path to control the voltage applied to said tube to vary the voltage applied to the cathode electrode whereby its temperature and emission are varied in response to variations in the inner resistance of the gas discharge path to maintain the current to the anode substantially constant.

3. The method of operating a gas discharge tube having a thermionic cathode electrode, a discharge grid electrode, a control electrode, and an anode electrode, and comprising applying a voltage to said tube to establish a gas discharge between said cathode electrode and discharge grid electrode, utilizing variations in the internal resistance of the gas discharge path to control the voltage applied to said tube to vary the voltage impressed between the cathode and said discharge grid electrode whereby the ionization of said gas discharge path is varied in response to variations in the inner resistance of the gas discharge path to maintain the current to the anode substantially constant.

4. The method of operating a gas discharge tube to obtain substantially uniform current through said tube, said tube comprising a cathode, a heater therefor, a discharge electrode, a control electrode, an anode electrode, and a source of voltage, and comprising applying a voltage to said tube to establish a gas discharge between said cathode and discharge electrode, utilizing variations in the internal resistance of the gas discharge path to control the voltage impressed between said cathode and said discharge electrode in said gas discharge tube to maintain the current to the anode substantially constant.

5. In combination a gas discharge tube having an envelope having a gaseous filling and containing a thermionic cathode, a discharge grid electrode, a control electrode, and an anode electrode, a source of voltage supply for heating said cathode and for providing a gas discharge between said cathode and the discharge grid electrode, a resistance in series with said voltage supply and a connection between said discharge grid electrode and said resistor, said resistor being connected between the positive side of the source of voltage supply and said discharge grid electrode whereby variations in the internal resistance of said gas discharge path will vary the voltage between said cathode and said discharge grid electrode to maintain the anode current substantially constant.

6. In combination a gas discharge tube having a cathode and a heater therefor, a discharge grid electrode, a control grid electrode, and an anode, and a source of voltage supply for heating said heater and for providing a gas discharge between said cathode and discharge grid electrode, and a resistor in series with said voltage supply and connected between the positive side of said source of voltage supply and said discharge grid electrode whereby variations in the internal resistance of the gas discharge path will vary the voltage applied to said heater to vary the emission from said cathode.

7. In combination a gas discharge tube having an envelope containing a gaseous medium, a cathode, a heater for said cathode, a discharge grid electrode, a control grid, and an anode, and a source of voltage connected between the cathode and the discharge electrode, the negative side of said source of voltage being connected to the cathode and a resistor in series with said source of voltage and said discharge grid electrode, said resistor being connected between the positive side of said source of voltage and the discharge electrode whereby variations in the internal resistance of the gas discharge grid path will vary the voltage applied to said discharge electrode to compensate for the variations in the ionization between the cathode and the discharge grid electrode.

8. In combination a gas discharge tube having an envelope containing a gaseous medium, a cathode, a heater for said cathode, a discharge grid electrode, a control grid, and an anode, and a source of voltage connected between the cathode and the discharge electrode, the negative side of said source of voltage being connected to said cathode and a resistor in series with said source of voltage and said discharge grid electrode, said resistor being connected between the positive side of said source of voltage and said discharge grid electrode whereby variations in the internal resistance of the gas discharge path will vary the voltage applied to said discharge grid electrode to compensate for the variations in the ionization between the cathode and the discharge grid electrode, and a grid electrode between the control electrode and said discharge grid electrode, for maintaining the potential of the electrodes providing the gas discharge constant with respect to the other electrodes independent of the variations of the voltage on the discharge grid electrode.

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