Aug. 12, 1941. J. F. ROUGVIE 2,252,645

APPARATUS FOR PRODUCING CONSTANT CURRENT

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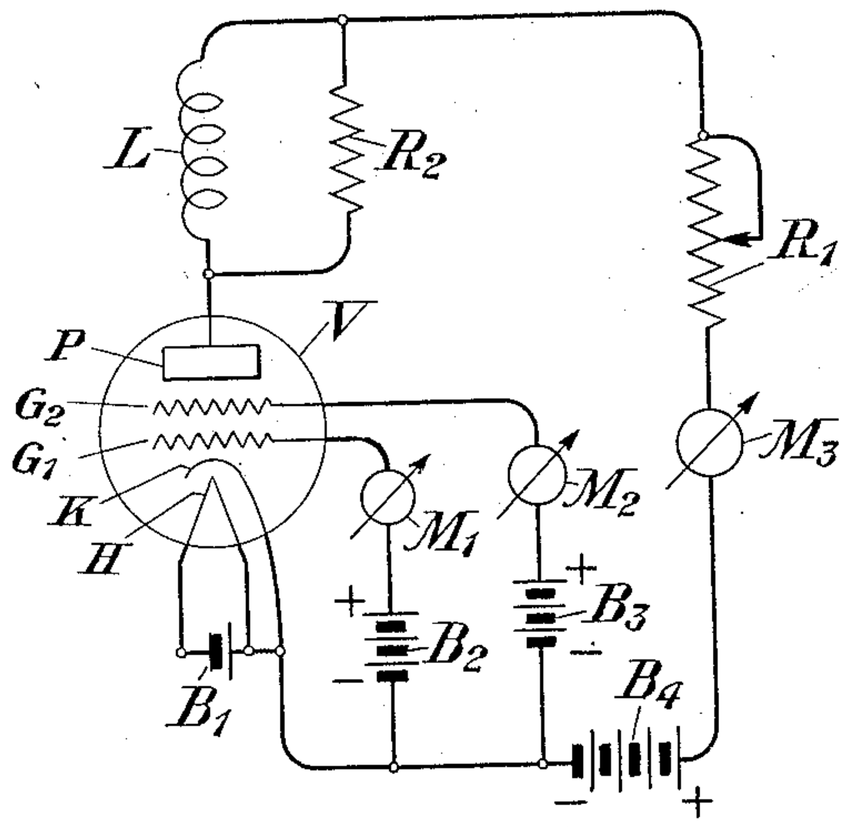

Fig. 1

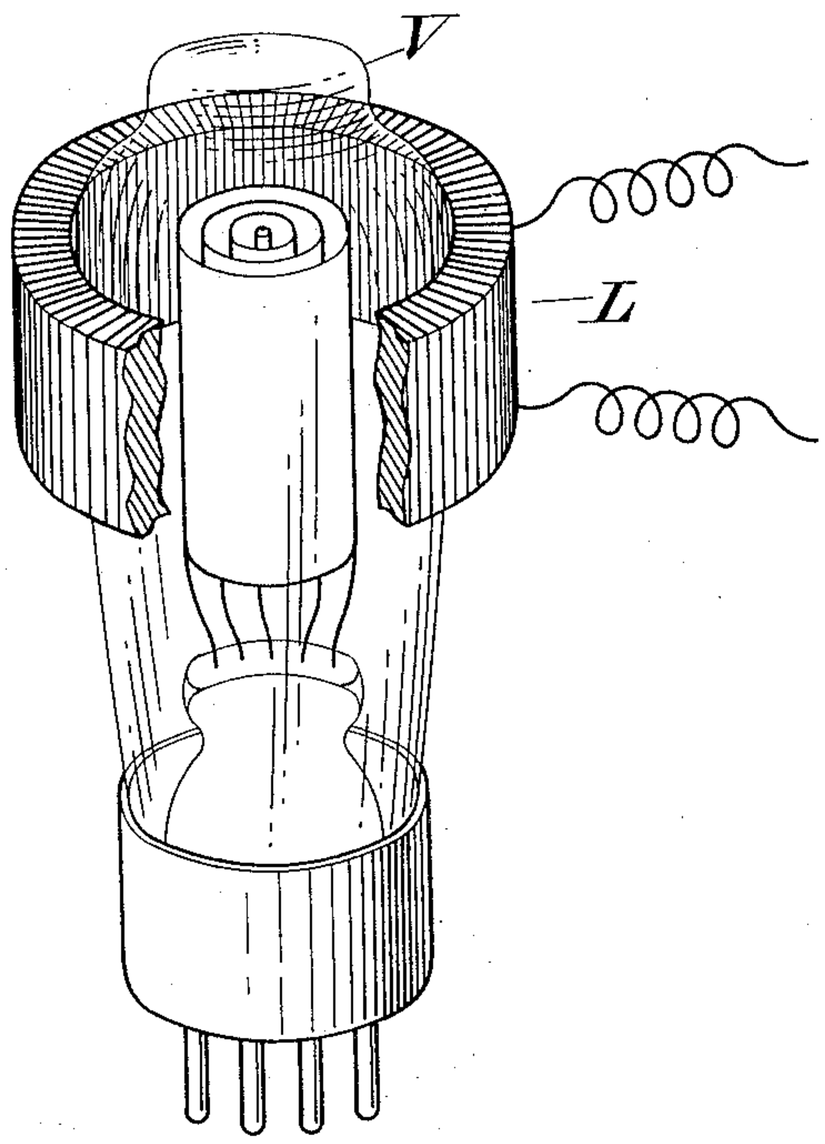

Fig. 2

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APPARATUS FOR PRODUCING CONSTANT CURRENT

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Application May 3, 1939, Serial No. 271,580

2 Claims. (Cl. 171—312)

This invention relates to gas discharge tube devices and to circuits therefor. More particularly, this invention relates to gas discharge tubes which are positioned within magnetic fields, as well as to circuits utilizing the features of such devices. Still more particularly, this invention relates to magnetically controlled gas discharge tube devices employed for the production of substantially constant currents.

In my copending application, Serial No. 271,579, filed of even date, there is shown and described one form of gas discharge tube device which is arranged for the production of rectified current of substantially constant amplitude to be supplied to a load circuit attached thereto. The control of the rectified current is obtained by applying to the grid electrode of the gas discharge device a voltage which varies in accordance with changes in impedance in the attached load circuit. The load circuit may, for example, be any one of a plurality of different telephone loop circuits having widely varying impedances, but the direct current supplied to all of these loop circuits will be substantially the same.

The present application discloses a gas-filled tube which, however, does not act as a rectifier of alternating current. The electrodes of the tube are surrounded by an annular electromagnet having its axis concentric with that of the tube. The electromagnet is supplied with current which is the same as that supplied to the attached load circuit. The magnetic field acts to maintain the current flow through the circuit substantially constant and practically independent of variations in the impedance of the load circuit.

One of the objects of this invention is, therefore, to obtain a substantially constant direct current from a gas tube circuit connected to a source of potential supplying direct current to a load circuit of varying impedance. This is accomplished by surrounding the tube with an electromagnet through the winding of which flows the current to be controlled.

This object as well as further features of this invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing, in which Figure 1 represents one embodiment of the invention given merely for the purpose of illustration, and Fig. 2 illustrates in perspective a portion of the electromagnetically controlled gas discharge tube which is an essential part of this invention.

Referring to Fig. 1 of the drawing, the reference character V designates a gas discharge tube comprising a plate or anode P, two grid electrodes G_1 and G_2, a cathode K and a heater H. The heater H is supplied with the necessary heating current by means of a battery B_1. The grid G_1 is maintained at a positive potential with respect to the cathode K by means of a battery B_2, the circuit interconnecting the grid G_1 with the cathode K including, in addition to the battery B_2, a meter M_1. The grid electrode G_2 of the tube V is also maintained at a positive potential with respect to the cathode K by means of a battery B_3, the grid electrode G_2 being connected to the cathode by a circuit including a meter M_2 in addition to the battery B_3. The anode P of the tube V is connected to the cathode K by means of a circuit including a coil L, a load circuit or resistor R_1, a meter M_3 and a battery B_4, all arranged in series relationship. A resistor R_2 may, if desired, be connected in shunt with the coil L.

The coil L is represented schematically in Fig. 1 immediately above the gas tube V, but this coil may be wound in the form of a toroid or doughnut about the envelope enclosing the electrodes of the tube. The axis of the coil will coincide with the vertical axis of the tube. The coil L is shown in Fig. 2 positioned about the envelope of the tube V, but cut away in part so as to illustrate that it is located closely adjacent to the envelope of the tube and about its electrodes, the axis of the coil being coincident with the vertical axis of tube V.

The resistor R_1 of Fig. 1 may be any device or circuit having an impedance which may vary from zero or from some negligible value to a very large value. A telephone loop circuit is one suitable form of impedance device, such a circuit or device being shown and described in the copending application above referred to. The object of the invention is, in the circuit arrangement of the copending application, to provide an apparatus for producing direct current of substantially constant magnitude which may be utilized, for example, for supplying telephone loop circuits with direct current required for telephone purposes, a constant direct current being essential for efficient telephone communication.

The gas discharge tube V may be, for example, of the RK–100 type, but other gas tube structures having coacting magnetic fields may be employed in the practice of this invention to obtain a substantially constant direct current under varying conditions of load. The coil L may be composed of a plurality of turns of copper

wire of smaller diameter, if desired, thereby dispensing with the use of any shunt resistor such as R_2.

In one installation in which the circuit of Fig. 1 was employed the batteries B_2, B_3 and B_4 had terminal voltages of approximately 13, 3 and 330 volts, respectively. The coil L, which was positioned coaxially about the envelope of the tube V and in proximity to the enclosed electrodes, was composed of approximately 13,200 turns of small gauge copper wire having a resistance of approximately 2,524 ohms. The coil L was about two inches long, and had an external diameter of 3⅜ inches and an internal diameter of 2⅛ inches. The shunting resistor R_2 was of approximately 818 ohms. The current as measured by the meter M_1 was about 50 milliamperes. The current flowing through the meter M_2 varied in accordance with the resistance in the load device R_1. As the load device R_1 was changed from a zero resistance to a value of approximately 1,600 ohms, the anode current as measured by the meter M_3 varied from between 43 to 50 milliamperes. The current flowing in the circuit of the grid G_2, as measured by meter M_2, varied between 150 and 350 milliamperes.

The extremely small variation of anode current above noted, with wide variations in the load impedance R_1, is of considerable importance in telephone installations where it is desired to obtain a highly constant direct current. As already stated, the circuit may be connected, for example, to any one of a plurality of telephone loop circuits of considerably different impedances without introducing any substantial change in the current flow therethrough.

It will be understood that the tube referred to and the constants of the various circuit elements have been given merely for the purpose of illustration. They are not to be construed as limitations upon the invention. It will be understood also that if a larger current is required for use in the load circuit device R_1 (or in apparatus or circuits attached thereto), the increased current may be obtained by employing a coil L of lower resistance and otherwise proportioning it to give optimum effects.

The maintenance of a substantially constant flow of direct current in the anode circuit was attested by the observations already referred to hereinabove. The control of the constancy of the current by the location and geometry of the electromagnet coil L was also determined from the fact that as the coil L was moved further and further away from the envelope of the tube V, the anode current variations were substantially wider, and hence lacked the constancy required for telephone uses. Such currents are of practically no utility for the purposes specified.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. Apparatus for supplying substantially constant direct current to a device having an impedance which may be varied over a large range, comprising a gas discharge tube including an anode, a cathode and two grid electrodes, a toroidal electromagnetic coil in close proximity to but outside the envelope of the tube and having its axis coincident with the axis of the envelope, said coil impressing a magnetic field upon all of the electrodes of the tube, a source of voltage connected in series with the coil and the anode and cathode electrodes of the tube as well as with said device, and means for applying predetermined positive voltages to said grid electrodes with respect to said cathode.

2. The combination of a gas discharge tube having a plurality of electrodes including an anode, two grid electrodes, and a cathode, a source of potential, a variable impedance device, means for continuously applying predetermined positive potentials to said grid electrodes, means for transmitting substantially constant direct current from said source through the anode and cathode path of said tube and through said impedance device, said latter means comprising a toroidal electromagnet the axis of which coincides with the axis of the tube, said electromagnet being positioned in close proximity to but outside the envelope of the tube, the coil of said electromagnet being connected between said source and said device, the magnetic component of said electromagnet being coaxial with the axis of the tube.

JAMES FERGUSON ROUGVIE.