March 19, 1940. O. KRINES 2,194,308

ELECTRIC VALVE CIRCUIT

Filed Dec. 16, 1937

Fig. 1.

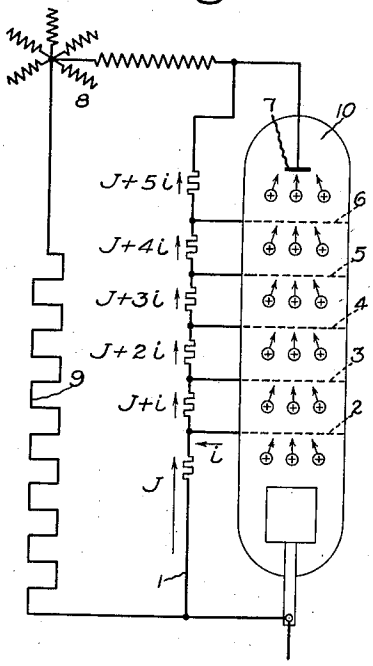


Fig. 2.

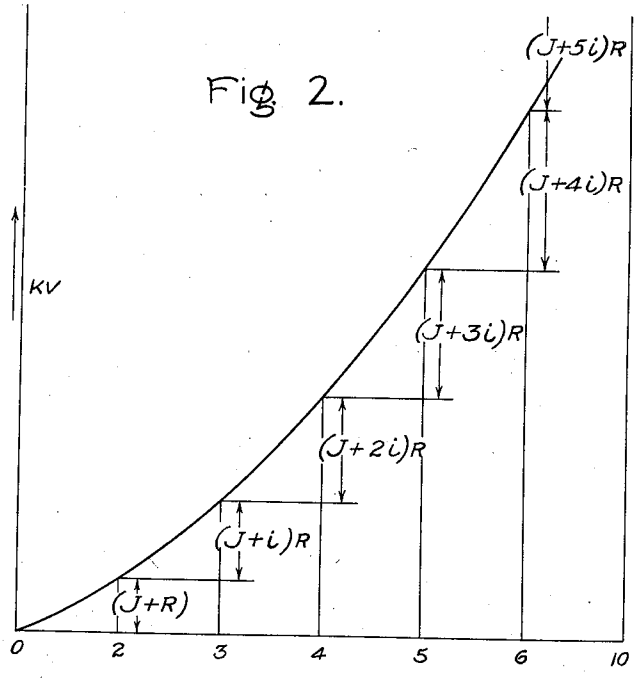


Fig. 3.

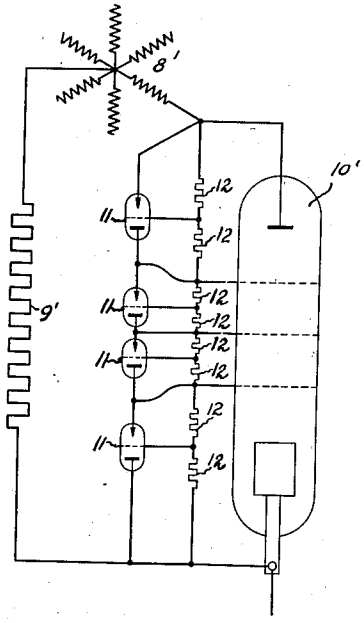


Fig. 4.

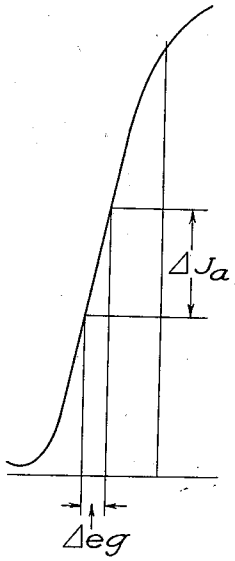
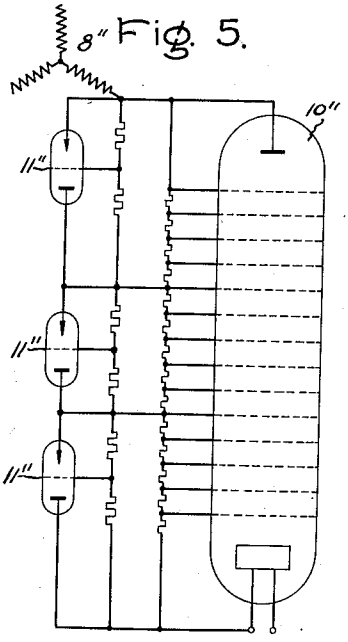


Fig. 5.



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2,194,308

ELECTRIC VALVE CIRCUIT

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Application December 16, 1937, Serial No. 180,249
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4 Claims. (Cl. 250—27)

In order to enable a high blocking voltage to be fed to the individual discharge sections of current rectifiers, it has already been suggested to incorporate into the discharge path a large number of intermediate electrodes, which are connected to a voltage divider between the anode and cathode. By this arrangement it is possible, during the time when no deionizing current (grid current) flows, to obtain a uniform division of the blocking voltage, i. e. a uniform field distribution in the discharge path. However, during the time immediately following the discharge, a considerably less favorable field distribution may occur due to the deionizing current, so that the uniform voltage distribution is lost.

An object of the invention is to restore the uniformity of the electric field in a gaseous discharge device after the field has become unevenly distributed during discharge due to the effects of positive ionization. In carrying out this object in accordance with one embodiment of my invention, I provide composite impedance means including vacuum tubes shunted across the potentiometer elements which are normally employed to distribute the voltage gradient throughout the discharge device. The vacuum tubes are adapted to carry the necessary equalizing currents. The invention will be better understood when reference is made to the following specification and the accompanying drawing in which Fig. 1 is a diagrammatic showing of a tube illustrating the effects of positive ionization in disturbing the voltage distribution between the electrodes. Fig. 2 graphically depicts these effects. Fig. 3 illustrates a tube and system improved in accordance with the present invention, while Fig. 4 shows the manner in which the system of Fig. 3 operates to equalize the field distribution. Fig. 5 illustrates a modified form of the improved field equalizing means.

From Fig. 1, it will be seen that the compensating current J, driven by the blocking voltage across the voltage divider, flows through the voltage divider 1. Furthermore, the voltage divider extracts the deionizing current i at each point of connection of the intermediate electrodes 2, 3, 4, 5 and 6. For simplicity's sake, in the illustration of Fig. 1, which shows only a single discharge section 7 connected to a multi-phase transformer 8 through a loading resistance 9, it is assumed that all deionizing currents are of equal value. In reality, they follow the known $V^{3/2}$ law, so that the voltage distribution shown in Fig. 2 becomes even less favorable. It will further be noted from Fig. 2 that the voltage drops in the individual members of the voltage divider become greater, the closer the potentiometer tapping point approaches to the point of connection of the anode 10. Directly following the discharge, that is, during the deionizing period, such high field strengths occur in the region of the anode, that the operation of the device becomes unstable and irregular. According to the invention, therefore, in order to improve the field strength conditions, a chain of three electrode vacuum tubes 11 is connected in parallel to the potentiometer elements 12, as shown in Fig. 3. In this case, it will be expedient for the grid potential of the vacuum tubes to be supplied from an additional tap intermediate the ends of each resistance. It can also be arranged to have any of the resistances increase their response to the current more rapidly than the remaining resistances. If the voltage drop increases more in one chain link than it does in another, then, as shown in Fig. 4, the control grid of the connected vacuum tube also becomes more positive and therefore the latter is able to transmit more current. As a result the composite impedance of the particular chain link involved, including the associated resistance and vacuum tube, is caused to vary in continuous and inverse response to a change in current flow through the link. By means of such an arrangement it is possible to avoid practically in its entirety the undesirable and dangerous increase of the field strengths.

If it is desired to economize in discharge sections, each chain link need not be equipped with a vacuum tube. Instead, a number of these links can be collected into a group and connected in parallel to one tube. Fig. 5 shows such an arrangement.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, a high voltage gaseous discharge device having a cathode and an anode, a source of current for energizing said cathode and anode whereby an electric field is produced in the device, and means for maintaining the field uniform after a high current discharge between the cathode and anode, said means comprising an electrode interposed between the cathode and anode, separate resistances respectively connected between the said interposed electrode and the anode and cathode, and a thermionic discharge device connected across one of said resistances, said device being variable in conductivity in response to variations in current through such resistance.

2. In combination, a high voltage gaseous discharge device having an anode, a cathode and a plurality of intermediate electrodes, means for producing a discharge between the anode and cathode, a plurality of impedance means respectively connected between the various electrodes, and means for passing a current serially through the said impedance means so as to establish a desired potential relationship between the various electrodes, the impedances of at least certain ones of the impedance means being continuously and inversely variable in response to changes in current flow through them, thereby to minimize departures from the said desired potential relationship caused by the deionizing current flowing at the termination of a discharge period.

3. In combination, a high voltage gaseous discharge device having a plurality of electrodes including an anode, a cathode and an intermediate electrode, separate impedance means respectively connected between the various electrodes, means for producing a discharge between the anode and cathode and for passing a current serially through the said impedance means so as to establish a desired potential relationship between the various electrodes, and means for varying the impedance of at least one of the impedance means in continuous and inverse response to changes in current flow therethrough, thereby to prevent substantial departures from the said desired potential relationship as a result of deionizing current flowing at the termination of a discharge period.

4. In combination, a high voltage gaseous discharge device having a plurality of electrodes including an anode, a cathode and an intermediate electrode, separate resistances respectively connected between the various electrodes, means for producing a discharge between the anode and cathode and for passing a current serially through the resistances so as to establish a desired potential relationship between the various electrodes, and an electron discharge device shunting at least a portion of the resistance which is connected between the anode and the intermediate electrode, the said electron discharge device being provided with control means effective to increase the conductivity of the device in response to an increase in current through the said last-named resistance.

OSKAR KRINES.