May 15, 1945. O. I. THOMPSON 2,375,877

DEVICE FOR MAINTAINING A FIXED BIAS

Filed Nov. 14, 1942

Fig. 1.

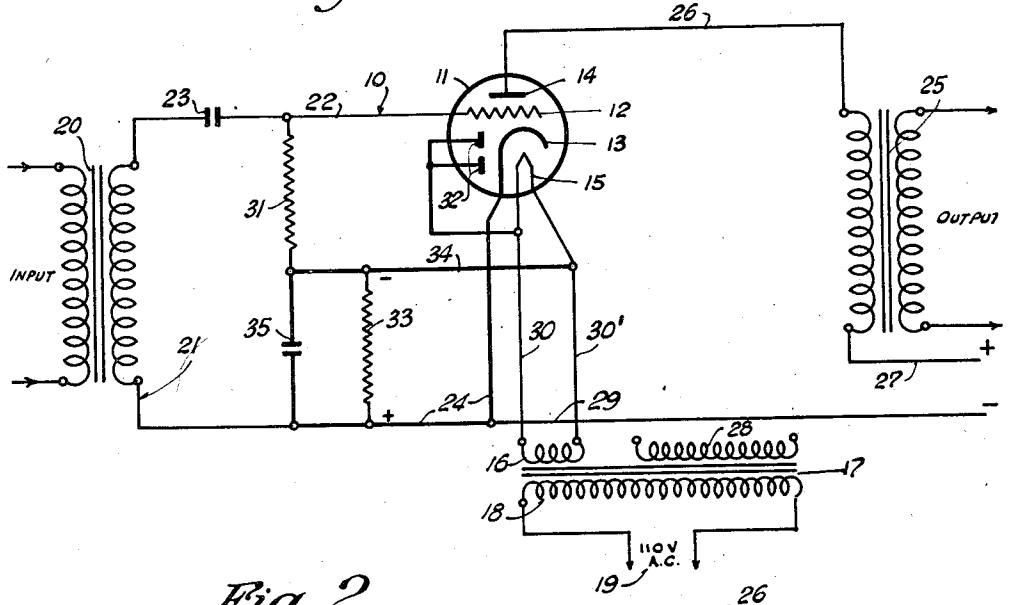


Fig. 2.

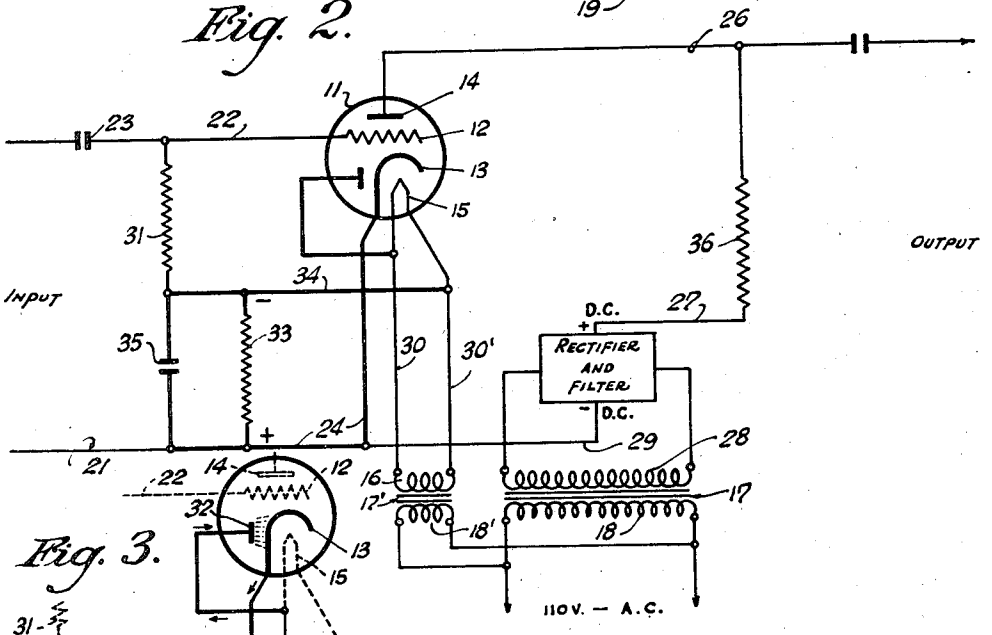
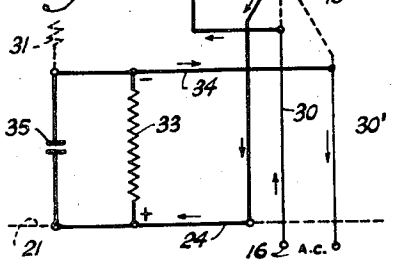


Fig. 3.



Orville I. Thompson
INVENTOR.

BY Clarence E. Threedy
HIS ATTORNEY.

Patented May 15, 1945

2,375,877

UNITED STATES PATENT OFFICE

2,375,877

DEVICE FOR MAINTAINING A FIXED BIAS

Orville I. Thompson, Chicago, Ill., assignor to De Forest's Training, Inc., Chicago, Ill., a corporation of Illinois

Application November 14, 1942, Serial No. 465,595

5 Claims. (Cl. 250—27)

This invention relates to electron discharge devices and more particularly to a device for maintaining a fixed bias from an already existing power supply in thermionic tube circuits.

It is one of the principal objects of this invention to provide a device for maintaining a fixed bias in electronic discharge circuits which will be simple in construction, economical in manufacture and highly efficient in use.

Another object of this invention is to provide in electron circuits a fixed negative potential having a source independent of the signal circuit and dependent upon a uniform voltage supply normally required in the operation of certain other elements employed in the electron discharge circuit.

A further object of this invention is to provide in radio circuits employing a multi-element tube, a rectifier circuit in the tube for converting already existing alternating current into a uniform direct current to supply a negative potential to a grid circuit also employed in the tube.

Other objects will appear hereinafter.

The invention consists in the novel combination and arrangement of parts to be hereinafter described and claimed.

The invention will be best understood by reference to the accompanying drawing in which:

Fig. 1 is a wiring diagram of an audio circuit embodying my invention;

Fig. 2 is a wiring diagram of another form of circuit embodying my invention; and

Fig. 3 is only that portion of a wiring diagram required to carry out the essence of my invention.

In the obtaining of maximum operating efficiency in either oscillator or amplifier circuits in which electron discharge devices are employed, it is essential that the various electrodes of such electron discharge devices be maintained at an electrical potential which varies only in proportion to the input or signal voltages. In maintaining the various electrodes at the desired electrical potential, the grid element is often operated at a certain fixed negative potential with respect to the anode and cathode elements of the tube, which difference of potential between the grid element and anode and cathode elements is called the "bias voltage."

Various circuit arrangements have been employed for supplying a fixed bias voltage to radio circuits. One common method of applying the negative grid potential is to employ a separate source of electrical energy such as a dry cell and while this method accomplishes the result of supplying a bias voltage, it has not been found satisfactory because such dry cells require additional space, are expensive in installation and due to their high mortality rate must be replaced too frequently. Separate rectifier units have been employed to rectify A. C. power supply to produce a fixed bias voltage for obtaining the optimum operating efficiency of the electron tube, but the size of such units and the additional expense of construction and material of separate rectifiers are prohibitive in the production of most electronic devices, and therefore such devices are not satisfactory.

Other methods of obtaining a negative potential for the grid circuit have been the semi-fixed bias method and the self-bias method, both of which are not entirely independent of the signal circuit and thus are variable and not fixed and will fluctuate with the signal, thus developing a distortion in the plate circuit.

In the present invention, the usual circuit is employed but in addition thereto a fixed bias voltage is produced from a uniform voltage supply already employed in the circuit for another purpose and which voltage supply is independent from the signal circuit. In the most desirable method of carrying out my invention, reference is made to the drawing where in Fig. 1 there is shown an amplifier circuit generally indicated at 10. In this circuit is arranged an electronic discharge device or tube 11 and this tube contains the usual grid 12, cathode 13 and plate or anode 14. The cathode 13 is indirectly heated by a filament 15 which obtains a low voltage supply of current by way of conductors 30—30' from a heater supply in the form of the secondary winding 16 of a transformer 17 having the usual primary winding 18 connected to an A. C. power supply 19.

As shown in Fig. 1, there is provided an input transformer 20 which is connected to the grid circuit 21 which includes a conductor 22 extending from the transformer 20 through a grid condenser 23 to the grid 12, and a conductor 24 extending from the cathode 13 back to the opposite terminal of the input transformer 20. An output transformer 25 is arranged in the circuit 10 and is connected by conductor 26 to the plate 14 to transmit plate current to the primary winding of the output transformer 25, the opposite terminal of the output transformer primary being connected via conductor 27 to the positive side of the plate supply voltage which is direct current or rectified A. C. from the secondary winding 28 of the transformer 17, the negative side of said plate voltage supply being connected

via conductor 29 to the cathode 13 via conductor 24.

A grid load in the form of a resistance 31 is connected across the leads 22 and 24 of the grid circuit 21 and to this is connected the grid bias voltage supply which is the essence of my invention. For this purpose the tube 11 is a multi-element special purpose tube of any of the conventional and well-known types which include, in addition to the electrodes already mentioned, one or more diode plates 32. These diode plates 32 in conjunction with the cathode 13 have a rectifying action on current bridging the diode and cathode and therefore by connecting these two electrodes to a fixed source of low voltage A. C. a fixed D. C. voltage will be produced, which D. C. voltage is adapted for use as a fixed bias voltage.

The voltage supply to the heater element 15 being of a low voltage and being otherwise uniform and unrelated to the signal circuit, has been found to be an ideal source of low voltage alternating current. I therefore connect the conductor 30 to the diode plate 32 and the conductor 30' to the cathode 13 and, in addition, I provide a filter for the direct current, thus provided, by connecting a resistor 33 from the conductor 24 leading from the cathode 13, and connect the opposite terminal of the resistor 33 to the positive conductor 30' (with respect to the diode circuit) of the heater supply circuit by way of conductor 34. The filter further includes a shunt condenser 35 which is connected in parallel with the resistor 33 and together with the latter is connected in series with the grid resistance 31.

The wiring diagram illustrated in Fig. 2 is another form of circuit embodying the identical form of bias circuit but employing only a single diode electrode. The reference characters of Fig. 2 are the same as those applied to Fig. 1, with the exception of the separate transformer unit 17' and its primary winding 18' for the heater voltage supply and the inclusion of a plate resistor 36 in the output or the plate circuit.

As shown in Fig. 3, the heater element 15 will glow to produce a continuous heat, thereby indirectly heating the cathode 13 to cause electronic emissions from the cathode 13 to the diode plate 32, thus permitting part of the alternating current to flow through the diode rectifier elements of the tube 11. The rectifying action of the diode plates 32 will cause the effective portion of the alternating current to appear as pulsating direct current across the resistor 33, which with the shunt condenser 35 will provide a uniform D. C. voltage. The grid circuit 21 being shunted across the resistor 33 through the grid leak resistance 31, the voltage across the resistor 33 will be applied to the grid circuit as a fixed negative potential.

The current in the plate supply line passes through the cathode directly to the plate supply negative and has no effect on the voltage developed across the resistor 33. It will therefore be seen that the "bias voltage" produced by my invention is entirely independent of the signal voltage with respect to both input and output sides of the tube circuit, and for that reason a fixed bias is obtained.

While I have illustrated and described the preferred form of construction for carrying my invention into effect, this is capable of variation and modification without departing from the spirit of the invention. I, therefore, do not wish to be limited to the precise details of construction set forth, but desire to avail myself of such variations and modifications as come within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to protect by Letters Patent is:

1. A bias circuit for an electronic device of known type which includes a plurality of anodes, a cathode for said anodes, a heater for said cathode and having a pair of terminals adapted to be connected to a source of alternating current, a control grid between a first one of said anodes and said cathode, said bias circuit comprising: a bias resistor having a first terminal connected to a first terminal of said heater, said bias resistor having a second terminal connected to said cathode, a second anode connected to a second heater terminal aforesaid whereby to produce a uni-directional voltage drop across said bias resistor, means connected with said bias resistor for smoothing the bias voltage developed thereacross, a leakage resistance connecting said grid with the negative terminal of said bias resistor, and an input circuit connecting with said grid and said cathode, whereby to actuate said device without substantially loading said bias circuit.

2. In a bias circuit for an electronic tube of the type which includes an anode, a diode plate, a control grid, a cathode adapted to be energized from a source of alternating current, bias means comprising: a resistor connected between said cathode and one energizing terminal for said heater, a second resistor connected between said control grid and that terminal of the first-mentioned resistor which is connected to the heater aforesaid, filter means shunted across said first-mentioned resistor, and a connection between a second terminal for said heater and said diode plate, whereby said grid is rendered negative with respect to said cathode, together with input connections to said grid and cathode, adapted to impulse said grid without traversing said first-mentioned resistor.

3. An electronic tube circuit comprising: a tube having a grid, a main anode, a rectifier anode, a cathode for said anodes, a heater filament for said cathode, said heater filament having a pair of terminals adapted for connection to a source of alternating current, a pair of resistors having a common bias terminal connection with one of said pair of heater terminals, a first one of said resistors having a remaining terminal connected to said cathode, the other said resistor having a remaining terminal connected to said control grid, a filter reactance shunted across the terminals of said first resistor, and a load circuit shunted across the aforesaid remaining terminals of the respective resistors, said first resistor providing a negative bias potential for said grid, whereby no effective portion of energy from said load traverses said first resistor to disturb the bias potential provided thereby.

4. A bias circuit for an electronic tube of the type which includes a first anode, a control grid for said anode, a rectifier anode, a cathode for said anodes, a heater for said cathode and having energizing terminals adapted to be connected to a source of heater energy, said circuit comprising: a resistance component connected in shunt across said control grid and said cathode, a bias connection to said resistance component at a point between the aforesaid shunt-connection terminals therefor, said bias connection being connected to an energizing terminal for said heater, a connection between said rectifier

anode and another said energizing terminal for the heater, a filter condenser shunted between said bias connection and said cathode, said tube being adapted to have a signal load connected across said resistance component, said bias connection providing a negative bias potential for said control grid which bias potential is substantially unaffected by said load.

5. Apparatus of the class described comprising a thermionic tube including a cathode, a heater for said cathode and adapted to be energized from a source of alternating current, a first anode cooperable with said cathode, a grid for controlling space current between said cathode and anode, a second anode cooperable with said cathode, circuit connections applying the alternating potential across said heater to said second anode and said cathode, whereby to provide a rectified bias potential, reactance means connected to smooth said bias potential, and connection applying the negative aspect of said bias potential to said grid, whereby to render the latter negative with respect to said cathode.

ORVILLE I. THOMPSON.