

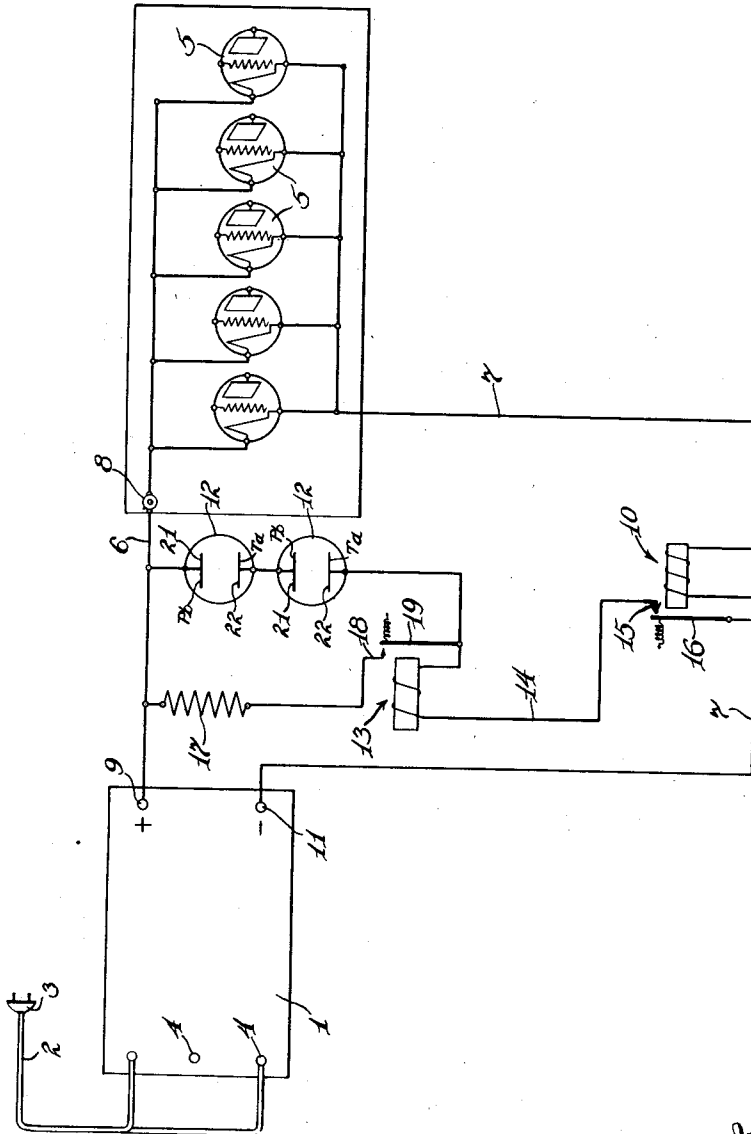
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VOLTAGE REGULATOR

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UNITED STATES PATENT OFFICE.

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VOLTAGE REGULATOR.

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Our invention relates to voltage regulators. More particularly it relates to devices of this character which are especially adapted to be used to regulate the voltage of the current supply to the filaments of vacuum tubes of radio receiving sets. However, in their broader aspects, some of the features of our invention are capable of application in related arts.

10 An object of our invention is to provide improved means for regulating the voltage of the current supply to the tube filaments of radio receivers.

15 A further object is to provide an improved voltage regulator which is effectively sensitive in operation and which is operative over a comparatively wide range of voltages.

Other objects will appear from the following description, reference being had to the accompanying drawing which shows a circuit diagram of our improved voltage regulator.

In the drawing the current supply unit 1, such as the A battery eliminator, may be connected to a suitable source of alternating current by the cord 2 which carries connecting plug 3. A plurality of terminals 4 may be provided on the current supply unit to permit connection to alternating current lines of different voltages. The tubes 5 are connected in parallel to the conductors 6 and 7. The tubes may be turned "on" and "off" by a suitable switch 8 in the conductor 6, this switch forming a customary part of the receiving set. The vacuum tubes 5, as is usual, are mounted in suitable sockets from which they may be readily removed. The conductor 6 is directly connected to the direct current positive terminal 9 of the supply unit, while the conductor 7 is connected to the winding of an electro-magnetic relay 10, the other end of this winding being connected to the negative terminal 11 of the current supply unit. A plurality of electrolytic valve cells 12 are connected in series between the conductor 6 and the winding of a relay 13. This winding is connected by a conductor 14 to the fixed contact 15 of the relay 10 and the energization of the latter relay is adapted to complete an electrical circuit through the armature 16 of the relay 10 to the conductor 7. Upon the energization of the relay 13 a circuit in parallel with the valve cells 12 is completed from the conductor 6 through the resistance 17, to the fixed contact 18 and through the armature

19 of the relay 13. The electrolytic valve cells 12 each comprise a lead electrode 21 and a tantalum electrode 22 which are immersed in a dilute solution of sulphuric acid and iron sulphate.

For the purpose of aiding in the explanation of the operation and in furtherance of a complete understanding of our invention, the numerical values of the resistances, etc. which have been found practical for the certain conditions of operation will be herein given, although it is to be clearly understood that such values are merely illustrative and that the embodiment of the invention is not limited to these values, but they may be varied to suit individual requirements.

The current supply unit for the purposes of illustration, may be considered to have an open circuit voltage of 15 volts, which is to be regulated so that a potential difference of 6 volts will be maintained at the tube filaments, or, practically speaking, at the "A battery" terminals of the receiving set. The relay 13 is adjusted so as to actuate its armature upon a current of 0.32 amperes and the relay 10 to operate on 0.25 amperes, the resistance 17 being about 5.5 ohms. Assuming that all the tubes 5 are being used, upon turning the switch 8 "on" a current of considerably more than 0.32 amperes will flow through the relay of the winding 10. Thus, the electrolytic valve cells 12 will be connected in parallel with the vacuum tubes through the armature 16, fixed contact 15, conductor 14 and winding 13. The cells 12 have the peculiar characteristic that for certain potential differences on their electrodes they act as a high resistance, but that the resistance suddenly decreases upon a very slight increase of potential difference above the critical voltage.

Since a single tube will transmit 0.25 amperes at its normal potential difference of 5 volts, the relay 10 will operate as soon as the switch 8 is closed and the armature 16 will maintain the circuit through the valve cells 12 as long as one or more of the tubes 5 are connected across the conductors 6 and 7. When less than the full number of tubes are in use, the direct current voltage of the current supply unit would be very high due to the transformer characteristics of the unit. However, as soon as the relay 10 operates, the additional current path through the cells 12 is placed in parallel with the tube or tubes,

and the voltage between the conductors 6 and 7 will drop correspondingly.

When, for example, the switch 8 is closed with all of the tubes in use, the relay 10 will operate to close the parallel circuit through the valve cells, but the current flowing through the cells will be very small and insufficient to operate the relay 13. If one of the tubes 5 is then removed from its socket, the current through the valve cells will increase slightly due to a small rise in voltage between the terminals 9 and 11, but will still be insufficient to operate the relay 13. However, when all but two of the tubes have been removed the current through the cells will be sufficient so that the relay 13 will operate to bridge the resistance 17 around the cells 12, thus providing an additional path for the current and prevent a rise in the filament voltage. This condition will remain if four tubes are removed, the only difference being that more current will flow through the valve cells and the resistance 17 to compensate for the removal of the additional tube. If all of the tubes are removed, the relay 10 and consequently relay 13, will, of course, be deenergized and will open the bridged regulating circuits.

If, after all but two of the tubes have been removed from the circuit, one or more tubes are reinserted, the voltage at the tubes will drop slightly due to the fact that the relay 13 will not be deenergized and the resistance 17 will remain in parallel with the tubes. To remedy this condition, it is merely necessary for the operator to turn the switch 8 "off" for an instant and then turn it "on" again. This will permit the deenergization of relay 13 and leave only the valve cells in the regulating circuit.

The operation of the switch 8 opening the circuit to the tube filaments will cause the relays 10 and 13 to return to their non-operated position and prevent the flow of current through the regulating circuit. The current used by the current supply unit when the switch 8 is "off" is only the very small core loss of the transformer in the current supply unit.

The invention is capable of variation and adaptation for use in different embodiments without departure from the principles of the invention. We do not restrict ourselves in any unessential particulars, but what we claim and desire to secure by Letters Patent is:

1. In a device of the class described in combination, a source of "A" current, a plurality of thermionic tube filaments, connections between said source and said filaments, a voltage regulating circuit comprising a valve cell, a resistance, means to connect said cell in parallel with said filaments upon the passage of current through one or more of said filaments, and means for connecting said

resistance in parallel with said valve cell upon the passage of a predetermined current through said valve cell.

2. In a device for regulating the filament voltage of a radio receiving set, the combination of a source of "A" current, thermionic tube filaments, means for connecting said source to said filaments, a plurality of electrolytic valve cells arranged to be connected in parallel with said tube filaments upon the passage of a predetermined current through one or more of said filaments, a resistance, and means operative upon the passage through said cells of a current of a predetermined value to connect the resistance in parallel with said valve cells.

3. In an "A" current supply system for radio receivers, the combination of a source of direct current, a plurality of thermionic tube filaments, connections between said filaments and said source, a plurality of electrolytic valve cells, a relay operable to connect said valve cells in parallel with said filaments when said filaments are being supplied with current, and a resistance arranged to be connected in parallel with said valve cells and means actuated by the passage of a current of predetermined value through said cells for connecting said resistance in parallel thereto.

4. In an "A" current supply system for radio receivers, the combination of an "A" battery eliminator, thermionic tube filaments connected so as to be heated by current from said eliminator, a series of electrolytic valve cells, means for connecting said valve cells in parallel with said filaments upon the flow of current through said filaments, and means operative upon the flow of a predetermined current through said valve cells for connecting a resistance in parallel with said valve cells.

5. In a filament voltage regulator for radio receivers, a source of direct current, thermionic tube filaments, connections between said source and said filament, electrolytic valve cells, means for connecting said cells in parallel with said filaments, a resistance, and means operative upon the flow of current of a predetermined value through said cells for connecting said resistance in parallel with said cells.

6. In a filament current voltage regulating device for radio receivers, the combination of an "A" battery eliminator, a plurality of vacuum tubes, filaments in said tubes, connection between said filaments and said eliminator, a plurality of electrolytic valve cells arranged to be connected in parallel with said filaments, a resistance, and means operative upon the passage of a current of predetermined value through said valve cells for connecting a resistance in parallel with said cells.

7. In combination a source of direct current, variable load terminals, connections be-

- tween said source and said terminals, a circuit including an electrolytic cell arranged to be bridged across said terminals, means actuated by load current for closing said circuit, a circuit including a resistance arranged to be bridged across said electrolytic cell, and means actuated by current flowing through said cell for closing said second circuit.
8. In combination conductors connecting a source of direct current to variable load terminals, a circuit including a tantalum-sulphuric-acid electrolytic cell arranged to be bridged across said conductors, means actuated by load current for closing said circuit, a circuit including a resistance arranged to be bridged across said electrolytic cell, and means actuated by current flowing through said cell for closing said second circuit.
- In witness whereof, we hereunto subscribe our names this 4th day of September, 1926.

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