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J. P. RADCLIFF ET AL

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GAS FILLED DISCHARGE TUBE SYSTEM

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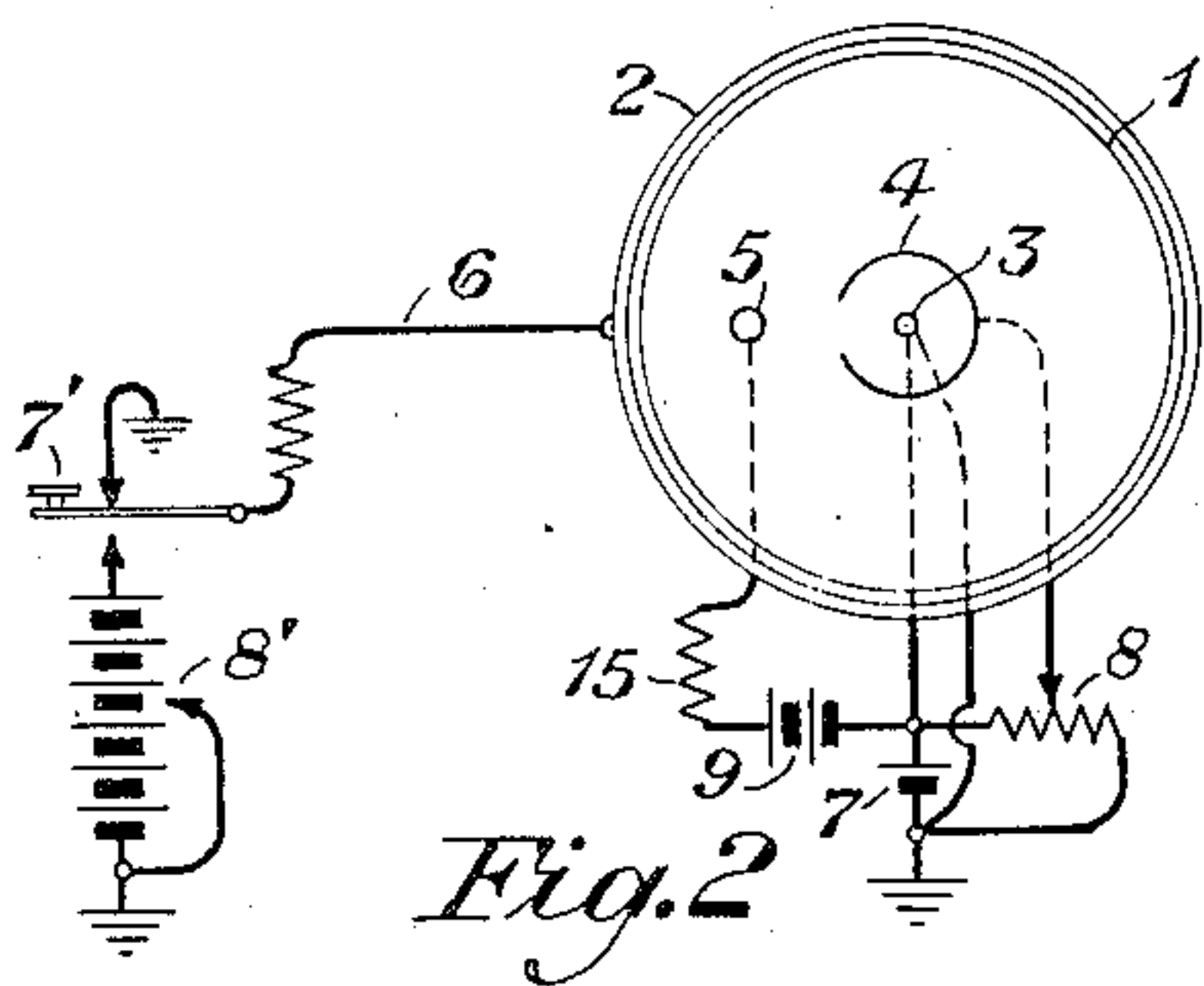


Fig. 2

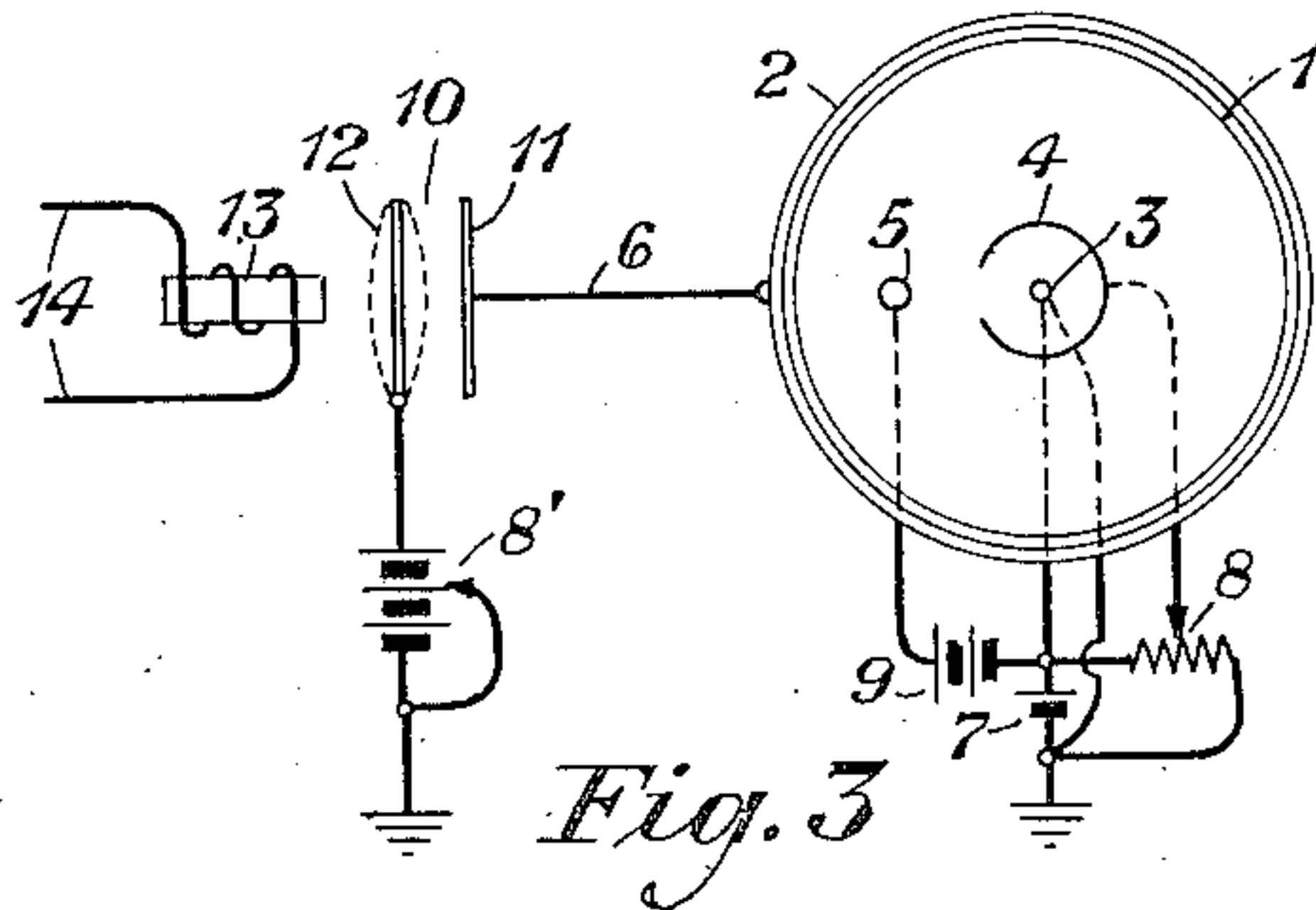


Fig. 3

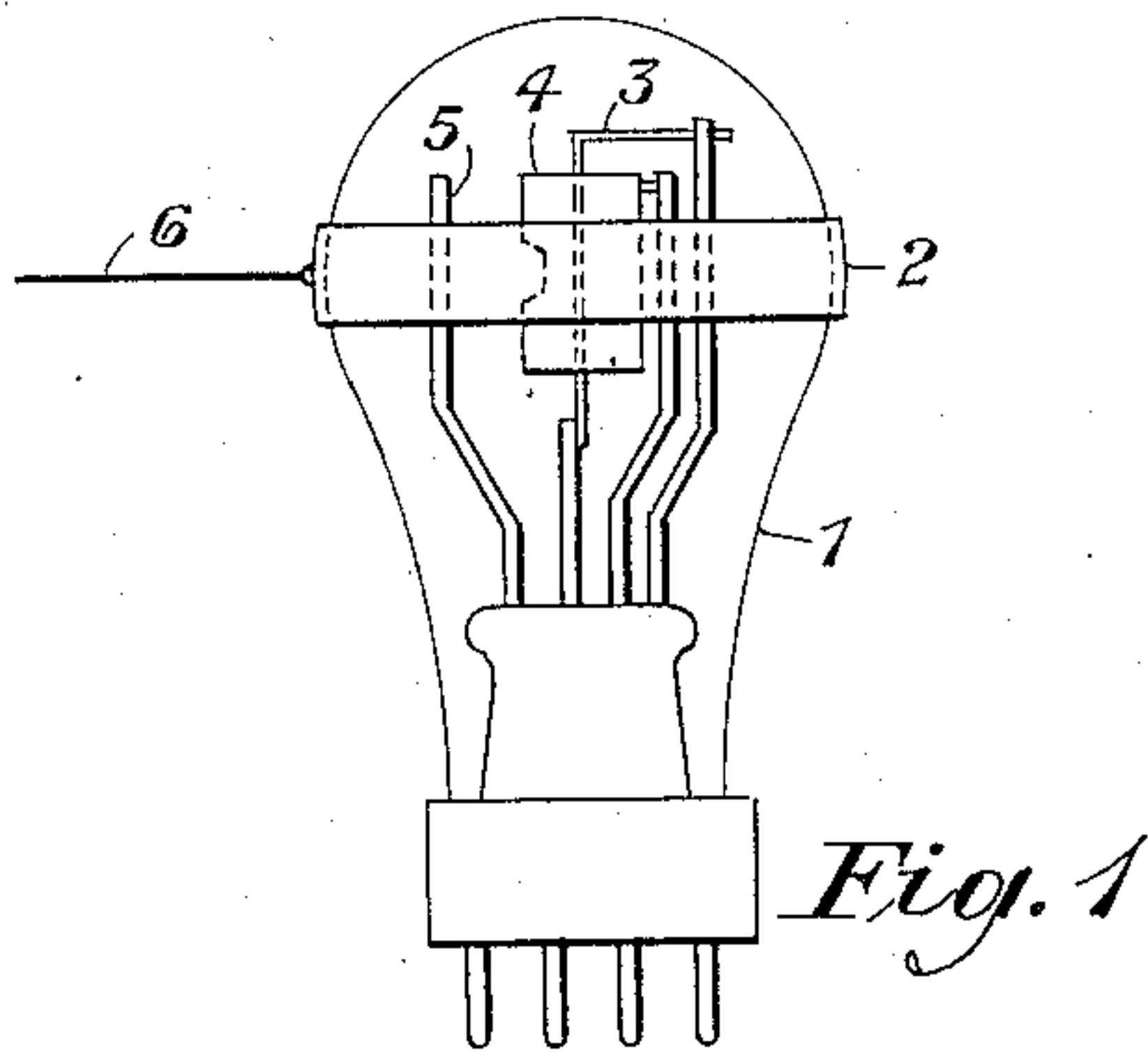


Fig. 1

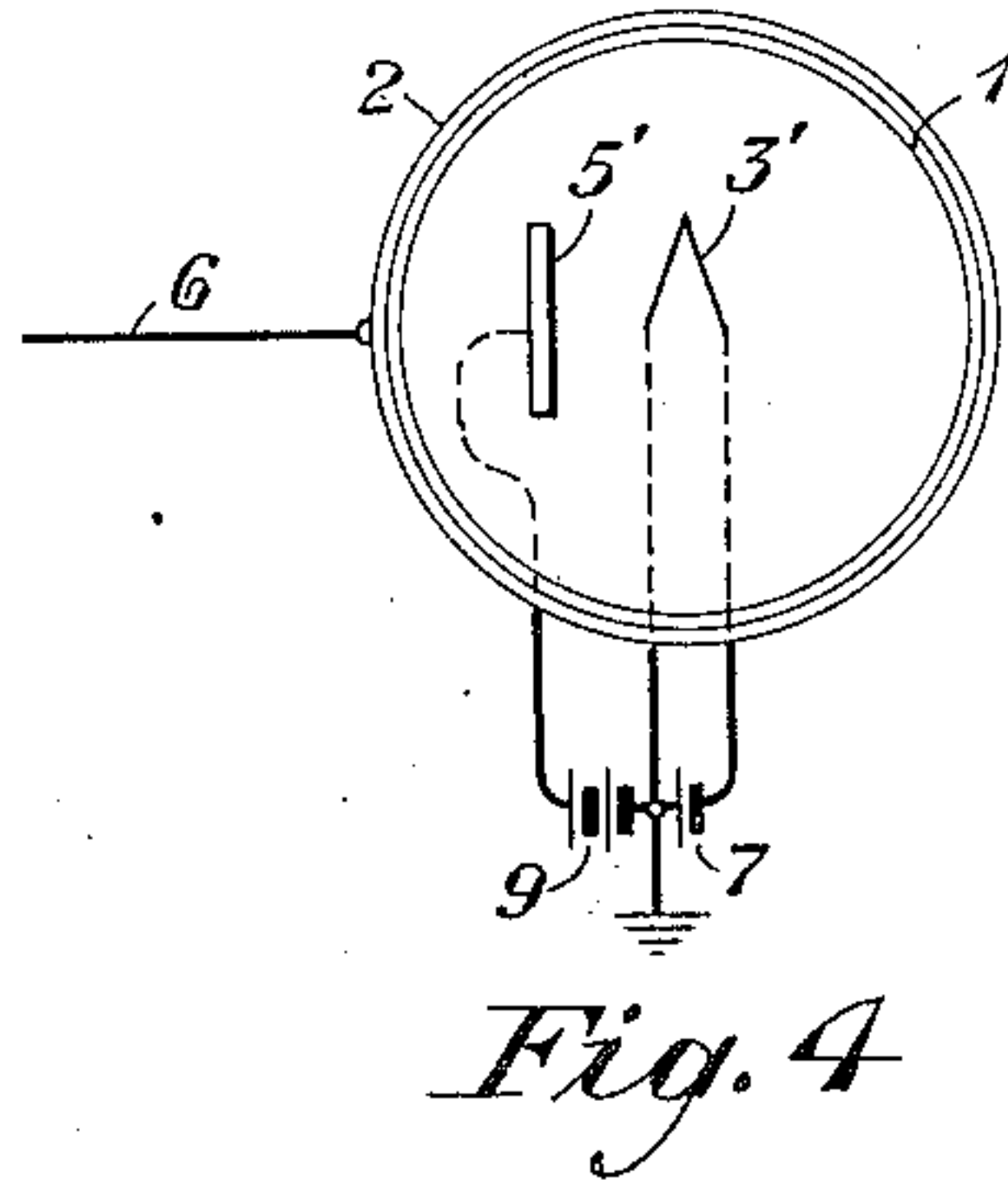


Fig. 4

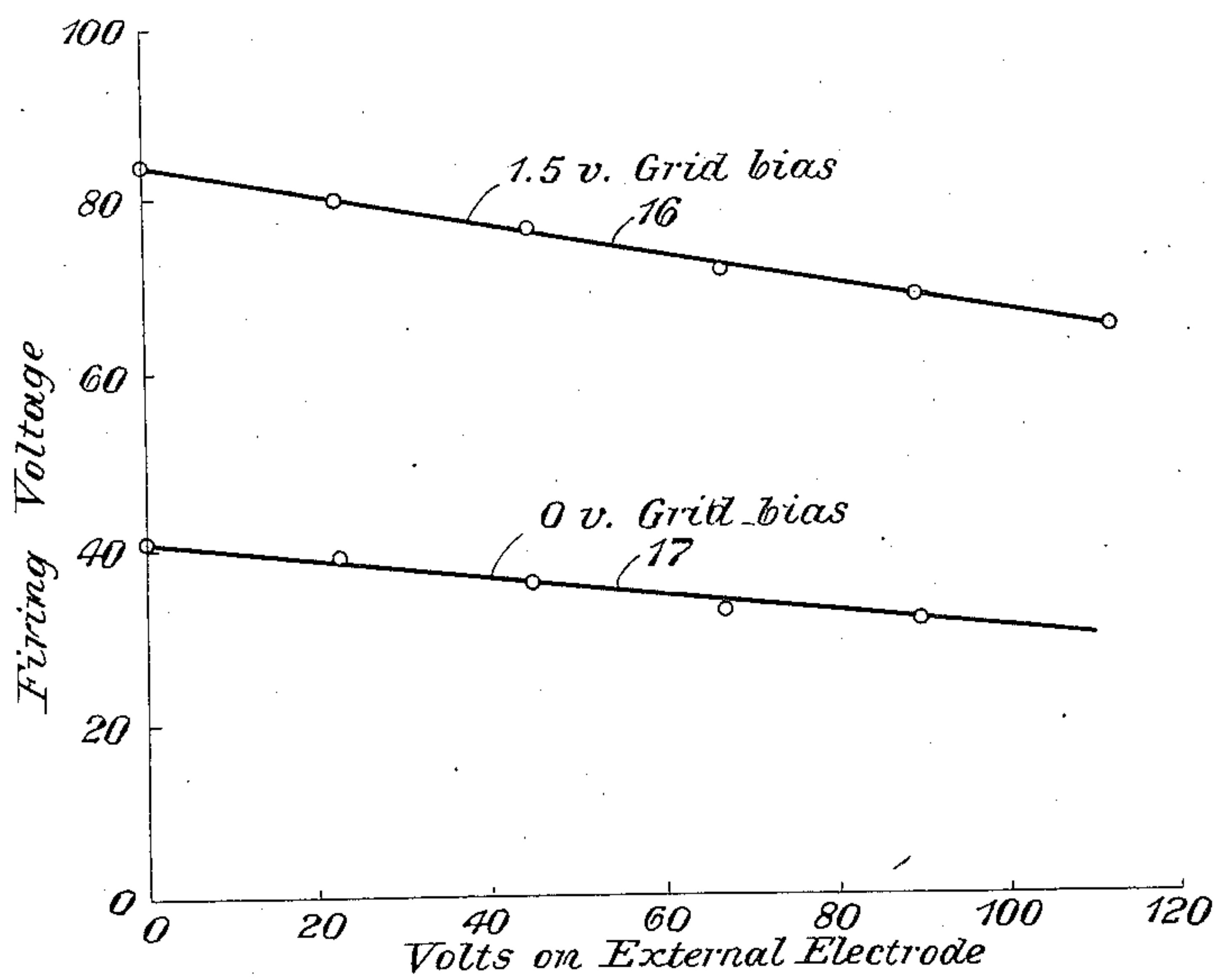


Fig. 5

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GAS-FILLED DISCHARGE TUBE SYSTEM

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Application April 9, 1935, Serial No. 15,481

4 Claims. (Cl. 250—27)

This invention relates to thermionic tubes of the type containing gas and depending upon the ionization of the molecules of the gas for operation, and more particularly relates to a method of and means for controlling the operation or breakdown voltage of tubes of this type.

At present thermionic or gas-filled discharge tubes consist essentially of an envelope containing a cathode and an anode, and in many instances a grid which is used to control the passage of current from the cathode to the anode. These elements are immersed in a gas which will vary in nature and pressure depending upon the duty for which the tube is designed. One of the primary objects of this invention consists in providing a method of controlling the breakdown or operating voltage of tubes of this type which is electrostatic in nature. The electrostatic method of this invention for controlling the operation or breakdown voltage of ionic tubes, so that the tube may be started in operation, may be employed either for primary or secondary control, that is to say, the electrostatic control may be employed as the main source of control of the tube or as a means for modifying the action of the tube when the said tube is to be controlled by some other means, such as by the voltage applied to the grid. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawing, in the Figures 1, 2, 3, 4 and 5 of which the invention is illustrated.

Fig. 1 is a diagrammatic showing of a gas-filled discharge tube embodying certain of the arrangements of the invention. Figs. 2 and 3 are plan views of Fig. 1 together with certain circuit arrangements of the invention. Fig. 4 is a plan view of a tube which shows a modification of the invention. In Fig. 5 are shown graphically certain features of operation of the invention. Similar reference characters have been used to denote like parts in all of the figures.

In Fig. 1 is shown a gas-filled discharge tube having a glass envelope 1. Within the tube and mounted on a stem are shown a cathode 3, a grid 4 and an anode 5. The cathode is of the solid heated thermionic emitting type. In Fig. 2 the battery 7 serves as the source for heating the cathode. The grid 4 may be cylindrical and have a small opening therein and will surround the cathode. The bias on the grid may be varied by the adjustable resistance 8 and battery 7. Between the cathode 3 and the anode 5 is provided

a source of potential, such as the battery 9. The voltage of battery 9 should be below the normal breakdown voltage of the tube but above the voltage needed to sustain a discharge in the tube after it has broken down, or started to discharge. In accordance with the arrangements of this invention, the tube is provided with an external electrode 2. This may be affixed to the outside of the glass envelope, if desired, and may be in various forms. A desirable form is to make it of a metal band, for example of brass, surrounding the tube. However, other forms and materials may be used for the external electrode. In accordance with the arrangements of this invention the breakdown voltage of the tube may be varied by applying different charges of potential to the external electrode. Thus the external electrode, when a charge is applied thereto, may be used either for exercising primary or secondary control over the operation of the tube and accordingly may be used to start a continuous discharge in an inert tube.

In Fig. 2 is shown a circuit arrangement whereby the external electrode may be used for starting a continuous discharge in the tube. As heretofore pointed out the battery 9 interconnecting the anode 5 and cathode 3 will be of a potential above the voltage needed to sustain the tube in operation but below the voltage needed to cause the tube to break down. The external electrode 2 will be connected to a switching device 7'. When the switch 7' is operated a charge will suddenly be applied from the device 8' capable of supplying the desired voltage to the external electrode 2 and will result in causing the tube to break down and discharge. The charge on the external electrode 2 may be removed by operating the key to the grounded contact shown. In other words a gas-filled tube of the type having a solid heated thermionic emitting cathode may in accordance with the arrangements of this invention be started in operation by the establishment of an electrostatic field in the vicinity thereof. A load 15 in the cathode-anode circuit is shown. The tube arrangements may of course be used for many things, such for example as a relay device.

In Fig. 5 the effect of the establishment of an electrostatic field on the operating or firing voltage is illustrated graphically. The curves 16 and 17 show the relationship in certain type of tube utilized between the firing or breakdown voltage and the voltage applied to the external electrode. Curve 16 shows the relationship when the bias on the grid is 1.5 volts, while the relationship

without any bias on the grid is shown by curve 17. For example, from curve 16 it will be seen that with a grid bias voltage of 1.5 volts the anode voltage necessary to permit firing was reduced from a normal of 84 volts with no charge on the external electrode, to 65 volts with a charging potential of 112.5 volts on the external electrode.

In Fig. 3 is shown a view of the same tube as shown in Figs. 1 and 2 with circuit arrangements whereby the tube could be caused to start a continuous discharge by other means than the switch 7' shown in Fig. 2. In Fig. 3 the external electrode 2 is connected by conductor 6 to the fixed plate 11 of a condenser 10. The other plate 12 of condenser 10 is connected to the variable source of potential 8' and may be bent or warped in the manner of a diaphragm by means of the magnet 13 in a control circuit 14. An impulse sent over circuit 14 will, accordingly, change the relationship between the plates of condenser 10 and suddenly vary or apply a charge to the external electrode 2. This will serve to start the tube in operation with a continuous discharge.

In Figs. 1, 2 and 3 tubes having three internal electrodes have been illustrated. However the arrangements of the invention are applicable to other types of tubes having solid heated thermionic emitting cathodes. For example, the grid electrode might be omitted as shown in Fig. 4. The heated cathode in this arrangement is shown as 3' and the anode as 5'. In this arrangement the anode may be in plate form if desired. The only difference in this tube would be the lack of any grid or biasing effect. Furthermore, tubes having cathodes with an auxiliary heater device might equally well be utilized in the arrangements of the invention.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A gas-filled discharge tube including cathode and anode electrodes within an envelope containing gas at low pressure, said cathode being of the solid heated thermionic emitting type, a circuit including a direct current source interconnecting said electrodes, the voltage of said source being below the breakdown voltage of said tube but above the voltage needed to sustain a discharge therein after breakdown, a third elec-

trode external to said envelope, and means for causing a difference of potential to exist between said external electrode and one of said other electrodes whereby a continuous discharge may be started in said tube.

2. A gas-filled discharge tube including cathode and anode electrodes within an envelope containing gas at low pressure, said cathode being of the solid heated thermionic emitting type, a circuit including a direct current source interconnecting said electrodes, the voltage of said source being below the breakdown voltage of said tube but above the voltage needed to sustain a discharge therein after breakdown, a third electrode external to said envelope, and means for suddenly applying a voltage to said external electrode to cause a continuous discharge to start in said tube.

3. A gas-filled discharge tube including cathode, anode and grid electrodes within an envelope containing gas at low pressure, said cathode being of the solid heated thermionic emitting type, a circuit including a direct current source interconnecting said cathode and anode electrodes, the voltage of said source being below the breakdown voltage of said tube but above the voltage needed to sustain a discharge therein after breakdown, adjustable means for applying biasing potentials to said grid electrode, a fourth electrode external to said envelope, and adjustable means for suddenly applying a desired voltage to said fourth electrode to cause a continuous discharge to start in said tube.

4. A gas-filled discharge tube including cathode and anode electrodes within an envelope containing gas at low pressure, said cathode being of the solid heated thermionic emitting type, a circuit including a direct current source interconnecting said electrodes, the voltage of said source being below the breakdown voltage of said tube but above the voltage needed to sustain a discharge therein after breakdown, a third electrode external to said envelope, a condenser having a fixed plate and a movable plate, means for connecting said fixed plate to said third electrode, variable means for causing a difference of potential to exist between the plates of said condenser, and means for suddenly moving the movable plate of said condenser to vary the charge on said third electrode whereby a continuous discharge may be started in said tube.

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