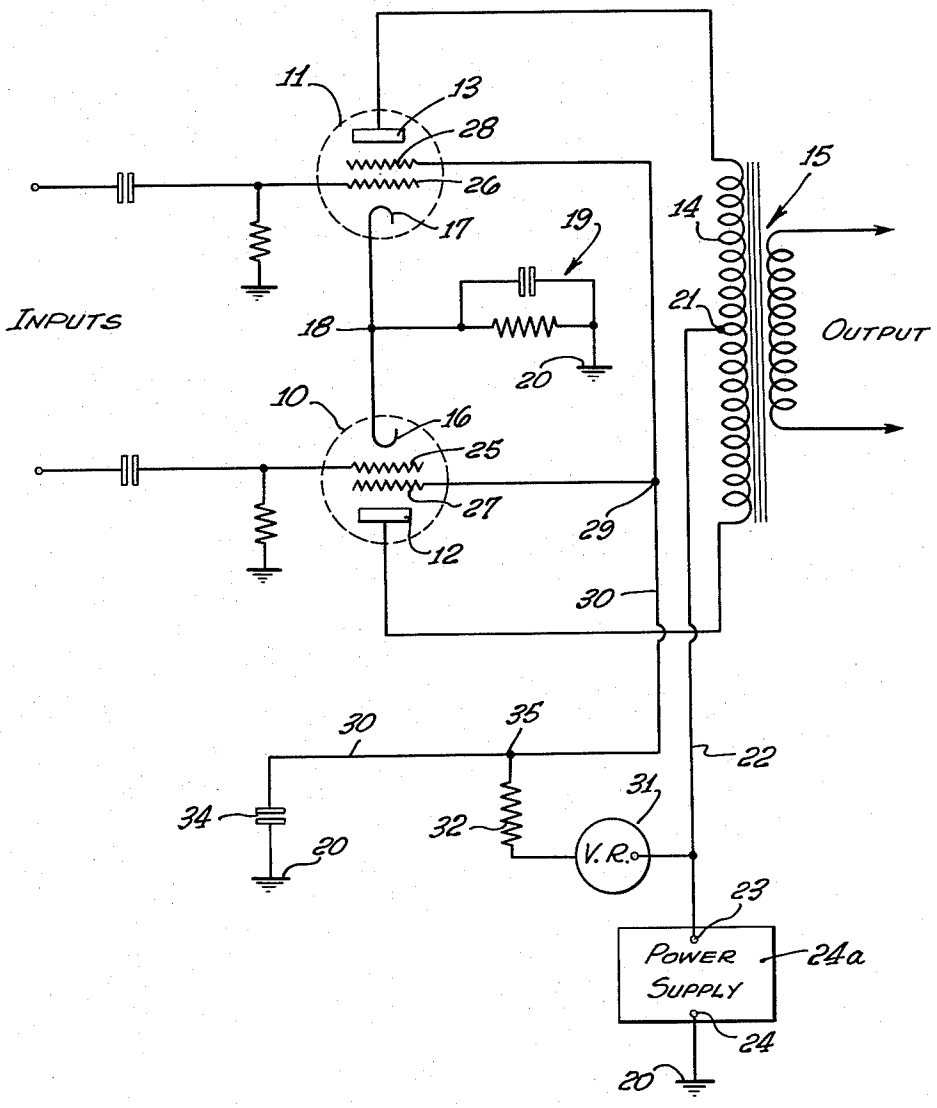
Oct. 17, 1961 D. J. LESLIE 3,005,162

DERIVATIVE VOLTAGE REGULATION CIRCUIT

Filed May 6, 1958



INVENTOR.

DONALD J. LESLIE

BY

Flam and Flam

ATTORNEYS.

United States Patent Office 3,005,162 Patented Oct. 17, 1961

3,005,162
DERIVATIVE VOLTAGE REGULATION CIRCUIT

Donald J. Leslie, 313 S. Fair Oaks Ave., Pasadena, Calif.

Filed May 6, 1958, Ser. No. 733,339
2 Claims. (Cl. 328—267)

This invention relates to a voltage regulation system, such as for use in multigrid power amplifier tubes.

In order to provide any measure of stability in the plate characteristics of a screen grid tube, the voltage applied to a screen grid must be reasonably constant throughout the range of possible screen grid currents. The screen grid currents often vary substantially, and hence the voltage will vary substantially if a simple dropping resistor is used, with a consequent poor amplifier performance. Furthermore, the screen grid voltage is desirably maintained at as low a value as possible in order to maximize, for a given plate supply voltage, the usable range of the plate characteristics. This is due to the fact that operating plate voltage near the screen grid voltage is unusable in traditional applications.

Known regulation systems have been used for providing regulated lower voltage supply for screen grids. Thus, for example, the screen grid may connect between a dropping resistor and a bleeder resistor, which resistors are serially connected across a voltage source. Or, the screen grid may connect between a dropping resistor and a voltage regulator tube substituted for the bleeder resistor. In the latter case and in a known manner, the load current causes compensating variations in tube current.

In the case of the bleeder resistor, the current therethrough must be many times the maximum screen grid current if regulation is to be satisfactory. In the case of VR tubes, the idle current must exceed the maximum screen or load current; otherwise, the VR tube will extinguish since increased load current causes corresponding decrease in tube current. Also, it may be necessary to use a plurality of VR tubes in series.

In either case, there is a power loss that is substantial if good regulation is obtained.

One of the objects of this invention is to provide suitable regulation, such as for a screen grid, without requiring any bleeder resistor whatsoever and without requiring any VR or equivalent device which consumes substantial idle current. Accordingly, the power consumption necessary for regulation is virtually nil.

Another object of this invention is to provide regulation, such as in connection with a screen grid tube in a power amplifier or the like, that can be held readily within two or three percent. With poor regulation, a high, no-load screen voltage must be specified in order to ensure at least a minimum screen grid voltage. Improved regulation for a screen voltage thus makes possible reduced no-load value for screen voltage. Plate characteristics can be more effectively utilized.

In order to accomplish the foregoing objects, novel use is made of a voltage regulator tube, diode or comparable device which, when operative, provides a predetermined and stable voltage drop. The voltage regulator tube or the equivalent device is inserted between the high voltage power supply and the screen grid directly and without any bleeder circuit whatsoever. All current through the regulator tube passes through the screen grid and to the cathode of the tube. No current passes through a shunt or bleeder resistor. The regulation for the screen grid is derivative in that it depends upon the stability of the high voltage supply for the system as a whole. Normally this is maintained within small limits that are quite acceptable. Accordingly, appropriately well regulated

lower voltage is provided for screen grid or equivalent use.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose, there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

The single figure is a diagrammatic representation of a power output section of an amplifier incorporating the present invention.

In the drawing, there is illustrated the final stage of a push-pull power amplifier. Two tetrodes **10** and **11** are arranged in push-pull relationship. Plates **12** and **13** of the respective tubes connect to opposite ends of a primary winding **14** of an output transformer **15**.

The tetrodes **10** and **11** have cathodes **16** and **17** connected together, as at **18**. The cathodes **16** and **17** so connected are grounded through the usual resistor capacitor biasing network **19** to a ground connection **20**. A plate voltage, such as for example at 400 volts, is provided for the tubes **10** and **11**. For this purpose, a central tap **21** of the transformer primary **14** connects via a lead **22** to the high voltage terminal **23** of a power supply. The opposite terminal **24** of the power supply **24***a* is connected to ground **20**.

Grids **25** and **26** of the respective tubes **10** and **11** are driven in push-pull relationship by the preceding stage (not shown).

Screen grids **27** and **28** of the respective tubes **10** and **11** are supplied with regulated voltage at a value less than that of the terminal **23** of the power supply. The screen grids **27** and **28** are joined, as at **29**, to a common lead **30**. Between the lead **30** and the B+ terminal **23** of the power supply, a voltage regulator tube **31** (such as a VR105) and a small resistor **32** (of about 270 ohms) are serially inserted. The firing potential of the regulator tube **31** is stable, and a predetermined voltage drop (neglecting the small drop in resistor **32**) is provided between the power supply and the screen grids. If the B+ terminal is maintained at 400 volts, with a swing of, say, —8 volts, the screen grids **27** and **28**, when a VR105 tube is used, will be at 295 volts, with the same —8 volt swing.

The voltage deviation at the screen grids is virtually no more nor less than the voltage deviation of the B+ terminal **23** of the power supply **24***a* because the device or tube **31** introduces a definite voltage differential. Since the power supply is itself well regulated, the voltage at the screen grids **27** and **28** is correspondingly regulated. When using a voltage regulator tube, a minimum current of several milliamps must be provided to maintain operation, in accordance with well-known characteristics of such tubes.

A capacitor **34** is connected between ground **20** and to the common screen grid lead **30**, as at a junction **35**. The capacitor **34** serves as further filtering means for bypassing high frequency impulses from the screen grids. Its value, determined with respect to this intended function, may be of the order of ten to thirty microfarads. The capacitor, of course, absorbs no power. No bleeder resistor steals power.

The small resistor **32**, which may have a value of about several hundred ohms, ensures against any oscillatory condition created by virtue of the presence of the capacitor **34**.

A regulated voltage source lower than that of the main

power source is thus, in a simple manner, provided for the screen grids **27** and **28**. Improved characteristics can be achieved for the tubes **10** and **11**.

It will be obvious that the circuit is described in connection with a typical application. Instead of a voltage regulator tube, any device of this character that introduces a predictable voltage drop can be substituted therefor. The circuit differs from a normal regulation circuit in that regulation derives from, or is derivative with respect to, the main power supply.

The inventor claims:

1. In an electrical system of the class including a regulated direct current voltage supply having a high voltage terminal and a load extrinsic to said voltage supply designed to be supplied with regulated voltage at a value lower than that of said high voltage terminal, the combination therewith of a serial connection between said high voltage terminal and said load including a constant voltage device, the serial connection being devoid of associated power consuming bleeder circuits so that the average or net current of the load is the average or net current through said constant voltage device.

2. In an electrical system of the class including an electronic emission tube having a series of electrodes including a screen grid, a plate and a cathdoe, and a regulated direct current voltage supply having a high voltage terminal connected to said plate and a relative ground terminal connected to said cathode, the combination therewith of connection means between said high voltage terminal and said screen grid, serially including a device having the characteristics of a voltage regulator tube, said connection means being devoid of associated bleeder circuits so that the screen grid current and the current through said device are equal whereby the plate characteristics of the electronic emission tube are stabilized by constant screen grid voltage without auxiliary power loss.

References Cited in the file of this patent

UNITED STATES PATENTS

2,010,881	Numans	Aug. 13, 1935
2,127,822	Kock	Aug. 23, 1938
2,409,317	Rosa et al.	Oct. 15, 1946
2,752,555	Light	June 26, 1956
2,790,134	Fox	Apr. 23, 1957
2,843,735	Held	July 15, 1958