

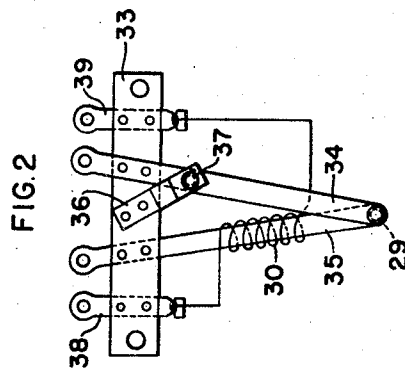
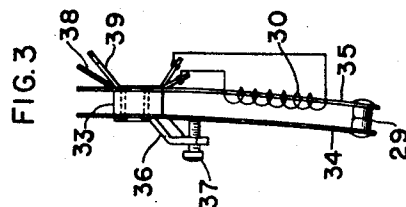
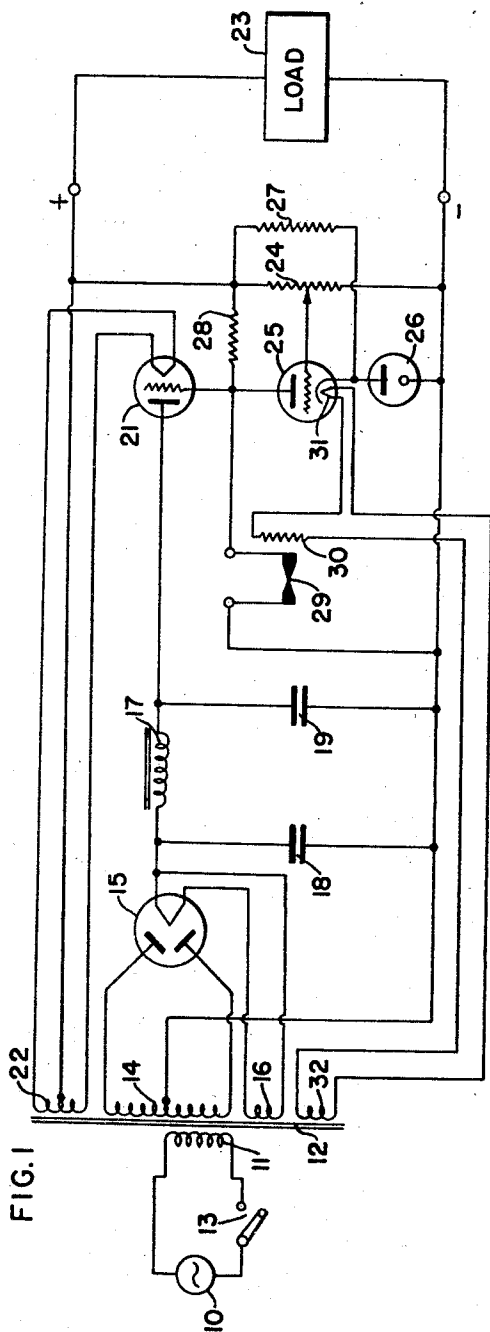
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PROTECTIVE APPARATUS

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PROTECTIVE APPARATUS

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This invention relates to voltage regulating apparatus and particularly to such apparatus employing thermionic tubes.

According to conventional practice, where a power supply is required to be maintained at a substantially constant voltage, a voltage regulator employing one or more thermionic tubes frequently is used. In one such an arrangement there is provided a rheostat tube having its output circuit connected in series with one of the conductors furnishing the voltage to be regulated. Another tube is employed for controlling the rheostat tube and is connected so that its input circuit responds to deviations of the voltage from the desired constant value. The control is effected by subjecting the input circuit of the rheostat tube to voltage variations occurring in the output circuit of the control tube as it responds to the deviations of the voltage to be regulated.

As is well understood in the art, however, it often is necessary to employ as the rheostat tube one which is capable of a substantial power output. There is available a type of tube having such a qualification, which is equipped with a filamentary or directly heated cathode. A tube suited to the usual design of such apparatus for use as a control tube is equipped with an indirectly heated cathode. Consequently, the rheostat tube is conditioned for operation substantially immediately upon the application of power thereto. However, this is not true of the control tube which requires some time to be operatively conditioned by reason of its indirectly heated cathode. Also, if during the operation of the voltage regulator the heater circuit of the control tube fails for any reason, this tube is rendered inoperative. Thus, during inoperative periods of the control tube there is no regulating action effected by the rheostat tube as the bias voltage on its grid will be zero. Consequently, the voltage which is supplied to the load circuit is permitted to increase considerably over the value at which it is desired to maintain this voltage constant. For certain types of loads, such an excessive voltage may cause damage to some of the apparatus.

An object of the present invention, therefore, is to provide means for maintaining the impedance of a rheostat tube employed in a voltage regulator at a value whereby the voltage is pre-

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vented from exceeding a predetermined value during inoperative periods of a tube used for controlling said rheostat tube.

Another object of the invention is to provide, in a voltage regulator, a thermal responsive device for controlling the regulating effectiveness of a rheostat tube during periods when a tube used for controlling the rheostat tube is inoperative.

A further object of the invention is to provide a novel thermally controlled contact embodying means for effecting a compensation for ambient temperature changes.

In accordance with the present invention, there is provided a direct current power supply and thermionic apparatus for regulating the voltage thereof. This apparatus includes a rheostat tube connected to the power supply and provided with an input circuit for controlling the regulating effectiveness thereof. In order to prevent the voltage from exceeding a predetermined value, there is provided means for applying to the grid circuit of the rheostat tube, a self-bias potential. The apparatus also includes a control means which is adapted to be operatively conditioned to subject the grid circuit of the rheostat tube to a control potential for maintaining the voltage at a substantially constant value. There also is provided a means operable during periods of operation of the control means for rendering inoperative the means by which the bias potential is applied to the input circuit of the rheostat tube.

In the illustrated embodiment of the invention, the bias potential is applied to the grid circuit of the rheostat tube by a circuit which includes a pair of normally closed contacts. The control potential to which the input circuit of the rheostat tube is subjected is controlled by a thermionic control tube having its input circuit connected for response to deviations of the voltage to be controlled from a predetermined value. The rheostat tube is provided with a directly heated cathode and the control tube is equipped with an indirectly heated cathode. By reason of this arrangement the bias potential is applied to the grid circuit of the rheostat tube during periods when the cathode of the control tube is insufficiently heated to render this tube operative. When the control tube is operatively conditioned, a thermal device associated with the heater ele-

ment of the control tube is effective to open the contacts and thereby to render ineffective the bias potential for subsequent control of the rheostat tube.

The thermally controlled contacts are constructed in a manner whereby ambient temperatures are ineffective to control the contacts. In the illustrative embodiment of the invention herein disclosed the contact structure is one in which two similar bimetallic strips, each supporting one of the contacts, are arranged so that the contacts are normally engaged. Ambient temperatures have the same effect on both strips and thus do not affect the engagement of the contacts. A heater element is associated with one contact strip whereby, upon energization thereof, this strip is acted upon differently from the other strip and thus causes the disengagement of the contacts.

For a better understanding of the invention together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing:

Fig. 1 is a circuit diagram of a voltage regulator embodying the instant invention;

Fig. 2 is a front view of a contact structure in accordance with the invention; and

Fig. 3 is a side view of the contact structure.

Referring now more particularly to Fig. 1 of the drawing, there is shown schematically a rectifier for converting alternating current to produce a direct current power supply. The circuit also includes a thermionic voltage regulator for maintaining the voltage of the direct current power supply at a substantially constant value.

Energy from an alternating current source 10 is supplied to the primary winding 11 of a transformer 12 upon the closure of a switch 13. The terminals of a rectifier secondary winding 14 of the transformer are connected to the respective anodes of a full wave rectifier tube 15 which is provided with a filamentary cathode whereby the tube responds immediately to the closure of the switch 13. The cathode of the rectifier tube is connected to a secondary filament winding 16 and to a filter network comprising a series choke coil 17 and two shunt condensers 18 and 19. The circuit from the cathode of the rectifier tube is extended further to the anode of a rheostat tube 21. This tube may be a type 2A3 or its equivalent. Such a tube also is provided with a directly heated filamentary cathode which may be connected to the terminals of a filament secondary winding 22 of the transformer 12. The midpoint of the filament winding is connected to the positive output terminal of the regulated voltage supply. The midpoint of the rectifier winding 14 is connected to the negative output terminal. A load circuit 23 is connected between the positive and negative output terminals.

There also is connected between the positive and negative terminals a relatively high impedance comprising a resistor 24. A thermionic control tube 25 is provided with a control grid which is connected to a point on the resistor 24 whereby the input circuit including the grid and the cathode, which is connected to the negative output terminal through a regulator tube 26, responds to fluctuations of the voltage applied to the output terminals. The cathode of the control tube is also connected through a resistor 27 to the positive output terminal so as to

furnish suitable current for the operation of the regulator tube 26. The anode of the control tube is connected through a load resistor 28 to the positive output terminal. The control tube may be a 6SF5 triode type or its equivalent and is provided with an indirectly heated cathode. The anode of the tube 25 is also connected to the control grid of the rheostat tube 21.

A low impedance connection is made from the negative direct current terminal through a pair of normally closed contacts 29 to the control grid of the rheostat tube 21. This shunt or short circuit around the control tube 25 applies a self-bias potential to the grid of the rheostat tube. One of these contacts is provided with a heater element 30 whereby to effect the opening of the contact upon suitable energization of the heater. The heater element 30 is connected, in series with the heater element 31 for the cathode of the control tube 25, to the terminals of a heater secondary winding 32 of the transformer 12.

Referring now to Figs. 2 and 3, there is shown a contact structure in accordance with the present invention. The contact elements and the auxiliary apparatus therefor are mounted on an insulating block support 33. The contact points 29 are rigidly attached adjacent the ends of extended portions of respective bimetallic strips 34 and 35. Each of these strips is provided at the opposite end thereof with a lug for the connection of an electrical conductor. The strips 34 and 35 are attached at points adjacent the lug ends thereof, to the mounting support 33 at longitudinally spaced points thereof. The two contact strips are identical in form and material and are mounted upon the support 33 so that the extended portions thereof are disposed obliquely to the support, thereby effecting alignment of the contact points.

Each of these strips comprises a unitary structure of two unlike metals having substantially different temperature coefficients of expansion. When mounted in this contact structure they are positioned parallel to each other so that at normal temperatures each is deformed similarly as illustrated in Fig. 3. One contact point is mounted on the convex surface of the strip 34 and the other contact point is mounted on the concave surface of the strip 35. With this arrangement the contact so formed is normally closed as illustrated.

There is mounted on the support 33, between the contact strips 34 and 35, a bracket 36 which is provided adjacent its extended end with a tapped hole into which is threaded a screw 37. This screw is adjusted so as to engage the contact strip 34 and serves to limit the travel of the contact structure in one direction.

The contact strip 35 is provided with the heater winding 30 referred to hereinbefore. The ends of this winding are attached to terminal strips 38 and 39 which are provided with connecting lugs, and are mounted upon the supporting member 33.

The described contact supporting structure operates to compensate for ambient temperature changes by reason of the described arrangement of contact strips of identical material and form. It is seen that any temperature change which has the effect of changing the deformation of one of the contact strips, will similarly affect the other. Consequently, the condition of the contacts 29 at the time of an ambient temperature change is not disturbed. Such a compensating feature is necessary where the device is to be used in connection with apparatus which is inclosed in

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such a manner that the temperature of the air within the inclosure varies considerably due to the use of apparatus which must dissipate considerable heat. However, when the heater winding 30 is energized the strip 35 alone is subjected to the heating effect. Consequently, this strip will be deformed to a greater extent than the contact strip 34, whereby the contact points will be disengaged, and thus open the contact 29.

Referring now to the operation of the apparatus embodying the present invention, when the switch 13 is first closed to energize the primary winding 11 of the transformer 12, the alternating current is converted substantially immediately into a direct current power supply through the action of the secondary winding 14 and the rectifier tube 15. The filament winding 22 and the heater winding 32 are energized at this time and, by means of the former, the filamentary cathode of the rheostat tube 21 is heated substantially immediately to the electron emission temperature. Consequently, this tube is operatively conditioned. However, the control tube 25 is not conditioned for operation at this time since the cathode thereof requires some time before it is heated by the heater element 31 to the electron emission temperature.

The impedance of the rheostat tube 21 is maintained relatively high so as to increase the effectiveness of this tube to decrease the voltage which is applied to the positive and negative output terminals. The maintenance of the high impedance of the rheostat tube is effected by the connection of the control grid thereof directly to the negative terminal of the direct current supply through the closed contacts 29.

The contacts 29 are adjusted by means of the backstop screw 37 so that they are maintained closed until after the control tube 25 becomes conditioned for operation. The heater winding 30 for the contacts is then effective to cause the opening thereof and thereby to render ineffective the self-bias potential which was previously applied to the control grid of the rheostat tube 21. The bias potential is developed by the flow of current through the various circuits connected to the positive and negative output terminals.

The grid of the rheostat tube 21 then is subjected only to control by the control tube 25. The potentials which are applied to the grid of the rheostat tube vary in accordance with the conductivity of the control tube 25. Conduction in this tube depends upon deviations of the voltage of the direct current power supply from a predetermined value as determined by the point on the resistor 24 to which the control grid of the tube 25 is connected.

It will be noted that the apparatus in accordance with the instant invention is effective, not only to prevent the voltage from exceeding a predetermined value during the initial heating period of the control tube 25, but also at any time during the operation of the apparatus when the control tube is rendered inoperative by reason of a failure of the heater element 31 thereof. In such a case the circuit through the heater winding 30 of the contact structure is similarly affected and permits the contact strip 35 to assume the same deformation as that of the contact strip 34, whereby the contacts 29 become closed. As in the initial case, the closure of these contacts increases the effectiveness of the rheostat tube to decrease the voltage applied to the load 23.

While there has been described what, at pres-

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ent, is considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a voltage regulator, a direct current supply, a vacuum tube for regulating the voltage of said supply, a grid electrode for said tube to control the regulating effectiveness thereof, a normally closed self-biasing circuit for said grid electrode to prevent said voltage from exceeding a predetermined value, a normally open variable biasing circuit for said grid electrode to maintain said voltage at a substantially constant value, a circuit including an impedance device connected directly to said direct current supply and responsive at all times to the voltage of said supply, a control vacuum tube having an output circuit connected when operative to close said variable biasing circuit and an input circuit coupled to said impedance device, and a contact in said self-biasing circuit operative only in response to an operative condition of said control vacuum tube to open said self-biasing circuit.

2. In a voltage regulator, a voltage regulating rheostat tube and a control tube therefor, the effectiveness of said rheostat tube to decrease the voltage being an inverse function of the magnitude of the impedance of said control tube, a low impedance circuit in shunt with said control tube for preventing said voltage from exceeding a predetermined value during periods of inoperativeness of said control tube, contact means operative only during periods of operativeness of said control tube for opening said shunt circuit, and means responsive to the operative conditioning of said control tube for operating said circuit opening means.

3. In a protective system, a vacuum tube having a space discharge path, a control tube connected to said vacuum tube to vary the impedance of said space discharge path, a directly heated cathode for said vacuum tube, an indirect heater for the cathode of said control tube, and means for preventing the conductivity of said vacuum tube from exceeding a predetermined value during the heating period of said control tube cathode, said means comprising, a short circuit around said control tube including a pair of contacts normally closed during said heating period, a bimetallic strip carrying one of said contacts, and a heater element for said strip energizable concurrently with said indirect cathode heater for causing separation of said contacts following said heating period, whereby to open said short circuit.

4. In a protective system, a first vacuum tube having a space discharge path and a control circuit including a control grid and a filamentary cathode, a second vacuum tube having an output circuit connected to the control grid of said first tube to control the impedance of said space discharge path, said second tube having a heater type cathode, a source of negative voltage, a biasing circuit including a pair of normally closed contacts connected between said source of negative voltage and the control grid of said first tube to increase the impedance of said space discharge path, said contacts being supported respectively by a pair of similar bimetallic strips, whereby to

render said contacts unresponsive to ambient temperature changes, and a heater element for one of said strips connected in circuit with the cathode heater of said second tube to effect the opening of said contacts after said second tube is rendered operative by the heating of its cathode to effect its normal control of said first tube.

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