Aug. 7, 1934. A. H. COOPER 1,968,875

SUPPLY CIRCUITS FOR THERMIONIC TUBES

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Fig. 1.

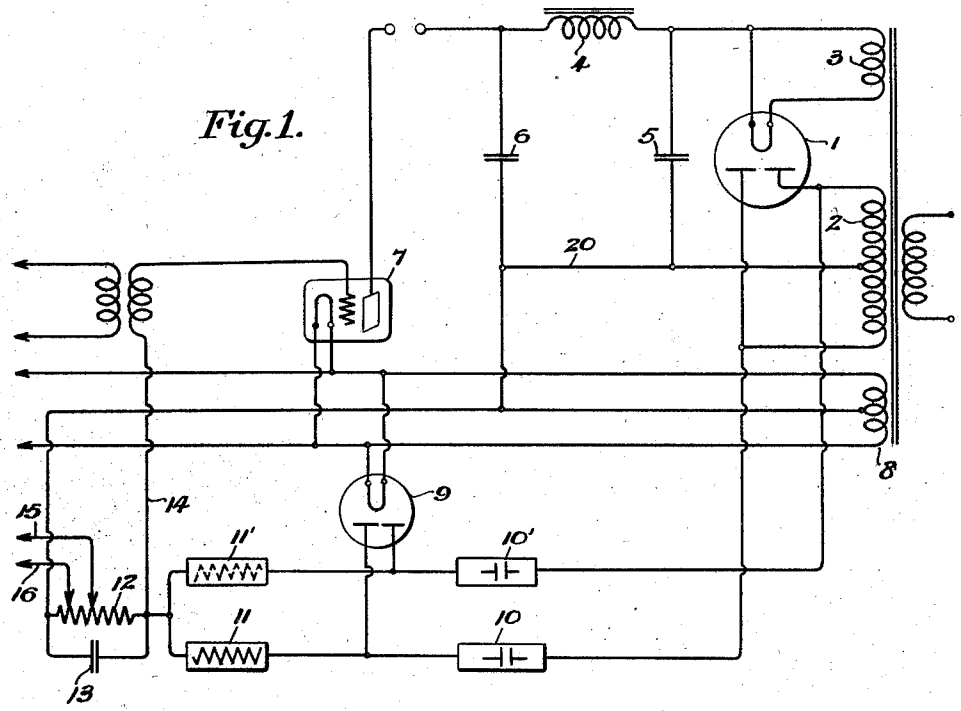
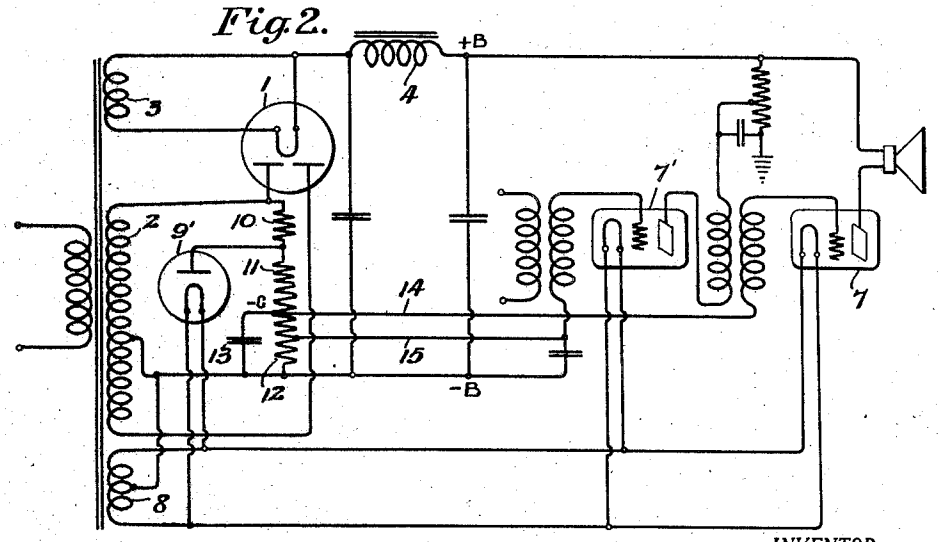


Fig. 2.



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SUPPLY CIRCUITS FOR THERMIONIC TUBES

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15 Claims. (Cl. 250—27)

This invention relates to means for supplying grid bias voltages to thermionic devices which are required to operate from alternating current supply mains.

Hitherto, where the grid bias voltage has been derived from alternating current supply mains, one or other of the two following methods has usually been employed for obtaining the required potential.

In one known method, a series resistance has been inserted in the negative high tension supply to one or more of the tubes, and the voltage drop along this resistance has been used to provide the grid bias. This method is open to objection for two reasons. Firstly, the high tension current of the last, and usually the largest tube must flow through this resistance and the energy thereby dissipated may amount to a quarter of the total energy consumption. Secondly, since the fluctuating current of the last tube is employed to provide a potential for the preceding grids, reaction is liable to be set up, and this must be prevented by additional apparatus entailing further expense.

In another known method, a rectifying unit, entirely separate from that employed for supplying the anode potential, has been provided for supplying the grid bias voltage. This method overcomes the disadvantages mentioned in the preceding paragraph but only at a considerably greater cost.

An object of this invention is to provide an inexpensive and reliable means for obtaining, from an alternating current supply, the grid potential for thermionic tubes.

A further object of this invention is to provide an inexpensive and reliable means for obtaining a main supply of unidirectional potential for a portion of thermionic tube apparatus, and one or more separate supplies of unidirectional potential for other portions, respectively, of such apparatus, deriving said supplies from a common alternating current secondary winding of a power transformer by means of separate rectifiers and filters.

According to this invention, in thermionic tube apparatus in which anode and grid bias potentials are derived from an alternating current source, the anode potential for a tube being obtained from the secondary winding of a transformer with the aid of a rectifier, there are provided means whereby the grid bias voltage for the same tube is obtained from the same secondary winding with the aid of a separate rectifier.

Other objects of my invention will become evident from the following detailed description taken in conjunction with the accompanying drawing, in which in

Fig. 1 there is illustrated diagrammatically a preferred method of carrying the invention into effect, and

Fig. 2 is a circuit diagram of a specific form of my invention.

Referring to the drawing, in Fig. 1 the two anodes of a full wave rectifying valve 1, hereinafter termed the main rectifier, are connected across the secondary winding 2 of a transformer, the primary winding of which is adapted to be supplied with energy from an alternating current source such, for example, as the electric supply mains. The current for heating the filament of the rectifier 1 is also derived from the same source of alternating current by means of a separate winding 3 on the transformer. The positive lead from the filament of the main rectifier 1 is connected through a suitable smoothing circuit or filter comprising a choke 4 in series and condensers 5 and 6 in shunt, to the anode circuit of a thermionic tube apparatus of which only one tube 7 is shown in Fig. 1. The negative lead 20 from the rectifier 1 is taken from the middle point of winding 2 and is connected to the middle point of a further secondary winding 8 on the transformer.

This winding 8 is adapted to supply the current for heating the filaments of the thermionic tube apparatus and, in addition, the filament of a second full wave rectifying valve 9 from which the grid biasing potential is to be derived. The rectifier 9, which may be of a small inexpensive single wave type, is adapted to be supplied with current from the same secondary winding 2 which supplies the rectifier 1. The anodes are connected through high impedances 10 and 10', which may be resistors or condensers, to the ends of the winding 2, and the filament to the middle point of the same winding. For purposes of illustration impedances 10 and 10' have been shown as condensers in Fig. 1. The output from the rectifier 9 is passed on to the negative side 20 of the circuit through high resistance or reactance elements 11 and 11' to one terminal of a potentiometer 12 shunted by a smoothing condenser 13. The positive lead from the rectifier 9 is connected to the other terminal of the potentiometer 12.

The grid bias for the tube 7 is obtained from the rectifier 9 through lead 14, and the grid bias of other stages is derived through leads 15 and 16 from tappings taken on the potentiometer 12.

As the current, which is derived from the winding 2, is usually at a high potential and there is,

therefore, an excessively high voltage available, the high impedance 10 and 10' may conveniently take the form of resistors, e. g. of the grid leak type, as illustrated in Fig. 2.

The apparatus above described operates in the well known manner of rectifying units. Thus the difference in potential between the center point and an end of winding 2 provides the potential gradient between the anodes and filament of each of the rectifiers 1 and 9, and when alternating current is passed through the primary winding of the transformer, rectified current for the anode circuit of the thermionic tube 7 and associated tubes is obtained from the rectifier 1, and the grid bias potential is obtained from the rectifier 9 and tapped off from the potentiometer 12.

It will be clear that the current for heating the filaments of the rectifier 9 and thermionic tubes 7 may, if desired, be derived from a separate source such, for example, as a battery and not from the secondary winding 8 of the transformer. Further, instead of connecting the filament of the grid bias rectifier 9 in parallel with the filaments of the thermionic valve apparatus, the rectifier filament can, if desired, be connected in series thereto.

For purposes of illustrating some of the above mentioned modifications I have shown in simplified rearranged form in Fig. 2 a diagram of a half wave bias valve 9' supplied with current from the secondary winding 2. The main system may similarly employ half wave rectification, but for reasons well known the double wave arrangement shown is preferred. The valve 9' may be conveniently connected to an end of the winding as by means of a resistor 10 of suitable value to reduce the voltage applied to the bias valve, substantially the same as if the valve were connected to an additional intermediate tap on the secondary 2. The resistance elements 10, 11 and 12 may obviously, if desired in practice, be in the physical form of a unitary high resistance or impedance element tapped at the desired points, the valve 9' being in shunt with portions 11 and 12. The resistance element 11, which may possess inductive reactance, constitutes with the condenser 13 an effective filter section for reduction of hum. In accordance with the above disclosure an additional tube 7' in cascade with power tube 7 has been shown, its grid being supplied by lead 15 from a tap on the potentiometer section 12.

It is obviously within the scope of my invention to reverse the direction of current flow through the bias resistor 12 by inverting the bias rectifier in order to provide a positive source of bias potential if desired.

In the above systems the bias rectifier has its anode circuit fed by the usual high voltage winding of the main rectifying system, and its filament energized by one of the usual filament windings for the radio apparatus, with a consequent saving in expense and with the possibility of adapting existing apparatus to my improved system. However, it is sometimes desirable to use another filament winding for the bias valve, separate from the winding 8, e. g. in case the current and voltage ratings of the filaments are different.

A reason for connecting the bias rectifier or valve in shunt relation with the load, or resistors 11 and 12, as above shown, has to do with the fact that the same filament winding 8 is used for both the bias valve and the radio apparatus. It is obvious, however, to one skilled in the art that if a separate filament winding is used for the bias valve the latter may be connected in series with its load in the conventional manner, as in the case of the main rectifier 1, and the valve may likewise be connected directly to a high potential end of the winding. Although a filament type of bias valve has been shown, any other suitable type of well known rectifier or converter could be used, and if desired two separate single wave valves may obviously be used in place of the main full wave rectifier valve 1.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

1. In combination with thermionic tube apparatus, an alternating current supply winding, means connected with one end of said winding for supplying a portion of said thermionic apparatus with rectified potential of positive polarity relative to a point of reference potential, and means connected to the other end of said winding for supplying unidirectional potential of negative polarity relative to said point to another portion of said thermionic apparatus, said point being connected to said winding intermediate the ends thereof.

2. In combination with thermionic tube apparatus, an alternating current supply winding, converting means connected in series with said winding between spaced points for supplying a portion of said thermionic apparatus with current, and a second converting means connected in shunt relation with said winding between other spaced points thereon for supplying unidirectional potential to another portion of said thermionic apparatus.

3. In combination, thermionic tube apparatus, an alternating current supply winding, a rectifier connected to said winding for supplying anode voltage to the tubes in said apparatus, an impedance network including inductive reactance means connected across a portion of said winding, and a second rectifier connected to said network for providing grid bias potentials for said thermionic tube apparatus, the connections being such that alternating potential is supplied to each rectifier in phase.

4. In a supply circuit for thermionic tube apparatus, means for supplying plate potential to said apparatus comprising a rectifier and a middle tapped secondary winding of a transformer connected to a source of alternating current, means for supplying grid bias potential to said apparatus comprising a second rectifier connected effectively in shunt relation to a portion of said winding, and a reactance element connecting an electrode of said second rectifier to a point of high potential on said transformer secondary winding with respect to the mid-point thereof.

5. In a supply circuit for thermionic tube apparatus, means for supplying plate potential to said apparatus comprising a rectifier and a secondary winding of a transformer connected to a source of alternating current, means for supplying grid bias potential to said apparatus comprising a second rectifier, a high impedance element for connecting an electrode of said second rectifier to a high potential point on said transformer secondary, a potentiometer connected to said rectifier and to an intermediate point on said winding, and means for connecting a control electrode of said apparatus to a point on said potentiometer.

6. In a supply circuit for thermionic tube apparatus, means for supplying plate potential to said tube apparatus comprising a rectifier and a secondary winding of a transformer connected to a source of alternating current, means for supplying grid bias potential to said thermionic apparatus comprising a second rectifier, an impedance element connecting the anode of said second rectifier to a high potential point on said secondary winding and a resistor connected between said rectifier anode and an intermediate point of lower potential on said winding for deriving said grid potential.

7. In a power supply system for thermionic apparatus comprising a middle-tapped alternating current supply winding, a full wave rectifier connected with said winding for supplying a portion of said thermionic apparatus with current, a second rectifier of the half wave type connected with one of the half portions of said winding for supplying unidirectional potential to another portion of said thermionic apparatus.

8. In a power supply system for thermionic tube apparatus, means for supplying anode potential to said apparatus comprising a double wave rectifier and associated alternating current supply winding, means for supplying grid potential to said thermionic apparatus comprising a high impedance network connected in shunt with a half of said winding, a second rectifier connected in shunt with a portion of said network, and means for filtering the rectified current from said second rectifier.

9. In a supply circuit for thermionic tube apparatus, means for supplying plate potential to said tube apparatus comprising a rectifier and a secondary winding of a transformer connected to a source of alternating current, means for supplying grid bias potential to said thermionic apparatus comprising a second rectifier associated with said secondary winding, a condenser for connecting said rectifier to a high potential point on said secondary winding and a filter network connected between said rectifier and a point of lower potential on said secondary for smoothing out the resultant rectified current.

10. In a supply circuit for thermionic tube apparatus, means for supplying plate potential to said tube apparatus comprising an alternating current supply winding, means for supplying grid potential to said apparatus comprising an impedance network connected across a portion of said winding, a rectifier having its anode connected to a relatively high potential point on said network and its cathode to a low potential point on said network, means connected with a portion of said network for deriving said grid potential.

11. In a supply circuit for thermionic tube apparatus, means for supplying plate potential to said tube apparatus comprising a rectifier and a secondary winding of a transformer connected to a source of alternating current, means for supplying grid bias potential to said thermionic apparatus comprising a second rectifier of the filamentary type whose anode is connected to a point on said winding, and a separate winding on said transformer for energizing the filament of said second rectifier, said separate winding being adapted to supply cathode current to a tube of said thermionic apparatus.

12. In combination, a power-transformer having a secondary winding, a plurality of rectifying devices each having an anode and a cathode, one device adapted to supply relatively heavy current at high potentials and another of said devices adapted to supply relatively light currents from which biasing potentials may be derived, and connections for applying alternating potentials to both of said devices from said secondary winding, the connections being such that alternating potential is supplied in phase to each device.

13. The invention set forth in claim 12 wherein the cathode of each device is energized from a transformer secondary individual thereto.

14. The invention set forth in claim 12 further characterized in that an anode of the second mentioned device is capacitively connected to an anode of the first mentioned device.

15. The invention set forth in claim 12 characterized in that the cathode of each device is energized from a transformer secondary winding individual thereto, and additionally characterized in that the cathode of the second mentioned device is conductively connected to the secondary winding supplying common anode potentials to the two devices.

ARTHUR HENRY COOPER.