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REGULATED VACUUM-TUBE BIAS SUPPLY

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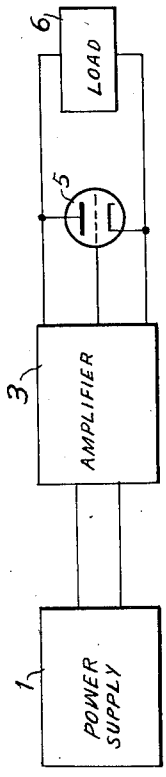


Fig. 1

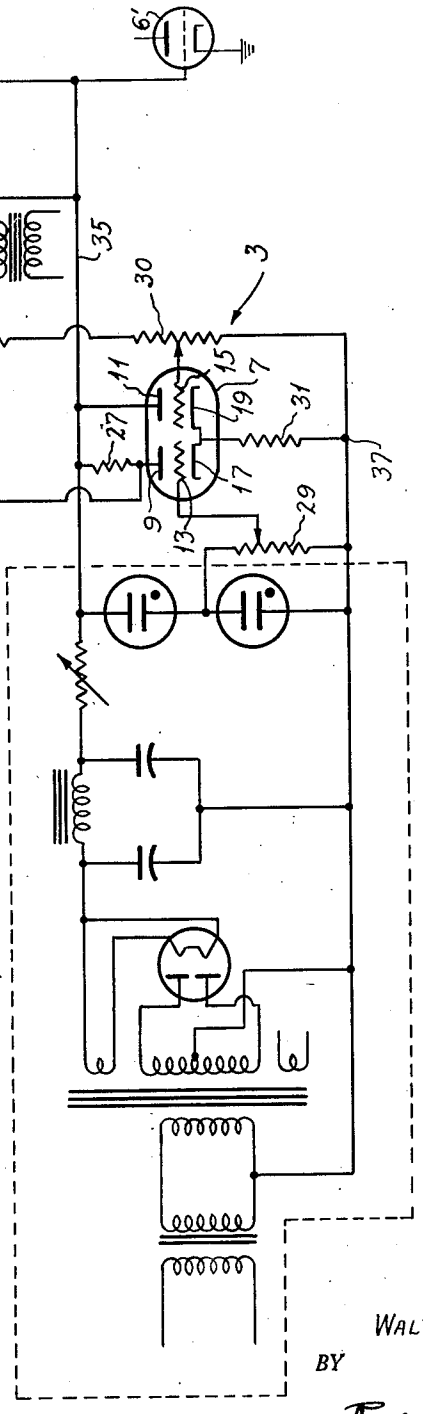


Fig. 2

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REGULATED VACUUM-TUBE BIAS SUPPLY

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1 Claim. (Cl. 250—27)

The invention relates to voltage-regulator circuits and more particularly to a circuit for maintaining the grid-to-cathode potential of a vacuum tube or tubes substantially constant, independent of the grid current flowing in such tube or tubes.

Grid bias for voltage amplifiers and power amplifiers is usually derived from the plate-supply system. A common method of providing such bias is by using a resistor between the cathode and ground that makes the cathode positive by the resistance drop produced by the total space current in the tube. Another method of providing grid bias is by using a grid-leak (resistor) in the grid circuit of a vacuum tube, such as, a resistor inserted between the grid and cathode of such tube. Still another method for providing grid bias is by inserting a bias cell or battery in the grid circuit of a vacuum tube to make the grid negative with respect to the cathode.

When grid leak and cathode resistors are employed to provide grid bias, there results variations in the potential developed across such resistors, said variations being caused by the fluctuations in current flowing through them. These variations produce undesirable variations in the output of the amplifier tube. Bias cells or batteries provide substantially constant grid-to-cathode potential, however, the cost of utilizing such devices can become exorbitant.

It is an object of the present invention to eliminate the above-mentioned disadvantages and provide a circuit for maintaining the grid-to-cathode potential of a vacuum tube substantially constant, independent of the grid current flowing.

Another object of the invention is to provide a device for obtaining constant bias potential from the potential drop across a tube.

The invention will best be understood from the following description of a specific embodiment when read in conjunction with the accompanying drawings wherein:

Fig. 1 is a block diagram, partly schematic, of the invention including the regulator tube for maintaining the grid-to-cathode potential of a vacuum tube substantially constant. Fig. 2 is a schematic wiring diagram of the invention of Fig. 1.

In the Figs. 1 and 2 there is shown the circuit for maintaining the bias potential constant, said circuit consisting of a regulated power supply 1 suitably connected to a two-stage amplifier 3, which in turn is connected to a three-electrode tube 5. The grid element of said three-electrode regulator tube or grid leak 5 is used to regulate the bias potential of a vacuum tube or tubes, or the potential across a device the resistance of which can be controlled electronically and capable of drawing current.

The regulated power supply 1 can be of any suitable design and as shown in Fig. 2 consists of a suitable transformer for stepping up the alternating current supplied to it, a suitable full-wave rectifier for converting the alternating current to direct current, a smoothing circuit for removing fluctuations in the direct current,

a resistance for limting the direct current to the desired value and two voltage-stabilizing devices connected in series across the line for maintaining the voltage constant despite fluctuations in the voltage of the alternating current source or of variations in the load. Said regulated supply provides power for operating the amplifier tube 7.

The two-stage amplifier circuit 3 includes a duotriode vacuum tube having two plates 9 and 11, control grids 13 and 15 and cathodes 17 and 19 suitably connected to the power supply 1 and grid leak 5. Resistors 27, 29, 30 and 31, in the plate, grid and cathode circuits respectively of tube 7, provide the proper voltages for operation of the amplifier. Said grid-leak tube 5 is an air-cooled triode having a plate 21, grid 23 and filament 25. The output voltage of regulator tube 5, taken across plate 21 which is grounded and cathode 25 is supplied to a vacuum tube 6' as bias potential.

Tube 5 connected to amplifier circuit 3 acts as a grid-leak resistor. The cathode-to-plate resistance of tube 5 can be varied by varying the potential applied to grid 23. Amplifier 7 amplifies deviations of potential drop across tube 5 and applies the resulting signal to the grid of said tube 5 in such a sense so as to correct the deviations of potential. To accomplish this, plate 21 of tube 5 is connected to grid 15 through resistors 33 and 30, thereby providing a negative feed-back loop and plate 9 of tube 7 is connected to grid 23 of tube 5 providing a forward loop for applying the amplified deviation to grid 23 of grid-leak tube 5. The net effect is to maintain the potential drop across tube 5 substantially constant regardless of the current flowing through it. The current that flows through tube 5 is the grid current of the tube controlled.

To illustrate further the operation of this device, assume that the bias on a controlled tube 6' increases. The controlled tube can be a vacuum tube having a minimum of three electrodes, namely, a plate, cathode and control grid. Such an increase could be caused by an increase in the grid current drawn by the controlled tube. Because of this increase in bias there results a change of potential in wire or "grid lead" 35 connecting plate 11 of tube 7 to filament 25 of tube 5 to a more negative value. The potential differences between plate 11 and grid 13 and between said plate and junction 37 are maintained constant by voltage-regulator tubes in the regulated power supply 1. Thus, a change of potential in grid lead 35 causes a change of potential of grid 15 to a value more positive with respect to its cathode 19 resulting in increased conduction in that half of tube 7.

An increase of space current between cathode 19 and plate 11 causes an increase in the potential drop across cathode resistor 31. Since the potential of grid 13 with respect to junction 37 is maintained constant due to power supply 1, the potential of cathode 17 will change to a value more positive with respect to grid 13, or stated another way, grid 13 becomes more negative with respect to cathode 17. This results in a decrease of space current between cathode 17 and plate 9 and a decreased potential drop across plate resistor 27. The potential of plate 9 therefore changes to a value more positive with respect to grid lead 35.

Plate 9 of tube 7 is connected directly to grid 23 of tube 5 and is also connected through resistor 27 to filament 25 of tube 5. The potential changes described above cause grid 23 of tube 5 to assume a potential more positive with respect to filament 25 thereby decreasing the potential difference between said filament and plate 21. However, this potential difference is the bias for the tube 6' to be controlled. Thus, the original increase in the bias of the controlled tube is compensated for by tube 5 producing a decrease in grid current to be fed to said controlled tube.

The filament-to-plate potential of grid leak **5** is dependent upon the grid current drawn by the controlled tube or tubes. As an example: If the invention were to provide a bias supply for ten tubes, each of said tubes drawing a grid current of 5 milliamperes, (ma), the total current passed by grid leak **5** would be of the order of 50 ma. In one embodiment, tube **5** is an RCA type 845. Its characteristics are such that with a plate current of 50 ma and a grid bias of minus 150 volts, the plate-to-filament potential difference is 1000 volts. This would be a stable operating condition providing a regulated bias of 1000 volts for the tubes to be controlled.

The bias potential of grid leak **5** is developed by the grid current of the controlled tube or tubes flowing from plate **21** to filament **25** of tube **5**. When said tube **5** conducts, filament **25** will be negative with respect to plate **21**, the potential difference being 1000 volts. It will be seen that any variation in the potential of grid **23** of tube **5** produced by the action of the regulator circuit will vary the filament-to-plate potential difference at a constant plate current (the grid current of the controlled tubes).

The invention is not to be construed as limited to the particular regulator tube, duotriode amplifier circuit or load circuit as described herein, since these are regarded to be illustrative rather than restrictive. For example, any equivalent device the resistance of which can be controlled electronically permitting utilization of the current flowing through it can replace the load circuit described herein. Any transistor amplifier circuit can be used so long as it amplifies the potential deviations and applies them in the proper sense to the regulator tube.

What is claimed:

A voltage regulator circuit for producing a regulated bias potential comprising a two-stage amplifier circuit, a regulated power supply connected to the amplifier circuit

for providing operating voltages to said circuit, a controlled vacuum tube having a plate, control grid and cathode, said tube drawing grid current, a grid-leak tube having a plate, control grid and filament, a capacitor connected across the filament and plate of said grid-leak tube, means for connecting the filament of said grid-leak tube to the control grid of said controlled tube, whereby the grid current of the controlled tube flows through said grid-leak tube setting up a variable potential difference across said tube, means for applying deviations in potential appearing across said grid-leak tube to one stage of said amplifier circuit, means for applying the output of said first amplifier stage to the input of the second amplifier stage, and means for applying the amplified output of said second stage to the grid of said grid-leak tube in such a sense so as to minimize the potential variations across the grid-leak tube, whereby constant bias potential across said grid-leak tube is maintained.

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