

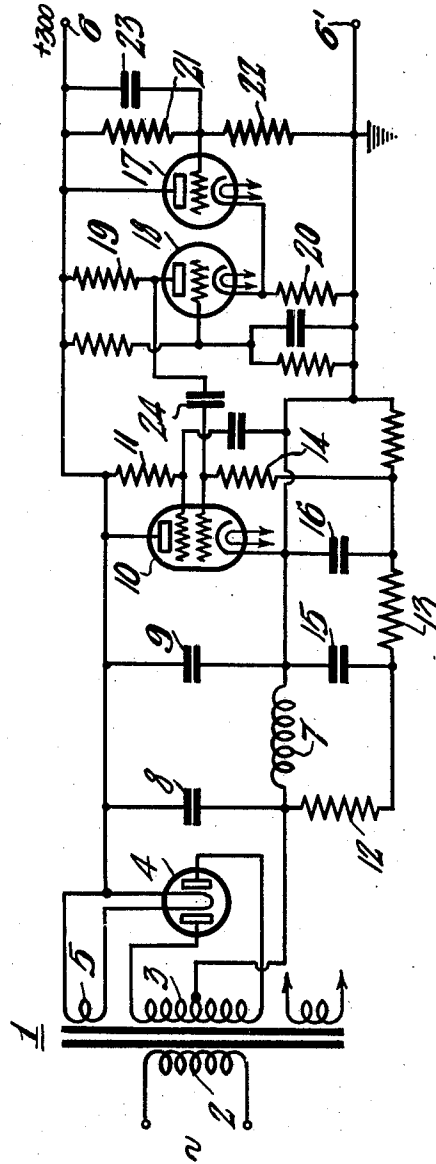
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VOLTAGE REGULATOR CIRCUIT

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VOLTAGE REGULATOR CIRCUIT

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This invention pertains generally to regulated power supply circuits and more particularly to a voltage regulator for a source of rectified and filtered alternating potential wherein the regulator provides a power source having substantially constant output voltage and a low output impedance.

Various types of voltage regulators have been used heretofore in conjunction with conventional power supply circuits for thermionic tube apparatus. Besides regulating the output voltage of a power supply within predetermined small limits, one of the prime requisites of a voltage regulator is to provide a power source having extremely low output impedance in order that variations in load or source impedances may have minimum effect upon the regulated output voltage.

The instant invention is an improvement over the invention described in the copending U. S. application of W. J. Poch, Ser. No. 515,038, filed December 20, 1943, and assigned to the same assignee as the instant application. It contemplates the use of a thermionic regulator tube having an anode, a cathode and at least one control electrode wherein the anode-cathode circuit of the tube provides a shunt impedance path across the output of a filter which is connected to the output of a conventional high voltage rectifier. A voltage divider, comprising a pair of serially-connected resistors, one of which is shunted by a capacitor, is also connected across the output of the filtered power supply. The anode of a first thermionic tube amplifier is connected directly to the positive output terminal of the filtered power supply. The anode of a second triode amplifier tube is also connected to the positive terminal of the filtered power supply through an anode coupling resistor. The cathodes of the two amplifier tubes are connected together and are connected, through a common cathode resistor, to the negative terminal of the filtered power supply. The anode of the second amplifier tube is connected through, for example, a one microfarad capacitor to the control electrode of the thermionic regulator tube.

Briefly, the operation of the system is as follows: The regulator tube provides a shunt impedance path across the output of the filtered power supply. A portion of the regulated output voltage degeneratively controls the first amplifier tube which is cathode coupled to the second amplifier tube. Suitable phase reversal is provided thereby for applying regulating voltages to the control electrode of the thermionic regulator tube, thereby varying the impedance of the regu-

lator tube and the shunt impedance path across the filtered power supply.

It will be seen that the circuit will compensate readily for substantially all except very gradual line surges, for residual hum and for fluctuations caused by all except very gradual variations in source and load impedances. Since the output voltage will remain substantially constant, notwithstanding variations in applied voltage and in load impedances, the effective output impedance of the circuit will be extremely low. The use of large capacitors across the output of the regulated voltage source therefore becomes unnecessary, resulting in considerable economy in space and cost.

Among the objects of the invention are to provide an improved voltage regulator for a source of uni-directional voltage. A further object is to provide an improved voltage regulator having a relatively small static current drain. Another object of the invention is to provide an improved voltage regulator for a uni-directional voltage source wherein a portion of the output regulated voltage is degeneratively applied to an amplifier which is connected to vary the shunt impedance of a regulator tube connected across the uni-directional voltage source. A further object of the invention is to provide an improved regulator circuit for controlling the output voltage of a filtered power supply circuit wherein a portion of the regulated output voltage is degeneratively applied to a first amplifier tube, and the output of the first amplifier tube is cathode-coupled to a second amplifier tube to provide control potentials which are applied to the control electrode of a thermionic regulator tube connected across the output of the filtered power supply. Another object of the invention is to provide an improved voltage regulator for a source of uni-directional potential wherein maximum voltage regulation and a low power supply output impedance are provided. A further object of the invention is to provide an improved voltage regulator for a source of uni-directional potential wherein substantially constant output voltage and relatively low power supply output impedance are accomplished without the necessity of employing relatively large capacitors across the output of the voltage regulator.

The invention will be described in further detail by reference to the accompanying drawing of which the single figure thereof is a schematic circuit diagram of a preferred embodiment.

Referring to the drawing, the circuit includes a conventional filtered high voltage power sup-

ply which comprises a power transformer 1 having a primary winding 2 connected to a source of alternating potential. The terminals of the high voltage secondary winding 3 are connected to the anodes of a full wave rectifier tube 4. A cathode of the full wave rectifier tube 4 is connected to a low voltage secondary winding 5 of the transformer 1. The cathode of the rectifier tube 4 is also connected to the positive output terminal 6. The center tap of the high voltage secondary winding of the transformer 1 is connected, through a relatively high reactance coil 7, to the grounded negative output terminal 6'. A first filter capacitor 8 is connected between the cathode of the rectifier tube 4 and the center tap of the high voltage secondary winding 3 of the transformer 1. A second filter condenser 9 is connected from the cathode of the rectifier tube 4 to the grounded output terminal of the reactance coil 7.

The anode of a thermionic regulator tube 10 is connected to the cathode of the rectifier tube 4. The anode is also connected through a screen coupling resistor 11 to the screen electrode of the regulator tube 10. The cathode of the regulator tube 10 is connected to the grounded terminal of the filtered power supply circuit. Suitable negative bias potential for the control electrode of the thermionic regulator tube 10 is applied thereto through the series resistors 12, 13, 14, which are connected to the center tap of the high voltage secondary winding 3 of the transformer 1. Additional filtering of this bias potential is provided by third and fourth filter capacitors 15, 16, connected respectively between the junctions of the series resistors 12, 13, and 14 and the grounded terminal of the power supply circuit.

The anode of a first amplifier tube 17 is connected to the positive output terminal 6 and to the cathode of the rectifier tube 4. The anode of a second amplifier tube 18 is connected, through an anode coupling resistor 19, to the cathode of the rectifier tube 4. The cathodes of the first and second amplifier tubes 17, 18 respectively, are connected together, and are connected, through a common cathode resistor 20, to the grounded negative terminal 6' of the power supply. A voltage divider, comprising a pair of serially connected resistors 21, 22, is connected between the output terminals 6 and 6'. A capacitor 23 is connected across the first series resistor 21. The junction of the series resistors 21, 22 is connected to the control electrode of the first amplifier tube 17.

It will be seen that variations in the output voltage applied to the output terminals 6, 6' will be applied degeneratively to drive the first amplifier tube 17. The output of the first amplifier tube 17 is cathode coupled to the second amplifier tube 18 to provide properly phased control potentials at the anode of the second amplifier tube 18 which are applied through a coupling capacitor 24 to the control electrode of the thermionic regulator tube 10.

It should be understood that various modifications of the amplifier circuit disclosed herein may be employed for degeneratively utilizing a portion of the regulated output voltage to control the impedance of the thermionic regulator tube which is connected across the output of the filtered power supply.

Thus the invention disclosed comprises an improved voltage regulator circuit for a source of uni-directional potential wherein a portion of the

regulated output voltage is coupled degeneratively to a control electrode of a thermionic regulator tube comprising a shunt impedance path across the output of the source of uni-directional potential. The resultant circuit provides substantially constant output potential at an effectively low power supply output impedance.

I claim as my invention:

1. A voltage regulator for a source of direct voltage including a thermionic regulator tube having a cathode, an anode and at least one control electrode, means connecting the anode-cathode circuit of said tube across said voltage source, a pair of thermionic amplifier tubes having a common cathode circuit, means connecting the anode-cathode circuits of said amplifier tubes across said voltage source, means including said source for degeneratively controlling one of said amplifier tubes, capacitive means coupling said one amplifier tube to the other of said amplifier tubes, and means coupling said other of said amplifier tubes to a control electrode of said regulator tube for varying the shunt impedance of said regulator tube across said voltage source.

2. A voltage regulator for a source of uni-directional voltage including a thermionic regulator tube having a cathode, an anode and at least one control electrode, means including said tube providing a shunt impedance path across said source, a pair of cascaded amplifier tubes each having a cathode, an anode, at least one control electrode and a common cathode resistor, means for degeneratively applying at least a portion of said voltage to said control electrode of the first of said cascaded amplifier tubes, capacitive means coupling said anode of said first amplifier tube to a control electrode of the second of said amplifier tubes, means for deriving a control potential from said second of said amplifier tubes, and means for applying said control potential to said regulator tube to vary said shunt impedance in response to variations in said uni-directional voltage.

3. A voltage regulator for a source of direct voltage including a thermionic regulator tube having a cathode, an anode and at least one control electrode, means including said tube providing a shunt impedance path across said voltage source, a pair of cascaded thermionic amplifier tubes having a common cathode circuit, means connecting said amplifier tubes across said source, means for degeneratively applying at least a portion of said voltage to one of said amplifier tubes, capacitive means coupling said one amplifier tube to the other of said amplifier tubes, means for deriving a control potential from said other of said amplifier tubes, and means for applying said control potential to said regulator tube to vary said shunt impedance in response to variations in said direct voltage.

4. A voltage regulator for a source of uni-directional voltage including a thermionic regulator tube having a cathode, an anode and at least one control electrode, means including said tube providing a shunt impedance path across said source, a pair of cascaded amplifier tubes each having a cathode, an anode, at least one control electrode and a common cathode resistor, means for degeneratively applying at least a portion of said voltage to said control electrode of the first of said cascaded amplifier tubes, capacitive means coupling said anode of said first amplifier tube to a control electrode of the second of said amplifier tubes, means for deriving a control potential from said second of said amplifier tubes, and

means for applying said control potential to said control electrode of said regulator tube to vary said shunt impedance in response to variations in said unidirectional voltage.

5. A voltage regulator for a source of unidirectional voltage including a thermionic regulator tube having a cathode, an anode and at least one control electrode, means including said tube providing a shunt impedance path across said source, a pair of cascaded amplifier tubes each having a cathode, an anode, at least one control electrode and a common cathode resistor, means including a capacitor and a resistive network for degeneratively applying at least a portion of said voltage to said control electrode of the first of said cascaded amplifier tubes, capacitive means coupling said anode of said first amplifier tube to a control electrode of the second of said amplifier tubes, means for deriving a control potential from said second of said amplifier tubes, and means for applying said control potential to said control electrode of said regulator tube to vary said shunt impedance in response to variations in said unidirectional voltage.

6. A voltage regulator for a source of unidirectional voltage including a thermionic regulator tube having a cathode, an anode and at least one control electrode, means including said tube providing a shunt impedance path across said source, a pair of cascaded amplifier tubes each having a cathode, an anode, at least one control electrode and a common cathode resistor, means including a capacitor and a resistive network for degeneratively applying at least a portion of said voltage to said control electrode of the first of said cascaded amplifier tubes, capacitive means coupling said anode of said first amplifier tube to a control electrode of the second of said amplifier tubes, means for deriving a control potential from said second of said amplifier tubes, and capacitive means for applying said control potential to said control electrode of said regulator tube to vary said shunt impedance in response to variations in said unidirectional voltage.

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