

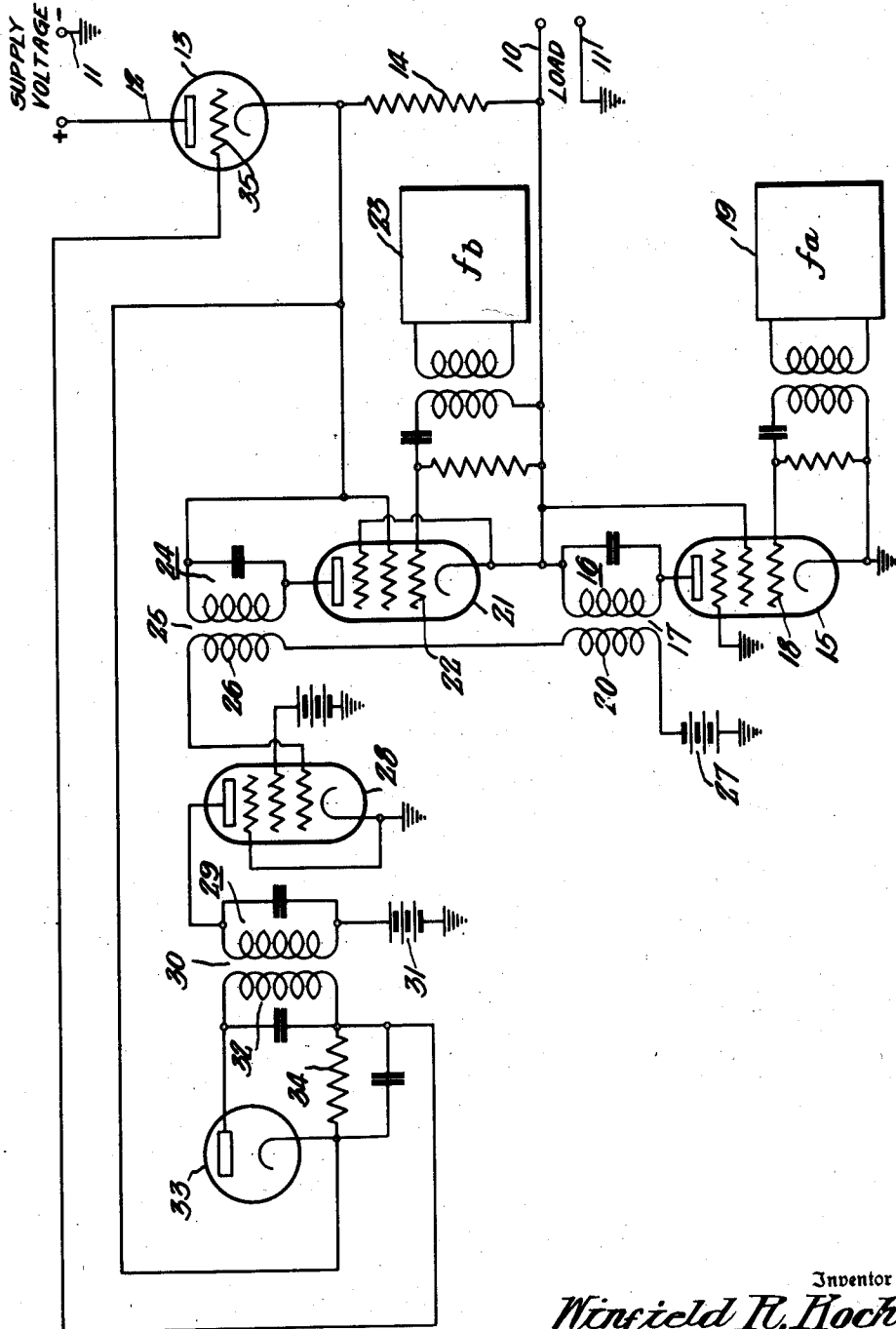
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W. R. KOCH

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POWER-REGULATING DEVICE

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Inventor
Winfield R. Koch
Griffith
Attorney

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POWER-REGULATING DEVICE

Winfield R. Koch, Haddonfield, N. J., assignor to
Radio Corporation of America, a corporation of
Delaware

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This invention relates to power-regulating devices such as are operable to cause a constant amount of power to be supplied to a variable load circuit. It has for its principal object the provision of an improved apparatus and method of operation whereby the power supplied to a load circuit is maintained constant irrespective of variations in the operating conditions of this circuit. This result is attained without the use of the mechanical contacts usually involved in such regulating apparatus.

The improved regulator of this invention is based on the principle that the resultant sum or difference of two different frequency potentials impressed on a nonlinear element is proportional to the product of the amplitudes of these potentials. By making these amplitudes in direct proportion respectively to the current through and to the voltage across the load circuit, it is thus possible to derive a control potential which is always proportional to the power delivered to the load. A further feature of the invention is the detection of this resultant or control potential and the application of the detected potential to the input circuit of an electron discharge device through which power is supplied to the load circuit.

Such a power regulator has many useful applications. Thus, it operates to supply power to the filament of a standard light source with a higher degree of constancy than can be realized from the use of a voltage or current regulator. Likewise, in adjusting an oscillation generator for maximum output efficiency, such a regulator is useful in holding the generator input at a safe constant value, thus facilitating and amplifying an adjustment which is otherwise difficult for the reason that the generator input current and voltage change with every variation of the generator output.

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.

The single figure of the drawing is a wiring diagram of a power regulator embodying the invention.

This regulator is illustrated as applied to a load circuit 10—11 which is supplied with power from a suitable source (not shown) through leads 11—12, a regulating device 13 of the electron discharge type, and a resistor 14.

Responsive to the voltage of the load circuit 10—11 is an amplifier 15 which has its electron discharge path connected to this circuit through

the tuned primary circuit 16 of a transformer 17, its screen grid directly connected to the circuit, and has applied to its control grid 18 from a generator 19 electrical oscillations of a frequency f_a . Under these conditions, there is delivered to the secondary winding 20 of the transformer 17 a potential which varies in amplitude as the voltage of the circuit 10—11 and has a frequency f_a .

Likewise connected across the resistor 14 are the anode and screen grid paths of amplifier 21 which has applied to its control grid 22, from an oscillation generator 23, electrical oscillations of a different frequency f_b . The anode circuit of the amplifier 22 is completed through the tuned primary circuit 24 of a transformer 25. With these connections there is delivered to the secondary circuit 26 of the transformer 25 a potential which varies in amplitude as the current of the circuit 10—11 and has a frequency f_b .

To the end that the amplifiers 15 and 21 may be operated at relatively high efficiency and have output amplitudes exactly proportional to the controlling voltages, both of them may be operated class C.

Coupled to the amplifiers 15 and 21 through the secondary windings 20 and 26 and a bias potential source 27 is the input circuit of a mixing tube or electron discharge device 28. The output circuit of the device includes the primary circuit 29 of a transformer 30 and a plate potential source 31. This transformer is tuned to pass either the sum frequency or the difference frequency of f_a and f_b .

When the two potentials, having frequencies f_a and f_b , with amplitudes proportional to the voltage across the load and to the current through the load, respectively, are applied to the input circuit of mixing tube 28, the plate current will have components of many frequencies. These components have been treated in such well-known texts as Communication Engineering—Everitt, 1st ed., and Radio Engineering—Terman, 2nd ed. Because of the selectivity secured by the tuned transformer 30, only the component having a frequency $f_a + f_b$ (or $f_a - f_b$) is of interest.

The resultant potential thus made available at the secondary winding 32 of the transformer 30 is detected by a rectifier 33, and the detected resultant potential appearing at the terminals of a resistor 34 is applied to the control grid 35 of the regulating tube 13. In accordance with accepted authorities such as those hereinbefore referred to, the amplitude of an output current

is proportional to the product of the amplitudes of each frequency which produced it, i. e., if E_1 is the amplitude of the input component of frequency f_1 and E_2 is the amplitude of the input component of frequency f_2 , then the amplitude of the component of the output current at a frequency $f_1 + f_2$ will be proportional to $E_1 E_2$. From this, it is evident that the voltage applied to the diode will be proportional to the product of the voltage of f_a and that of f_b at the grid of tube 28, and therefore proportional to the product of the voltage across the load and the current through it. The control or bias potential derived from the rectifier or diode 33 will therefore be directly proportional to the voltage across the load, and to the current through resistor 14 and thence through the load, and therefore proportional to the product of the voltage and current, which is the power in the load circuit.

Under these conditions, the bias potential applied to the control tube grid 35 is made more negative when the power delivered to the load through the circuit 10—11 tends to increase and vice versa, thus maintaining the power delivered at a substantially constant value. In other words, any increase in power delivered to the load, as exhibited by an increase in the current and/or voltage, or product of the two, will result in an increase in negative bias on the grid of the tube B and a compensating reduction in applied current and voltage, tending to maintain the power to the load constant.

I claim as my invention:

1. The combination of power supply terminals, a regulating device provided with a cathode and anode and with a grid for controlling the current transmitted between said cathode and anode, a load circuit connected to said terminals through said cathode and anode, means for deriving one frequency potential which is dependent on the current of said circuit and another frequency potential which is dependent on the voltage of said circuit, and means for applying the detected resultant of said different frequency potentials to said grid.

2. The combination of power supply terminals,

a regulating device provided with a cathode and anode and with a grid for controlling the current transmitted between said cathode and anode, an impedance device, a load circuit connected between said terminals through said impedance device and said cathode and anode, means for deriving from said impedance device one frequency potential which is dependent on the current of said circuit, means for deriving from said load circuit another frequency potential which is dependent on the voltage of said circuit, and means for applying the detected resultant of said different frequency potentials to said grid.

3. The combination of power supply terminals, a regulating device provided with a cathode and anode and with a grid for controlling the current transmitted between said cathode and anode, a resistor, a load circuit connected to said terminals through said resistor and said cathode and anode, means including one amplifier for deriving from said resistor one frequency potential which is dependent on the current of said circuit, means for modulating the output of said amplifier at one frequency, another amplifier connected to said load circuit for deriving a potential which is dependent on the voltage of said circuit, means for modulating the output of said other amplifier at a different frequency, means for combining the outputs of said amplifiers, means for detecting the resultant of said combined output, and means for applying to said grid a potential dependent on said detected resultant output.

4. In a power regulating system, the combination of a load circuit, means for deriving from said circuit a potential proportional to the load current, means for amplifying and modulating said potential at a predetermined frequency, means connected with the load circuit for amplifying the load potential, means for modulating said potential at a second predetermined frequency, means for combining said modulated potentials, means for detecting the resultant potential, a load control tube having a control grid, and means for applying to said control grid said resultant potential.

WINFIELD R. KOCH.