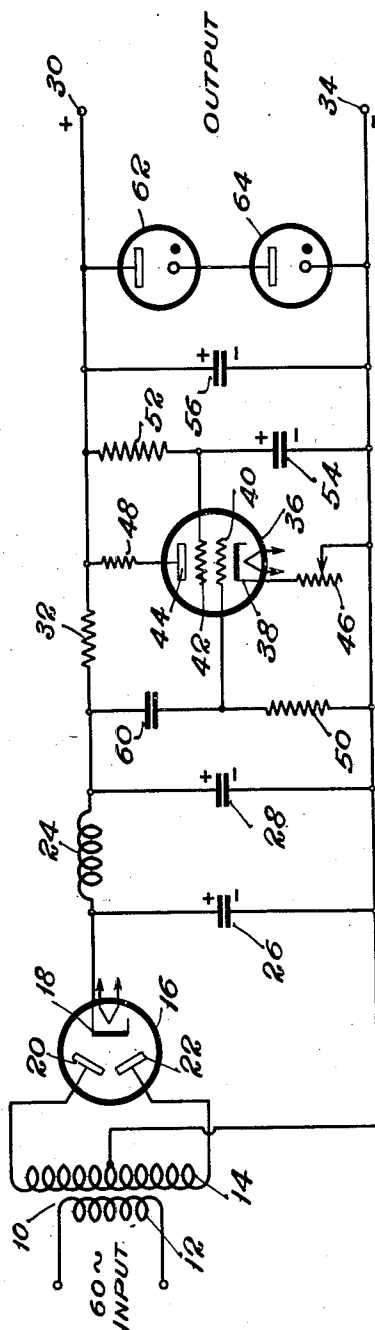


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ELECTRONIC TUBE CIRCUIT

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ELECTRONIC TUBE CIRCUIT

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This invention relates to an improvement in power supplies, and more particularly to an electronic power supply in which provision is made for regulating the voltage supplied thereby.

In most radio equipment, an electronic power supply is provided by means of which it is possible to rectify the usual 60 cycle alternating current power line voltage. In most cases a transformer is interposed between the power line and the rectifier in order to provide a higher alternating voltage. The rectified voltage is then normally supplied to a filter network or circuit for removing the pulsations and for producing a substantially constant voltage source. It is customary to use either a single or a full wave rectifier, and the filter network normally comprises a plurality of series resistances or inductances and a plurality of parallel capacitances.

In such a system, the voltage available at the output of the rectifier is a function of the effective line voltage, the ratio of transformation in the transformer, the rectifier tube impedance and the various constants of the filter network. Furthermore, the voltage available from the rectifier unit or power supply is also a function of the load imposed upon the rectifier since naturally a certain voltage drop is produced throughout the power supply when a load is imposed upon the rectifier. Such electronic power supplies are normally sufficient and are fully capable of handling electron tube anode power demands as well as other current demands in usual radio and electronic circuits. However, there are instances where variations in the supplied voltage cannot be tolerated, and such variations may arise because of variations in the load demand, or because of variations or surges in the 60 cycle power line voltage.

Where a substantially constant voltage is required, it is frequently customary to provide some regulating means for maintaining the output voltage constant, and such means have heretofore been in the form of constant current regulating tubes which may be located in the primary of the transformer, or constant potential regulating tubes (such as a voltage regulator tube) connected across the output circuit of the power supply unit. Even with the one or the other of these regulating elements included in the circuit, the degree of regulation is still in some instances insufficient, and additional means must be provided for affording a more accurate control over the voltage supplied by the power supply unit.

In some electronic apparatus where two or more power supplies are used, it is frequently desirable to provide power supply circuits of such a nature that disturbances, oscillations or transient conditions present in the load circuit of one of the power supply units will not be reflected into the load circuit of the other power supply unit. In such apparatus, feedback through the power supply may be highly objectionable and may result in an erratic or undesired abnormal operation of one of the other pieces of equipment.

In the present invention, an electronic power supply unit is provided in which provisions are made for compensating for variations in the output supply voltage in order that a substantially constant voltage may be derived from the output terminals of the power supply unit. In addition, the present invention includes means whereby the possibility of any feedback through the power supply unit is substantially eliminated.

One of the purposes of the present invention, therefore, resides in the provision of a power supply unit in which a means is provided for compensating for changes in the output or terminal voltage of the supply unit.

Another purpose of the present invention resides in the provision of means in an electronic power supply unit for eliminating or compensating for alternating current variations in the voltage supplied by the rectifier unit.

A still further purpose of the present invention resides in the provision of means in an electronic power supply unit whereby disturbances, oscillations or transients which exist in the load circuit of the power supply unit cannot be reflected into the rectifier, and cannot thereby produce a feedback into other electrical apparatus.

Still another purpose of the present invention resides in the provision of an electronic power supply in which means are provided for compensating for relatively rapid variations in the terminal voltage of the power supply unit, while at the same time the terminal voltage of the power supply may be varied over a considerable range without imposing any load or functions upon the regulating means.

Still other purposes and advantages of the present invention will become more apparent to those skilled in the art from the following detailed description, particularly when considered with the drawing, wherein the single figure represents a preferred form of the present invention.

Referring now to the drawing, there is shown

a power transformer 10 having a primary winding 12 and a secondary winding 14. The primary winding 12 is energized from a conventional 60 cycle, 110 volt power line, and when so energized, a potential is induced in the secondary winding 14 having a value determined by the ratio of the number of turns on the primary and secondary windings. A rectifier tube 16 is provided having a cathode 18 and a pair of anodes 20 and 22. The anodes are connected to the ends of the secondary winding 14, and a mid-tap or center terminal on the secondary 14 of the transformer 10 may be connected to ground or to one side of the filter network associated with the rectifier tube.

The filter network includes, as shown in the drawing, an inductance 24 and a pair of filter condensers 26 and 28. One end of the filter choke 24 is connected to the cathode 18 in the conventional manner, whereas the opposite terminal of the filter choke 24 is connected to the output terminal 30 of the power supply unit by means of a series resistance 32. The center tap of the secondary 14 of the transformer 10 is connected to the other output terminal 34 of the power supply unit. As will be appreciated by those skilled in the art, the terminals 30 and 34 will supply rectified and filtered power, the terminal 30 being the positive terminal and the other terminal 34 being the negative terminal.

Following the filter network of the power supply unit is an electron discharge tube 36 having a cathode 38, a control electrode 40, a screen electrode 42 and an anode 44. The cathode 38 is connected to the negative terminal 34 by means of an adjustable resistance 46, while the anode 44 is connected to the positive terminal 30 by means of an anode resistance 48. The control electrode 40 is connected to the negative terminal of the power supply unit by means of a grid resistance 50, while the screen grid electrode 42 is connected to the positive terminal 30 by means of a screen grid resistance 52. In order to stabilize the potential applied to the screen grid electrode, a filter condenser 54, preferably of the electrolytic type, is connected between the screen grid electrode 42 and the negative terminal 34. The control electrode 40 is coupled to the rectifier end of the series resistance 32 by means of a coupling condenser 60, which may be of an appreciable size depending upon the rate of change that is desired to be corrected by the surge regulator tube 36.

By means of the surge regulator tube 36 and its associated circuits above referred to, it may be seen that a predetermined amount of current will be permitted to pass through the tube 36 depending upon the potential of the control electrode 40 with respect to the cathode 38. The cathode 38 is normally maintained positive with respect to the control electrode by reason of the inclusion of the adjustable cathode resistance 46.

Tube 36 operates as an amplifier tube which is adjusted to unity gain considering the voltage developed on the series resistor 32. When such an adjustment is made, the voltage developed across resistance 32 by reason of the current flow through the surge tube 36 exactly equals the voltage fluctuations present at the junction of inductance 24 and resistance 32, and this voltage is exactly out of phase with respect to the voltage variations at that point.

In operation, should a voltage variation or fluctuation (exceeding a predetermined rate) be present at condenser 28, this fluctuation or variation

in voltage will be impressed upon the control electrode 40 through condenser 60 to alter the amount of current permitted to pass through the surge tube 36. This, in turn, affects the amount of current which is permitted to pass through the series resistance 32, and since the tube is adjusted to have a gain of substantially unity, the produced fluctuations appearing across resistance 32 as a result of the change in the current permitted to pass through tube 36 will exactly compensate for the fluctuations or variations present at the condenser 28. Accordingly, the voltage available at the output terminal 30 will be entirely free from the fluctuations or variations which were present at the condenser 28.

The gain of the amplifier may be conveniently adjusted to perform a substantially complete cancellation of any fluctuations or variations by an adjustment of the cathode resistance 46 which regulates the degeneration of the tube.

Under some conditions, the surge tube may be followed by an additional filter condenser 56 and also, where desired, voltage regulator tubes such as 62 and 64 may be connected across the output terminals in order to compensate for relatively slow or gradual variations in the terminal voltage of the power supply unit.

It will be appreciated that by reason of the inclusion of the condenser 60, the surge tube 36 will respond only to variations above a predetermined rate, inasmuch as very slow variations in the potential at condenser 60, which may be termed direct current variations, do not have any effect on the grid voltage of surge tube 36, with the result that no compensation for these variations is provided. When the voltage regulator tubes 62 and 64, however, are included in the circuit, the amount of current passed by these tubes will depend upon the terminal voltage of the power supply unit, and by reason of the presence of the series resistance 32 together with the resistance component of the choke 24, a further regulating effect may be produced.

In some circumstances, it may be unnecessary to include the voltage regulator tubes 62 and 64 since the apparatus connected to the power supply unit may be substantially unresponsive to slow changes in the terminal voltage. Furthermore, it is conceivable that it may be desirable to alter manually the terminal voltage by some provision, in which case the voltage regulator tubes would naturally not be included. When the voltage regulator tubes 62 and 64 are omitted, it is, therefore, possible for the terminal voltage of the power supply unit to vary at a slow rate without affecting the surge tube 36, while more rapid fluctuations or variations present at condenser 60 will cause the electron stream in the tube 36 to be modulated with the result that these fluctuations or variations will be exactly compensated for.

The present invention has a distinct advantage over controlled regulator tubes which are affected by the direct current potential of the power supply voltage, since in such circuits the controlled regulator tube will function satisfactorily only provided no excessive changes are present in the terminal voltage of the rectifier. In the present invention, however, the surge regulator tube 36 will compensate for relatively rapid surges of fluctuations in the potential of the power supply irrespective of slow variations in the terminal voltage, and as a result, the surge tube 36 will be effective to remove undesired fluctuations such as, for example, hum modulations or line voltage surges, even though a consider-

able change may in fact occur in the direct current potential of the terminal voltage of the rectifier. The operating range of the surge tube 36 is, therefore, considerably extended as compared with the operating range of previously used controlled regulator tubes, yet the surge tube 36 is entirely effective for removing or compensating for relatively rapid variations in the potential present at condenser 28.

In the described circuit, resistor 48 serves to reduce the plate or anode voltage of tube 36 to a value consistent with its dissipation rating. In the design of the voltage regulator described, care should be taken to make the time constants of condenser 60 and resistance 50, as well as condenser 54 and resistor 52, of such a value as to pass the lowest frequency surges or disturbances which are to be eliminated. The effective gain of the tube 36 is preferably made equal to unity by suitably selecting the type of tube, the value of the resistance 32 and by adjustment of resistance 46.

Although the present invention is shown more or less specifically in the drawing and described somewhat in detail, it is to be understood that various alterations and modifications may be made therein without departing from the spirit and scope thereof, and it is desired that any and all such alterations and modifications be considered within the purview of the present invention, except as limited by the hereinafter appended claims.

Having now described my invention, what I claim as new and desire to have protected by Letters Patent is:

1. A stabilized electronic power supply having positive and negative output terminals comprising a rectifier for providing a source of pulsating voltage, a filter circuit having positive and negative energy terminals, the filter circuit operating to produce substantially constant voltage energy from the pulsating voltage, a load resistance connected between the positive energy terminal and the positive output terminal, an electron discharge tube having a cathode, a control electrode, a screen electrode and an anode, means including a resistance for connecting said cathode to the negative energy and output terminals, an anode resistance connected between said anode and the positive output terminal, a screen resistance connected between said screen electrode and the positive output terminal, a condenser connected between said screen electrode and the negative output terminal, a resistance connected between said control electrode and the negative output terminal, and a condenser connected between said control electrode and the positive energy terminal whereby the impedance of the electron discharge tube will be altered by voltage variations at the energy terminals to compensate for such variations and to produce a constant voltage at the output terminals.

2. A stabilized electronic power supply having positive and negative output terminals comprising means for providing a source of pulsating voltage, a filter circuit having positive and negative energy terminals, the filter circuit operating to produce substantially constant voltage energy from the pulsating voltage, a load impedance connected between the positive energy terminal and the positive output terminal, an electron discharge tube having a cathode, a control electrode and an anode, means including a resistance for connecting said cathode to the negative energy and output terminals, an anode resistance con-

nected between said anode and the positive output terminal, a resistance connected between said control electrode and the negative output terminal, and a condenser connected between said control electrode and the positive energy terminal whereby the impedance of the electron discharge tube will be altered by relatively rapid voltage variations at the energy terminals to compensate for such variations and to produce a constant voltage at the output terminals.

3. A stabilized electronic power supply having positive and negative output terminals, positive and negative energy terminals to provide substantially constant potential energy subject to fluctuations in potential, a load impedance connected between the positive energy terminal and the positive output terminal, an electron discharge tube having a cathode, a control electrode and an anode, means including a resistance for connecting said cathode to the negative energy and output terminals, an anode impedance connected between said anode and the positive output terminal, a resistance connected between said control electrode and the negative output terminal, and an electron storage element connected between said control electrode and the positive energy terminal whereby potential fluctuations at the energy terminals will cause the impedance of the electron discharge tube to be altered to compensate for such fluctuations and to produce a constant potential at the output terminals.

4. A stabilized electronic power supply comprising a source of substantially constant voltage energy that is subject to relatively high frequency fluctuations, an electron discharge tube having a cathode, a control electrode and an anode, a pair of load terminals, means including a resistance for connecting said cathode to one of the load terminals, a resistance connected between said control electrode and said one terminal, a condenser having a pair of plates, means for connecting one plate of the condenser to said control electrode, a pair of series connected resistances connected between the other plate of the condenser and said anode, means for connecting the other of said load terminals to the junction of said series connected resistances, and means for applying the voltage energy between said one load terminal and said other plate of the condenser whereby fluctuations in the applied voltage energy will cause corresponding fluctuations in the impedance of the electron discharge tube thereby to compensate for such fluctuations and to produce a constant voltage at said load terminals.

5. A stabilized electronic power supply comprising a source of direct voltage having superimposed thereon an alternating component, an electron discharge tube having a cathode, a control electrode and an anode, a pair of load terminals, means including a resistance for connecting said cathode to one of the load terminals, a resistance connected between said control electrode and said one terminal, a condenser having a pair of terminals, means for connecting one terminal of the condenser to said control electrode, a pair of series connected impedances connected between the other terminal of the condenser and said anode, means for connecting the other of said load terminals to the junction of said series connected impedances, and means for applying the voltage between said one load terminal and said other terminal of the condenser whereby the alternating component of the applied voltage will cause corresponding variations

in the impedance of the electron discharge tube thereby to compensate for such component and to produce a constant voltage at said load terminals.

6. A stabilized electronic power supply comprising a source of substantially constant potential energy that is subject to fluctuations, an electron discharge tube having a cathode, a control electrode and an anode, a pair of output terminals, means including an adjustable resistance for connecting said cathode to one of the output terminals, a resistance connected between said control electrode and said one terminal, a condenser, means for connecting one plate of the condenser to said control electrode, a load impedance and an anode impedance connected in series between the other plate of the condenser and said anode, means for connecting the other of said output terminals to the junction of said series connected impedances, and means for applying the potential energy between said one output terminal and the junction of the condenser and load impedance whereby fluctuations in the applied potential energy will cause corresponding fluctuations in the electronic current through the electron discharge tube thereby to compensate for such fluctuations and to produce a constant potential at said output terminals.

7. An electronic voltage regulator for removing voltage fluctuations from a substantially constant voltage energy source comprising an electron discharge tube having a cathode, a control electrode and an anode, a pair of output terminals, means including separate resistances for connecting said cathode and said control electrode to one of said output terminals, a condenser and a pair of impedance elements connected in series and in order between said control electrode and said anode, means for connecting the other output terminal to the junction of said impedances, and means for applying the substantially constant voltage energy between said one output terminal and the junction of said condenser and one of said impedance elements whereby fluctuations in the applied voltage energy will cause variations in the impedance of the electron discharge tube thereby to vary the potential drop across said one impedance element to compensate for the fluctuations and to produce a constant voltage at said output terminals.

8. An electronic voltage regulator for compensating for voltage fluctuations of a substantially constant voltage source comprising an electron discharge tube having a cathode, a control electrode and an anode, a pair of output terminals, means including resistances for individually connecting said cathode and said control electrode to one of said output terminals, a condenser and a pair of impedances, means for connecting the condenser and impedances in series between said control electrode and said anode with the

condenser adjacent the control electrode, means for connecting the other output terminal to the junction of said impedances, and means for applying the substantially constant voltage between said one output terminal and the junction of said condenser and one of said impedances whereby fluctuations in the applied voltage will cause variations in the electron current flow through the tube thereby to vary the potential drop across said one impedance to compensate for the fluctuations and to produce a constant voltage at said output terminals.

9. An electronic voltage regulator comprising a source of substantially constant potential energy that is subject to relatively rapid fluctuations in potential, a pair of output terminals, means including a resistance for connecting the substantially constant potential energy to said output terminals, a variable impedance electron discharge tube connected across said output terminals, and means for controlling the impedance of and the electron current flow through the electron discharge tube in accordance with the relatively rapid fluctuations of the potential energy thereby to produce a corresponding and opposing fluctuating potential across said resistance in order to compensate for such fluctuations and to produce a constant potential at said output terminals.

10. An electronic voltage regulator comprising a source of substantially constant voltage energy that is subject to fluctuations in potential, a pair of output terminals, means including an impedance for connecting the substantially constant voltage energy to said output terminals, a controllable electron discharge device connected across said output terminals, and means for controlling the impedance of the electron discharge device in accordance with the fluctuations of the voltage energy source thereby to produce a corresponding and opposing fluctuating voltage across said impedance in order to compensate for such fluctuations and to produce a constant voltage at said output terminals.

11. An electronic voltage regulator comprising a source of relatively constant voltage that is subject to fluctuations in potential, a pair of output terminals, means including an impedance for connecting the relatively constant voltage to said output terminals, an electron discharge device connected across said output terminals, and means for controlling the impedance of the electron discharge device in accordance with the fluctuations of the voltage source thereby to produce an opposing fluctuating voltage across said impedance in order to compensate substantially for such fluctuations whereby a substantially constant voltage is made available at said output terminals.

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