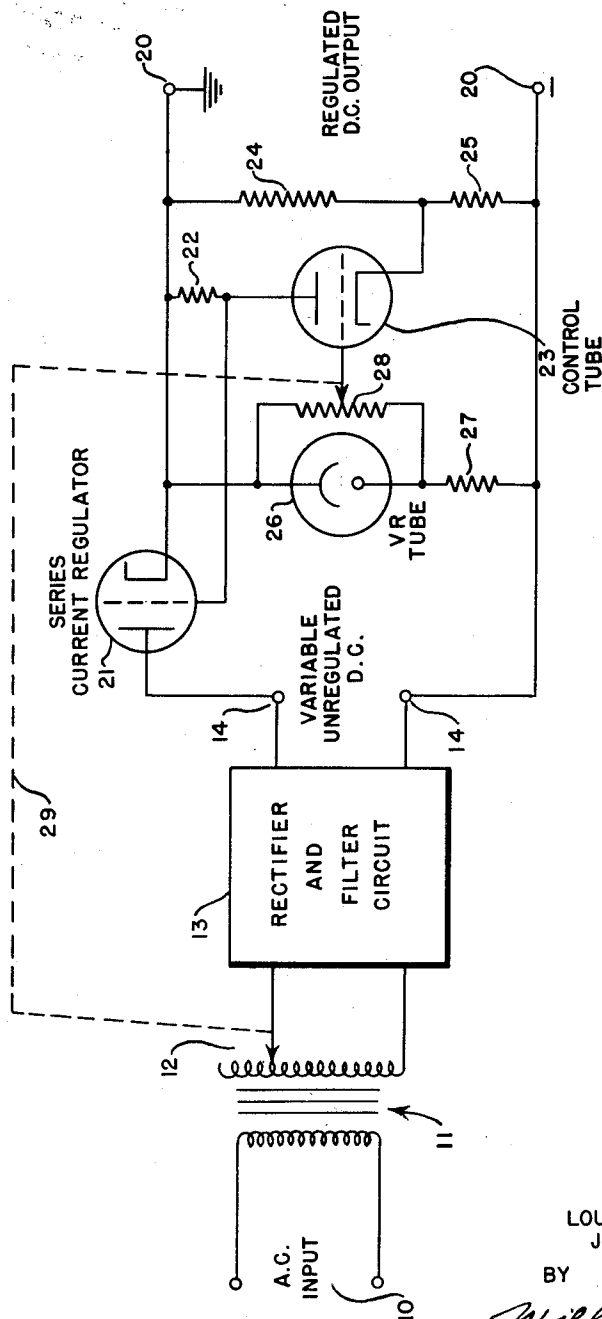


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VOLTAGE REGULATOR CIRCUIT

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VOLTAGE REGULATOR CIRCUIT

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2 Claims. (Cl. 321-19)

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The invention described in the specification and claims may be manufactured and used by and for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention relates to electrical apparatus in general and more particularly to improvements in voltage regulator circuits of the vacuum tube type. This application is a continuation-in-part of application Serial No. 648,537, filed February 18, 1946, which has been abandoned.

Vacuum tube voltage regulator circuits are used where a substantially constant voltage output is required. One well known type of voltage regulator circuit is the so-called "regenerative circuit."

In the so-called regenerative voltage regulator, a current-regulating vacuum tube, which serves as a variable impedance, is placed in series with the line from an unregulated power supply to a load. The tube used may be any type having sufficient current carrying capacity. If necessary, a plurality of tubes may be used in parallel. The grid-to-cathode voltage of the current-regulating vacuum tube is controlled by a control tube. The grid-to-cathode voltage of this control tube in turn depends on the output voltage of the regulator.

This regenerative circuit will not only compensate for changes in the line voltage, but will also compensate for changes in the load, and will tend to maintain a constant D. C. output voltage across the load. However, this circuit is not suitable where regulation over a wide range of different output voltages is required.

An important object of the present invention is the design of a variable output voltage regulator circuit, in which the voltage regulation is maintained over a wide range of output voltages. Other objects and advantages of the invention will be apparent during the course of the following description.

The present invention utilizes a potentiometer to vary the grid-to-cathode voltage of a control tube with the potentiometer ganged to an adjustable tap on a power input transformer. While the following description pertains to a regenerative type of voltage regulator circuit, the invention is not limited thereto.

The single figure of the accompanying drawing shows a simplified schematic diagram of a regenerative type of voltage regulator circuit which illustrates one possible embodiment of the present invention.

Referring to the figure, numeral 10 designates

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an A. C. input line. Power transformer 11 has a secondary winding 12, which has an adjustable contact to obtain a variable secondary output voltage. The secondary winding 12 furnishes a variable A. C. voltage to a rectifier and filter circuit 13. The output of the rectifier and filter circuit 13 is a variable unregulated D. C. voltage appearing at input terminals 14.

The remainder of the circuit is the voltage regulator proper.

Frequently, high voltage circuits require the positive voltage lead grounded and the negative voltage lead ungrounded. In the hereinafter described circuit the output of the voltage regulator is a variable regulated D. C. output voltage with a grounded positive voltage lead appearing at output terminals 20.

The invention, of course, may be applied as well to the regulation of power supplies where the negative output voltage lead is grounded.

A current-regulating vacuum tube 21 is placed in the line between the rectifier output and the load. This tube is shown as a triode, but any tube having the proper current carrying capacity may be used. The grid-to-cathode potential of tube 21 is determined by the voltage drop across anode resistor 22 in the anode circuit of a control tube 23.

The cathode potential of control tube 23 is obtained from a voltage divider consisting of resistors 24 and 25 which is connected across the output voltage. The cathode voltage of control tube 23 accordingly will be a function of the D. C. output voltage.

A substantially constant potential with respect to ground is obtained at the cathode of voltage regulator tube 26, which, with its series resistor 27, is placed across the D. C. output voltage. The potential at the grid of control tube 23 is obtained from a potentiometer 28, which is in parallel with voltage regulator tube 26. This grid voltage will be fairly constant despite variations in the D. C. output voltage. The adjustable contact of secondary winding 12 and the movable contact of potentiometer 28 are ganged together by means of connection 29.

The regulating action of the voltage regulator circuit shown in the figure will now be explained. The explanation will take the form of first explaining how regulation is accomplished with a fixed setting of the contact on secondary winding 12 for:

a. Variation of the A. C. input voltage.

b. Variation of the load resistance across the output terminals 20.

Suppose a surge in the A. C. input line 10 increases the regulated output voltage. This will then make the cathode of control tube 23 more negative, thereby increasing the current through control tube 23 and increasing the voltage drop across the anode resistor 22. The increased voltage across resistor 22 will increase the negative grid bias of current-regulating tube 21 thereby increasing the voltage drop across tube 21. The increased voltage drop across the current-regulating tube 21 will decrease the regulated output voltage. This regulating action tends to maintain the D. C. output voltage substantially constant.

Suppose the load across the regulator output decreases. A decrease in the load resistance will tend to cause a decrease in the output voltage. A decrease in the output voltage will make the cathode of control tube 23 more positive, decreasing the current through tube 23 and decreasing the voltage drop across anode resistor 22. A decreased voltage across anode resistor 22 decreases the negative grid bias of current-regulating tube 21, thereby decreasing the voltage drop across tube 21 and increasing the output voltage. This regulating action tends to maintain the D. C. output voltage substantially constant.

It is necessary to also investigate the change in voltage regulation caused by adjustment of the contact on secondary winding 12. This adjustment would in itself be accompanied by a variation of the D. C. output voltage and by a diminished regulating action of the circuit. The regulating action of the circuit is maintained over a wide range of D. C. output voltages by potentiometer 28 which is ganged with the contact on transformer secondary winding 12. Suppose that the contact setting on secondary winding 12 is increased, resulting in an increased output voltage, and, because of the ganged potentiometer 28, in a decreased positive grid potential for control tube 23. The increased output voltage also causes the cathode potential of control tube 23 to become more negative. Hence, the negative grid bias of control tube 23 tends to remain constant and consequently the regulating action of control tube 23 and current regulating tube 21 is maintained over a wide range of input and output voltages.

Despite the simplified form in which this circuit has been presented, it is obvious that the applications of this voltage regulator circuit are many. The current-regulating tube 21 may be a bank of tubes in parallel to assure the necessary current rating. A group of voltage regulator tubes in series may be substituted for the single tube shown if necessary to attain the proper grid voltage for control tube 23.

It will be apparent that there may be deviations from the invention as described which still fall fairly within the spirit and scope of the invention.

What is claimed is:

1. A power supply comprising first and second input terminals; a source of unregulated direct current voltage having the positive potential side thereof connected to said first input terminal and the negative potential side thereof connected to said second input terminal; voltage-control means coupled to said source for altering the magnitude of said unregulated voltage; a current regulator electron tube having at least a cathode, an anode and a control electrode; first and second output terminals adapted to have a load connected thereacross; means connecting said first input terminal to said first output terminal through the anode-cathode path of said current regulator tube; means connecting said second input terminal to said second output terminal; a control tube having at least a cathode, an anode and a control electrode; means for applying a fixed proportion of the voltage appearing across said output terminals to the cathode of said control tube; means shunting said output terminals for obtaining a point of potential having a fixed negative magnitude relative to the potential at said first output terminal; a potentiometer connected between said point of potential and said first output terminal; means for applying the potential at the movable tap of said potentiometer to the control electrode of said control tube; a resistor connecting the anode of said control tube to a point having a positive potential relative to the cathode thereof; means for applying the potential at the anode of said control tube to the control electrode of said current regulator tube; and means ganging the movable tap of said potentiometer and said voltage control means to alter the magnitude of the voltage between the movable tap of said potentiometer and said first output terminal in the same direction as the magnitude of said unregulated voltage.

2. The power supply defined in claim 1, wherein said means for obtaining said point of potential includes a gaseous discharge tube having its anode connected to said first output terminal, and a resistor connected between the cathode of said gas discharge tube and said second output terminal, said point of potential being at the junction of the cathode of said gaseous discharge device and said last-named resistor.

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