

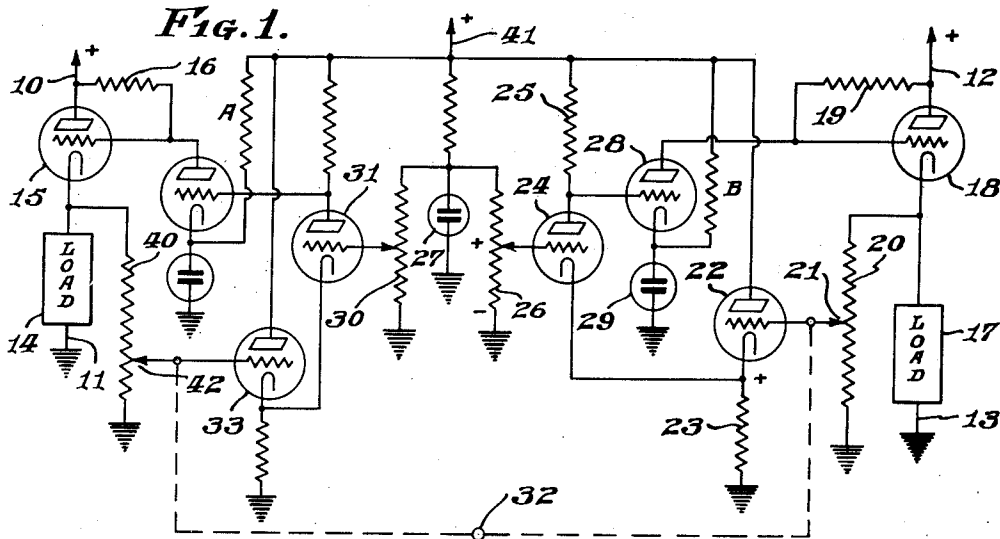
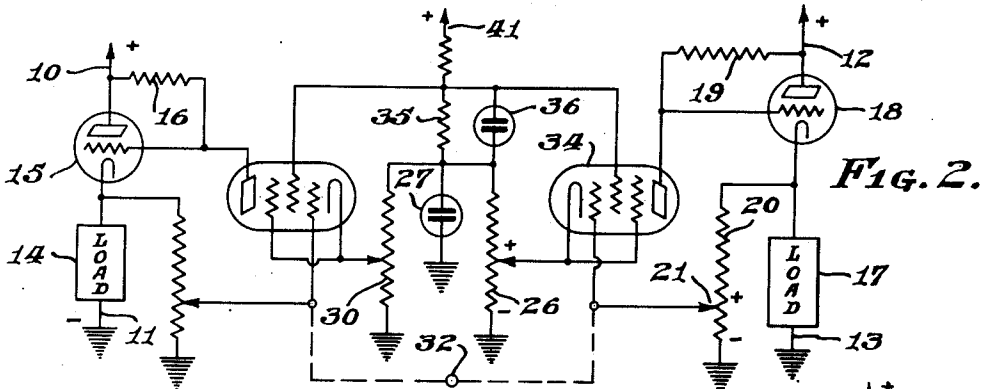
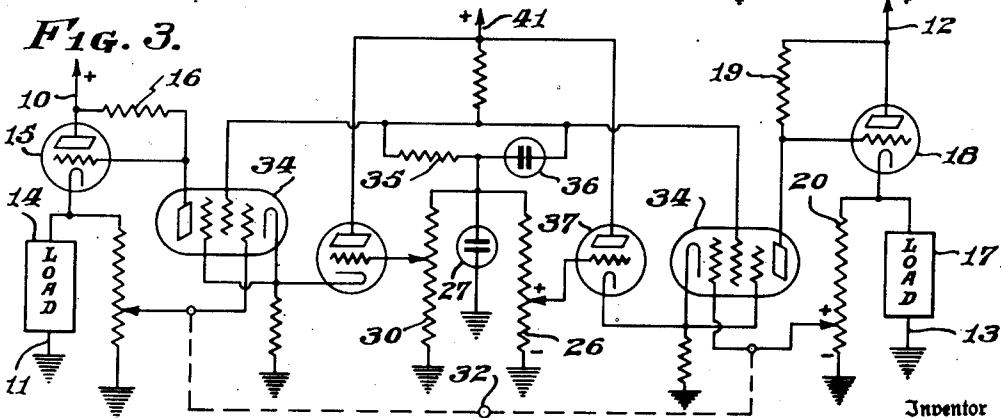
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REGULATING SYSTEM

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REGULATING SYSTEM

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This invention relates to regulating systems such as are utilized to regulate the voltage or current of an electrical load circuit, and has for its principal object the provision of an improved system and method of operation whereby the desired electrical characteristic of the load circuit may be regulated more effectively and with lower power losses than have heretofore been involved in the operation of such systems.

Another object is the provision of a regulating system capable of regulating and of maintaining a predetermined relation between the voltages of a plurality of load circuits which may be supplied with power from different sources.

A further object is the provision of improved control means which may be adjusted to establish a desired ratio between the regulated voltages of the different load circuits and which may thereafter be adjusted to vary the magnitudes of these load circuit voltages without disturbing this voltage relationship.

It is frequently desirable to maintain a predetermined ratio between the regulated voltages applied to the different circuits of an electrical apparatus. Thus, in the case of an end plate magnetron transmitter, for example, adjustment of the magnetron tube to desired operating characteristics is facilitated if the voltages applied to the cylindrical anode and to the end plates are maintained at a fixed, adjustable ratio, with a separate adjusting means for varying both voltages without altering their ratio. Constancy of output is also improved by operating the magnetrons at a constant voltage ratio, if the absolute values are subject to fluctuation. A further improvement in constancy of operation can be gotten by regulating the voltages so that they remain constant.

In one of the usual ways of connecting a magnetron, a potentiometer is connected across a source of adjustable voltage. The whole voltage across the potentiometer is applied to the electrode requiring the higher voltage (usually the cylindrical anode) and the voltage selected by the sliding contact is applied to the other electrode. In this arrangement, the current flowing to the second electrode not only alters the actual voltage ratio from the value established by the position of the potentiometer sliding contact, but also makes the lower voltage subject to variation as the current to the electrode varies. This system is effective only if the current flowing in the potentiometer is large relative to that utilized in the tube, in which case it is very wasteful of power.

In the other of the two usual ways of connect-

ing a magnetron tube, two separate regulators are used, one for each positive electrode. This system is economical in the use of power, and constant in operation, but is not easy to adjust to a desired condition of operation.

In accordance with the present invention, the good features of both the above systems are retained, and the disadvantages are eliminated, by a system which utilizes two voltage regulators interconnected in such a way that a fixed voltage ratio is maintained.

The invention will be better understood from the following description considered in connection with the accompanying drawing and its scope is indicated by the appended claims.

Referring to the drawing,

Figure 1 is a wiring diagram of a multi-load-circuit regulating system wherein the voltage to be regulated is applied to the control grid circuit of a control device and the cathode-anode current of this device is utilized to vary the cathode potential of a regulating circuit amplifier provided with a control grid maintained at a fixed potential;

Figure 2 is a wiring diagram of a similar system which differs from that of Fig. 1 in that the cathode of the regulating circuit amplifier is subjected to a fixed bias and the voltage to be regulated is applied to the control grid of this amplifier; and

Figure 3 is a wiring diagram of a system similar to that of Fig. 2 in that the potential to be regulated is applied to the control grid of the regulating circuit amplifier but different therefrom in that a control device subjected to a fixed control grid bias potential is utilized to stabilize the cathode voltage of the amplifier.

The system of Fig. 1 includes one pair of power supply leads 10 and 11 and another pair of power supply leads 12 and 13.

These different pairs of supply leads may derive power from the same source or from different sources and may be operated at different voltages suited to the loads which they supply. Power from the terminals 10 and 11 is supplied to a load 14 through the cathode-anode circuit of a regulating device 15 which has its anode and control grid interconnected through a resistor 16. Power from the terminals 12 and 13 is similarly supplied to a load 17 through the cathode-anode circuit of a regulating device 18 which has its anode and control grid interconnected through a resistor 19. The supply lead 41 furnishes power to other parts of the circuit.

Regulation of the voltage of the load 17 is

effected through a resistor 20 which is connected in shunt to the load and is provided with an adjustable terminal 21. Through this terminal potential is applied to the control grid of a control device 22 which may derive its cathode-anode voltage from the terminals 41 and 13, or from any other suitable source and which has a resistor 23 connected in its cathode lead. The potential drop of the resistor 23 is applied to the cathode of an amplifier 24 the anode circuit of which also includes a resistor 25 and the grid of which is subjected to a fixed voltage derived from a resistor 26 shunted by a glow tube 27 or other means suitable for stabilizing the grid voltage. The output of the amplifier 24 is coupled to the control grid of an amplifier 28, the cathode potential of which is stabilized by a glow tube 29 and the anode circuit of which includes the resistor 18.

It will be apparent that the power for operating the devices 22, 24 and 28 may be derived from either pair of power supply terminals or from an independent source depending on the operating conditions of the system.

With these connections, increase in the voltage of the load 17 makes the grid potential of the device 22 more positive, greater current is transmitted through the resistor 23, the cathode of the amplifier 24 is made more positive, less current is transmitted through the resistor 25, the grid potential of the amplifier 28 is made more positive, greater current is transmitted through the resistor 19, the grid of the regulating device 18 is made more negative and further increase of the load voltage is prevented. A similar but reverse regulating action is produced when the load voltage tends to decrease. This voltage is therefore maintained within narrow limits.

If the devices 22 and 24 are triodes having high amplification factors, they will operate with small grid-to-cathode voltages, of the order of 1 or 2 volts. It follows from this that the grids of the devices 22 and 24 are at almost exactly the same voltage with respect to the common negative terminal of the system (the ground connection). Also, since no current is taken from the resistance 20 through the lead 21 to the grid of the tube 22, the ratio of the voltage across 20 (and load 17) to the voltage from terminal 21 to ground is exactly equal to the ratio of the total resistance of 20 to the resistance between 21 and ground. Hence, the voltage applied to the load 17 is the product of the voltage applied to the grid of tube 24 by its connection to potentiometer 26, and the resistance ratio determined by the position of connection 21 on resistor 20. The voltage across potentiometer 26 is maintained constant by the gas discharge tube 27.

The connections and operation of the similar unit provided for regulating the voltage of the load 14 will be apparent in view of the foregoing explanation.

It will be noted that the ratio between the two load voltages may be adjusted by means of the adjustable terminal of the resistor 26 and the corresponding adjustable terminal of a resistor 30 which controls the input potential of an amplifier 31 corresponding to the amplifier 24. With the desired voltage relationship established, simultaneous control of the voltages without disturbing their established relationship is readily effected by means of a control member which simultaneously adjusts the grid voltages of the control device 22 and of a corresponding device 33 associated with the load 14 by means of two potentiometers 20 and 40 which are mechanically

coupled so that the terminals 21 and 42 connect to 20 and 40, respectively, at equal percentage values of the whole resistances, at all settings within the range of adjustment of 32.

If the movable contact on either 26 or 30 is kept in a fixed position, a scale may be attached to the other by means of which the ratio of the two load voltages may be determined from the position of the movable contact, and also a scale may be attached to 32 from which either or both load voltages can be read.

The system of Fig. 2 differs from that of Fig. 1 in that the regulating or control channel includes a single multigrid amplifier 34 in place of the two-stage amplifier 24-28 (22 does not amplify). This system has the advantage of greater simplicity but involves the transmission of the amplifier cathode-anode current through a part of the resistor 26.

For this reason it is necessary that resistor 26 carry enough current so that the added current from tube 34 is negligently small. The same applies to resistor 30. More power is wasted in these two resistors, therefore, than in the connection shown in Fig. 1. However, since the voltage across 26 is small compared to the load voltage in a magnetron circuit, for example, the power loss is small compared to what would be lost if one load circuit were supplied directly from a potentiometer, and therefore the advantage of the circuit is not sacrificed.

More specifically stated, there is provided an amplifier which (1) includes in its cathode-anode circuit the resistor 19 and the lower section of the resistor 26, (2) derives its screen grid voltage from a resistor 35 which has its potential drop stabilized by glow tube 27 and glow tube 36 and (3) derives its control grid voltage from the shunt resistor 20.

In the operation of the system of Fig. 2, an increase in the voltage of the load 17 produces a more positive voltage at the control grid of the amplifier 34, greater current is transmitted through the resistor 19, the control grid potential of the regulating device 18 is made more negative, further increase of the load voltage is prevented and this voltage is maintained within narrow limits.

As in the system of Fig. 1, fine adjustments in the relation between the different load voltages may be effected through the resistors 26 and 30 and simultaneous adjustment of these voltages is made by the control member 32.

The system of Fig. 3 differs from that of Fig. 2 in that a control device 37 is provided for deriving the cathode potential of the amplifier 34. From the adjustable terminal of the resistor 26 there is applied to the control grid of the device 37 a fixed potential which serves to stabilize the cathode voltage of this device and the amplifier 34 at a value within a few volts of that applied to the control device grid. This connection performs the same function as the direct connection of the cathode of 34 to 26 in Fig. 2 and has the advantage that since the grid of 37 takes no current from resistor 26, the latter may have as high a value as desired. Thus power wasted in 26 is minimized, and also the stabilizing action of 27 is enhanced by reason of the reduction in the amount of current bypassed around it by the resistors 26 and 30.

Circuits may be modified in various ways, etc. The adjustable voltage means typified by 26 and 30 in Fig. 1 may be adjusted so as to establish other relations than a constant ratio. For ex-

ample, if the means 32 is fixed in position, variable voltages can be had by adjustment of 26 and 30, and if a constant voltage difference is maintained between the voltages applied to the grids of 24 and 31 (by a suitable mechanical linkage of the controls for example, or in other obvious ways) the load voltages will also have a fixed voltage difference. The two voltages can be raised and lowered by adjusting 26 and 30 with a constant voltage difference, and the magnitude of the difference can be altered by adjusting 32, or by adjusting the linkage of 26 and 30.

By combinations of these control methods, various combinations of relations between the load voltages involving ratios and differences can be gotten.

Any relation that can be established between two or more load voltages can also be established among load currents. For example, a constant ratio of load currents can be gotten by connecting the load impedances in series with the potentiometers 20 and 40, respectively, in the leads connecting the high potential ends of 20 and 40 to the cathodes of the regulating devices 18 and 15, respectively, instead of in shunt. The operation of the system is then exactly the same as for maintenance of a constant voltage ratio.

I claim as my invention:

1. In a system for maintaining a predetermined relation between the regulated voltages of a plurality of load circuits, the combination of a plurality of regulating devices each provided with a control grid circuit and with a cathode-anode circuit serially connected with a different one of said load circuits, impedance means connected in shunt to each of said load circuits, a plurality of amplifiers each provided with an output circuit and with an input circuit responsive to the potential drop of a different one of said impedance means, means responsive to the current of each of said amplifier output circuits for regulating the control grid potential of a different one of said regulating devices, and means for simultaneously adjusting the input potentials of said amplifiers.

2. In a system for maintaining a predetermined relation between the regulated voltages of a plurality of load circuits, the combination of a plurality of regulating devices each provided with a control grid circuit and with a cathode-anode circuit serially connected with a different one of said load circuits, a resistor connected in shunt to each of said load circuits, a plurality of amplifiers each provided with an output circuit and with an input circuit responsive to the potential drop of a different one of said resistors, means responsive to the current of each of said amplifier output circuits for regulating the control grid potential of a different one of said regulating devices, and means for simultaneously adjusting the input potentials of said amplifiers.

3. In a system for regulating the voltage of a load circuit, the combination of a regulating device provided with a control grid circuit and with a cathode-anode circuit serially connected with said load circuit, an impedance device connected in shunt to said load circuit, an amplifier provided with a cathode-anode circuit and with an input circuit, means responsive to the current of said amplifier output circuit for regulating the control grid potential of said regulating device, a control device provided with an input circuit and with a cathode connected to the cathode of said amplifier, and means for applying the potential

drop of said impedance device to said control device input circuit.

4. In a system for regulating the voltage of a load circuit, the combination of a regulating device provided with a control grid circuit and with a cathode-anode circuit serially connected with said load circuit, an impedance device connected in shunt to said load circuit, an amplifier provided with a cathode-anode circuit and with an input circuit, means responsive to the current of said amplifier output circuit for regulating the control grid potential of said regulating device, a control device provided with an input circuit and with a cathode connected to the cathode of said amplifier, means for applying the potential drop of said impedance device to said control device input circuit, and means responsive to the cathode-anode current of said control device for controlling the cathode potential of said amplifier.

5. In a system for regulating the voltage of a load circuit, the combination of a regulating device provided with a control grid circuit and with a cathode-anode circuit serially connected with said load circuit, an impedance device connected in shunt to said load circuit, an amplifier provided with a cathode-anode circuit and with an input circuit, means responsive to the current of said amplifier output circuit for regulating the control grid potential of said regulating device, a control device provided with an input circuit and with a cathode connected to the cathode of said amplifier, means for applying the potential drop of said impedance device to said control device input circuit, means responsive to the cathode-anode current of said control device for controlling the cathode potential of said amplifier, and means for applying a constant bias potential to said amplifier input circuit.

6. In a system for maintaining a predetermined relation between the regulated voltages of a plurality of load circuits, the combination of a plurality of regulating devices each provided with a control grid circuit and with a cathode-anode circuit serially connected with a different one of said load circuits, impedance means connected in shunt to each of said load circuits, a plurality of amplifiers each provided with an output circuit and with an input circuit, means responsive to the current of each of said amplifier output circuits for regulating the control grid potential of a different one of said regulating devices, a plurality of control devices each provided with an input circuit and with a cathode-anode circuit, means for applying a constant bias potential to the input circuits of said amplifiers, means for applying the potential drops of said impedance means each to a different one of said control device input circuits, and means for controlling the potential of said amplifier cathode in response to the cathode-anode current of said control device.

7. In a system for regulating the voltage of a load circuit, the combination of a regulating device provided with a control grid circuit and with a cathode-anode circuit serially connected with said load circuit, impedance means connected in shunt to said load circuit, an amplifier provided with a cathode-anode circuit and with an input circuit, means including a resistor connected in the output circuit of said amplifier for regulating the control grid potential of said regulating device, a control device provided with an input circuit and with a cathode connected to the cathode of said amplifier, means for applying bias poten-

tial to said control device input circuit, and means for applying the potential drop of said impedance means to said amplifier input circuit.

8. In a system for maintaining a predetermined relation between the regulated voltages of a plurality of load circuits, the combination of a plurality of regulating devices each provided with a control grid circuit and with a cathode-anode circuit serially connected with a different one of said load circuits, impedance means connected in shunt to each of said load circuits, a plurality of amplifiers each provided with an output circuit and with an input circuit, means responsive to the current of each of said amplifier output circuits for regulating the control grid potential of a different one of said regulating devices, a plurality of control devices each provided with an input circuit and with a cathode connected to the cathode of a different one of said amplifiers, means for applying a constant bias potential to each of said control device input circuits, means for adjusting the constant bias potentials to a predetermined ratio, and means for applying the impedance means potential drops each to a different pair of said amplifier input circuits.

9. In a system for maintaining a predetermined relation between the regulated voltages of a plurality of load circuits, the combination of a plurality of regulating devices each provided with a control grid circuit and with a cathode-anode circuit serially connected with a different one of said load circuits, impedance means connected in shunt to each of said load circuits, a plurality of amplifiers each provided with an output circuit and with an input circuit, means responsive to the current of each of said amplifier output circuits for regulating the control grid potential of a different one of said regulating devices, a plurality of control devices each provided with an input circuit and with a cathode connected to the cathode of a different one of said amplifiers, means for applying a constant bias potential to each of said control device input circuits, means for adjusting the said constant bias potentials so as to establish a desired relation between the various load potentials, means for applying the impedance means potential drops each to a different amplifier input circuit, and means for simultaneously adjusting said potential drops.

10. In a system for regulating the voltage of a load circuit, the combination of a regulating device provided with a control grid circuit and with a cathode-anode circuit serially connected with said load circuit, impedance means connected in shunt to said load circuit, an amplifier provided with a cathode-anode circuit and with an input circuit, means responsive to the current of said amplifier output circuit for regulating the control grid potential of said regulating device, a control device provided with an input circuit and with a cathode connected to the cathode of said amplifier, means for applying a constant bias potential to said control device input circuit, and means for applying the potential drop of said impedance means to said amplifier input circuit.

11. In a system for regulating the voltage of a load circuit, the combination of a regulating device provided with a control grid circuit and with a cathode-anode circuit serially connected with said load circuit, impedance means con-

nected in shunt to said load circuit, an amplifier provided with a cathode-anode circuit and with an input circuit, means responsive to the current of said amplifier output circuit for regulating the control grid potential of said regulating device, a control device provided with an input circuit and with a cathode connected to the cathode of said amplifier, means for applying a constant bias potential to said control device input circuit, and means including a resistor for applying the potential drop of said impedance means to said amplifier input circuit.

12. In a system for regulating the voltage of a load circuit, the combination of a regulating device provided with a control grid circuit and with a cathode-anode circuit serially connected with said load circuit, impedance means connected in shunt to said load circuit, an amplifier provided with a cathode-anode circuit and with an input circuit, means responsive to the current of said amplifier output circuit for regulating the control grid potential of said regulating device, a control device provided with an input circuit and with a cathode connected to the cathode of said amplifier, means for applying a constant bias potential to said control device input circuit, means for applying the potential drop of said impedance means to said amplifier input circuit, and means for adjusting the input circuit potential of said control device.

13. In a system for maintaining a predetermined relation between the regulated voltages of a plurality of load circuits, the combination of a plurality of regulating devices each provided with a control grid circuit and with a cathode-anode circuit serially connected with a different one of said load circuits, a plurality of control devices each provided with an input circuit responsive to the voltage of a different one of said load circuits and with a resistor connected in the cathode lead of its output circuit, a plurality of amplifiers each provided with an output circuit and with an input circuit including a different one of said resistors, and means including a plurality of resistors each connected between the anode and grid of a different regulating device and each responsive to the output current of a different one of said amplifiers for regulating the potential applied to a different one of said regulating device control grid circuits.

14. In a system for maintaining a predetermined relation between the regulated voltages of a plurality of load circuits, the combination of a plurality of regulating devices each provided with a control grid circuit and with a cathode-anode circuit serially connected with a different one of said load circuits, a resistor connected in shunt to each of said load circuits, a plurality of amplifiers each provided with an input circuit including a different one of said resistors and with an output circuit, means for controlling each of said regulating device control grid circuits in accordance with the current of a different one of said amplifier output circuits, means for simultaneously adjusting the input potentials of said amplifiers, and means for establishing voltages between the cathode of the control devices and the negative terminal of power supply voltages to establish a desired relation between the load voltages.

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