

- [54] SELECTABLE RECTIFIED ALTERNATING VOLTAGE POWER SUPPLY**

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- [52] **U.S. Cl.**..... 321/2; 315/29; 321/15;
321/27 R

- [51] Int. Cl. H02p 13/22

- [58] **Field of Search** 321/2, 15, 27 R; 328/258,
328/267; 315/1, 3, 27 TD, 29; 178/7.5 R,
DIG. 11

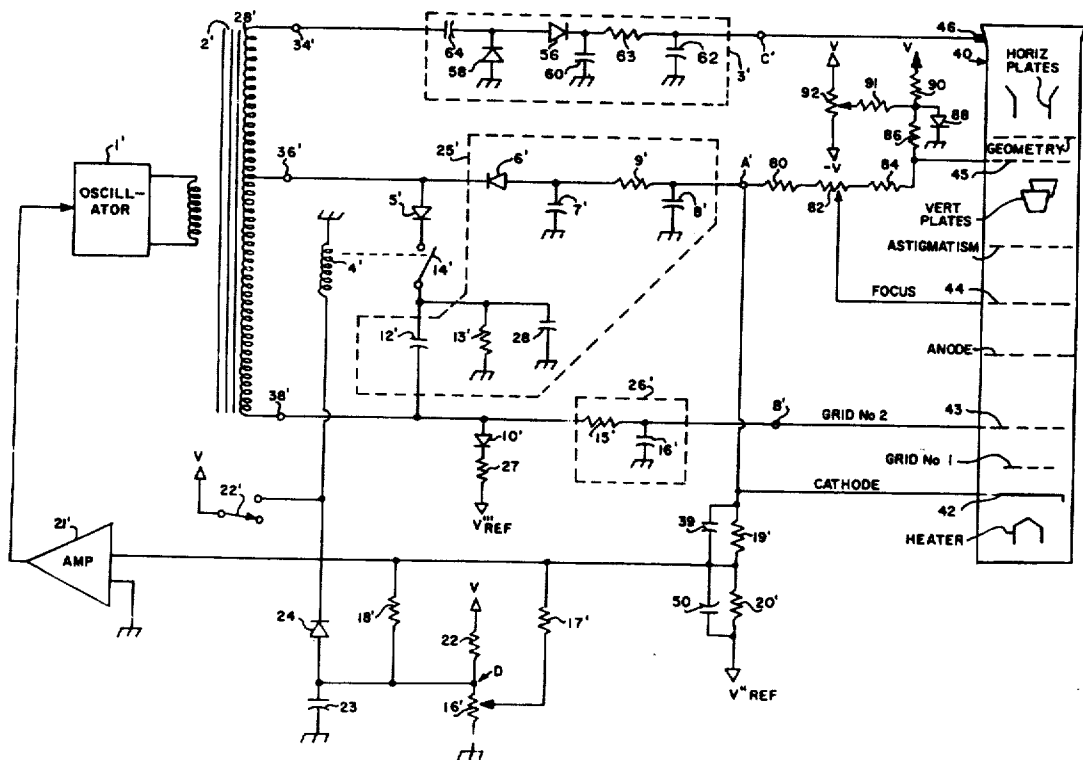
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- [57]
- ABSTRACT**

A power supply is provided wherein a plurality of rectified alternating voltages originating from a single transformer or equivalent are coupled to a plurality of loads and characterized in that at least one of the plurality of alternating rectified voltages can be switched to provide a different rectified alternating voltage to the associated load, all other rectified alternating voltages remaining constant.

18 Claims, 2 Drawing Figures



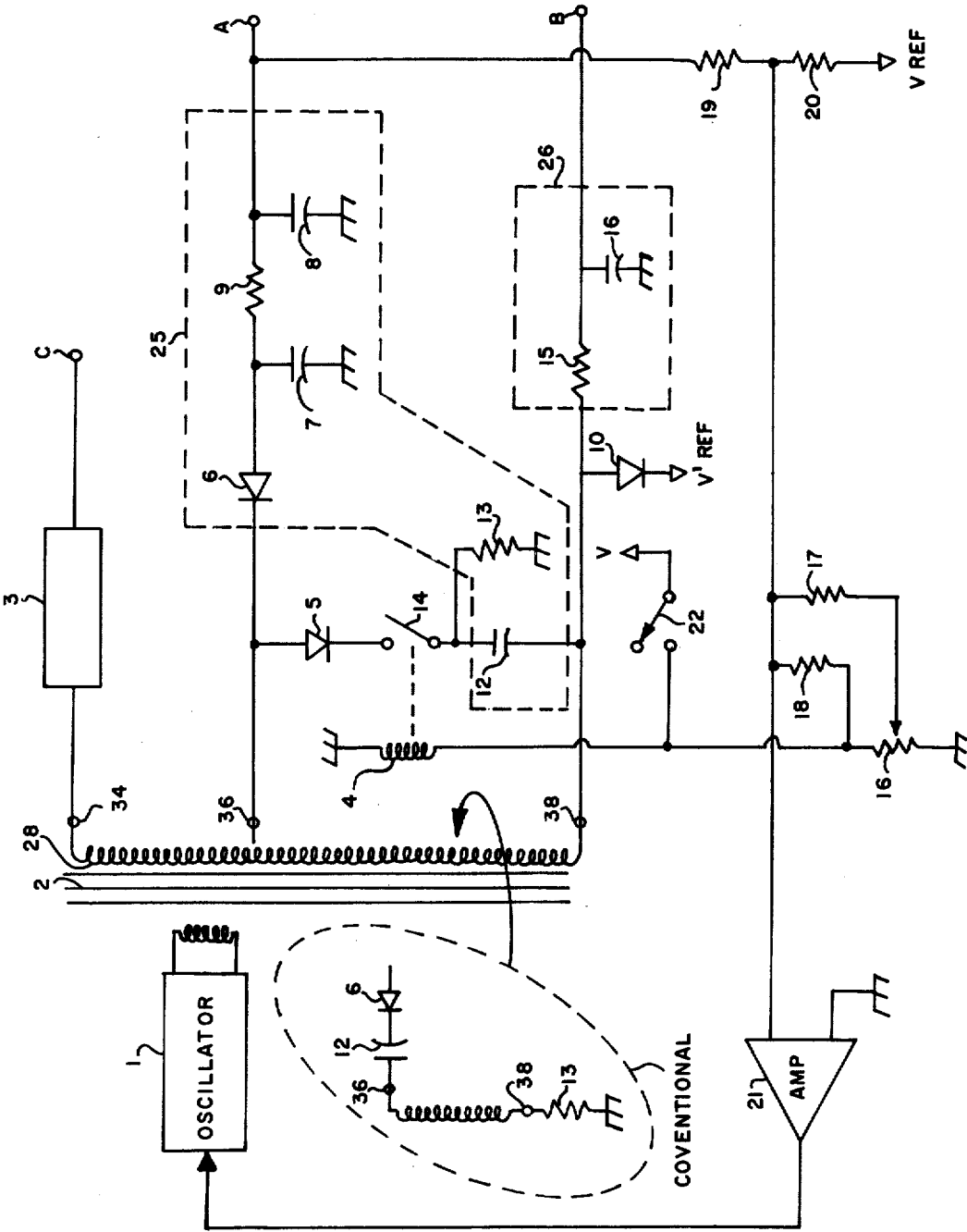


Fig-1

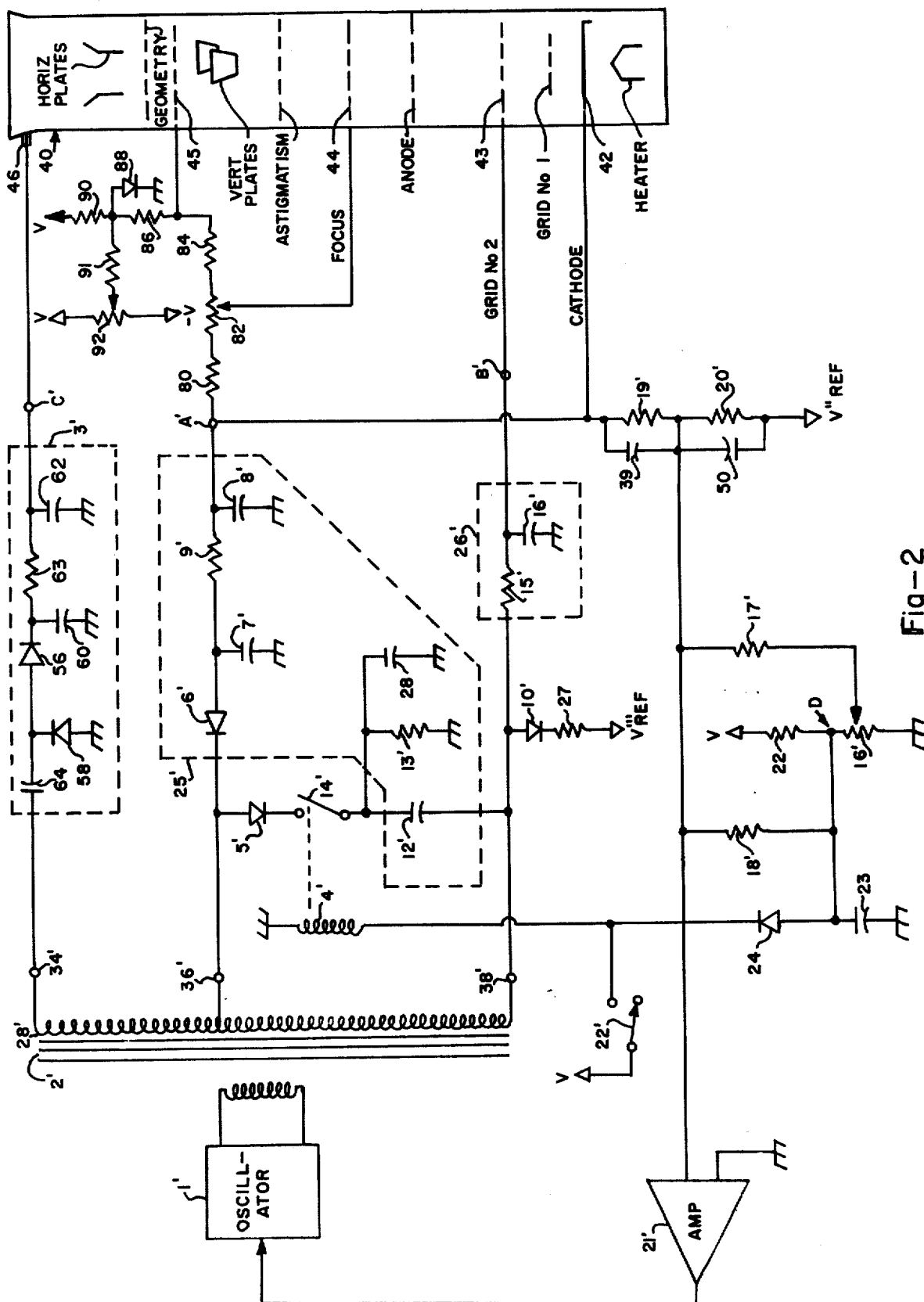


Fig-2

SELECTABLE RECTIFIED ALTERNATING VOLTAGE POWER SUPPLY

BACKGROUND OF THE INVENTION

The need for a power supply having the characteristic to change its voltage versus current characteristic in which the voltage drops substantially from a high voltage, no load condition to a relatively low but constant voltage, high current condition are well known. An example exists in well known light valve projection systems in which an arc lamp, such as of the xenon gas filled type, is used as described in U.S. Pat. No. 3,354,379 by David L. Swain et al.

It is also well known that a high voltage component, such as a cathode ray tube generally is powered by several high voltages which are closely and critically related to one another. The high voltages required either a power transformer having secondary windings driving separate rectifiers and filters for each voltage required, or a power transformer with a single secondary winding which drives voltage multipliers as described in U.S. Pat. No. 3,522,516 by David S. Cochran.

In a high frequency instrument such, for example, as a conventional or storage oscilloscope, the writing speed limits the maximum transition rate of an input signal capable of being observed, stored or photographed. Increased writing rate can be obtained by increasing the electron gun voltage. Higher gun voltage allows sharper focus of the electron beam at the point where it impinges onto a target electrode or phosphor screen thus increasing current density which increases writing rate. However, with a higher gun voltage there is also a proportional reduction in deflection sensitivity. This results in an apparent increase in writing speed since the distance in the reduced image has been reduced. The actual writing speed, write distance per given time, remains the same. As is well known, the deflection sensitivity must be precisely controlled in a device for measuring the absolute value of an electrical signal. The conventional method of controlling the deflection sensitivity is to correct amplification factors of the vertical and horizontal amplifiers associated with the deflection plates. Once the amplification factor is set for a particular gun voltage, it is undesirable to reset it for another value of gun voltage. If the gun voltage is changed by a precise and repeatable multiple, then the sensitivity will be changed by the inverse of that multiple. By choosing a convenient value for the multiple, say 2, the deflection sensitivity will be reduced to one-half and no adjustment need be made to vertical or horizontal amplifiers.

In power supplies of the prior art, especially where voltages are in the kilovolt ranges, switching of various voltages is usually difficult in that a plurality of relays or precautions taken to adequately insulate switches and wiring.

SUMMARY OF INVENTION

The present invention overcomes the disadvantages of the prior art by providing a plurality of rectified alternating voltages originating from a single transformer or equivalent to a plurality of loads and includes single switching means so that at least one of the plurality of rectified alternating voltages can be switched to a different rectified alternating voltages, all other rectified alternating voltages remaining constant. The switching

means includes a single pole single throw reed relay operated from a source of low voltage.

It is therefore an object of the present invention to provide a new and improved power supply which overcomes the disadvantages of the prior art.

It is another object of the present invention to provide a new and improved power supply for providing to a plurality of loads a plurality of rectified alternating voltages whereby at least one of the plurality of rectified alternating voltages can be changed without affecting the others.

It is still another object of the present invention to provide at least two different voltages originating from a single transformer or equivalent.

It is yet still another object of the present invention to provide a new and improved power supply for a voltage component requiring at least two different voltages originating from a single transformer or equivalent and having a single switch means.

It is a further object of the present invention to provide a new and improved power supply for a cathode-ray-tube which can be switched to change the writing rate and deflection sensitivity.

The foregoing and numerous other objects, advantages, and inherent functions of the present invention will become apparent as the same is more fully understood from the following description, in conjunction with the drawings wherein like reference characters refer to like elements, which describes the preferred embodiment of the present invention; it is to be understood, however, that these embodiments are not intended to be exhausting nor limiting of the invention but are given for purposes of illustration in order that others skilled in the art may fully understand the invention and principles thereof and the manner of applying it in particular use so that they modify it in various forms, each as may best be suited to the conditions of the particular use.

DESCRIPTION OF DRAWINGS

In the drawings:

FIG. 1 is a simplified diagram of the preferred embodiment of the present invention; and

FIG. 2 is a circuit diagram according to the simplified diagram of FIG. 1.

DESCRIPTION OF INVENTION

The present invention will be described in detail by reference to the drawings which illustrate the preferred embodiment of the invention in simplified block and circuit form; a high voltage power supply for a cathode-ray-tube. Although the present invention finds special usage in a cathode-ray-tube for controlling and switching the writing rate and deflection sensitivity, it is to be emphasized, however, that the invention is not to be so limited.

Oscillator 1, transformer 2, rectifier-filter combinations 3 and 25, feed back resistors 19, 20 and error amplifier 21 comprise a typical scheme for providing a plurality of loads connected to output terminals A, B and C with a plurality of rectified alternating voltages from a single DC voltage. Such scheme and others may be as described in "Power Supply Circuits," Circuit Concepts, second edition, June 1971, Tektronix, Inc. Basically, oscillator 1 generates a transcendental waveform which is stepped-up in amplitude due to transformer action of transformer 2. The stepped-up tran-

scendental waveform appears across the secondary winding 28 of transformer 2 and is rectified and filtered by rectifier-filter combinations 3, 25 connected across secondary terminals 34-38 and 36-38 respectively, to provide a plurality of rectified alternating voltages to a plurality of loads connected at the output terminals A and C. Rectifier-filter combination 25 consists of the diode 6, capacitors 7, 8, 12 and resistors 9, 13 connected in a conventional manner to provide the output terminal A with a negative voltage. The rectified alternating voltage at output terminal A is compared to a known source of reference voltage V_{REF} across a resistive divider consisting of the feed-back resistors 19 and 20. In response to the comparison voltage, a current is produced to drive error amplifier 21. Error amplifier 21 which can be any conventional error amplifier such as an operational amplifier is current driven to provide an error signal such that oscillator 1 maintains a constant amplitude transcendental waveform of desired frequency. (Frequencies of approximately 10-40 KHz are typical for a conventional cathode-ray-tube.) As can be discerned, any change in the rectified alternating voltage at the output terminal A due to increased load etc., is sensed and corrected back to the desired level.

A slight deviation from a conventional rectifier-filter combination as described is the location of the capacitor 12. Circuit operation however will not differ. In the conventional configuration, the capacitor 12 is in series with the diode 6 between the transformer secondary and such diode as shown in the FIG. 1 offset. In the present invention, capacitor 12 is still located in series with the diode 6, but is positioned below the transformer winding. Thus, an additional voltage is available which is filtered by resistor 15 and capacitor 16 for use at the output terminal B; referenced to a second reference voltage source V'_{REF} via the diode 10. Additionally, as the preferred embodiment is a power supply for a cathode-ray-tube, it is well known that a difference in voltage between a second grid and cathode of such a tube be maintained constant under varying load currents. Thus, a resistor 13, having an equal value of resistance as the resistor 9 connects the capacitor 12 to ground to complete the circuit.

Typical rectified alternating voltages for say, a conventional transistorized power supply for a cathode-ray-tube would be in the order of -1500, +50 and 7,000 volts at the output terminals A, B and C respectively.

As previously stated, the present invention provides a means to develop a plurality of rectified alternating voltages for a plurality of loads from a single transformer and providing a means for changing at least one of the rectified alternating voltages without changing the others. For example, using the stated typical voltages, changing the -1,500 and 50 volts at the output terminals A and B without changing the 7000 volts at the output terminal C.

Accordingly, the present invention incorporates in addition to the above described conventional circuitry a series circuit consisting of the diode 5 and the capacitor 12 in parallel with terminals 36-38 of the secondary winding 28 when the switch 14 is closed. Switch 14 is preferably a single pole-single throw reed relay and is closed when coil 4 is energized by applying a voltage V via a switch 22. Switch 22 can therefore be mounted, say, on the front panel portion of an instrument or the

like employing the invention without the need for special insulating as would be required to normally switch in the kilovolt ranges. A resistor 18 is connected to the coil 4-switch 22 junction and the input to error amplifier 21. A next resistor 16 of variable resistance is also connected to the said junction and ground whereas a resistor 17 is connected between the movable tap of the resistor 16 and said input.

When switch 22 is closed, say to control the deflection sensitivity of the cathode-ray-tube, the present invention is employed. Coil 4 is energized and closes switch 14. With this switch closed, the circuit comprising diodes 5, 6 and the capacitor 12 becomes a voltage doubler. Voltage at the output terminal A therefore increases to a more negative value which is now approximately two times more negative than without employing the present invention. Similarly, the voltage at the output terminal B will be approximately one-half the voltage at the output terminal A. Resistors 9, 13, 15 and capacitors 7, 8, 12 and 16 serve to reduce the AC component. As previously stated, capacitor 12 is also necessary for doubler action; hence, serves a dual function.

To maintain a constant transcendental waveform of constant amplitude across the secondary winding 28 of the transformer 2; hence, maintain the voltage at the output terminal C a constant voltage, additional current must be delivered to the error amplifier 21 when the present invention is employed. Such current is available from the source of potential V via the switch 22; the magnitude is determined by the equivalent resistance of the resistors 16, 17 and 18.

Typical voltages available at the output terminals A, B and C while employing the invention are, for example, -3,000 volts, -1,500 volts and 7,000 volts respectively. As can further be discerned, at least one of the rectified alternating output voltages has changed and at least one of the alternating output voltages remains constant.

Shown in FIG. 2 is a circuit diagram of an actual embodiment of the invention in preferred form according to the simplified diagram of FIG. 1. The power supply consists of oscillator 1', error amplifier 21' for control of oscillator 1' and the transformer 2'. Transformer 2' includes a secondary winding 28' having three terminals 34', 36' and 38' for providing operating voltages to a cathode 42, a post acceleration anode 46, a second grid 43, a focus electrode 44 and an isolation shield 45 of a cathode-ray-tube 40. It is well known that the cathode-ray-tube 40 also includes vertical and horizontal deflection means, heater means, etc., which are essential to the cathode-ray-tube operation but not essential to the present invention and are therefore only shown representative in the drawing.

Rectifier-filter combination 3' is connected to the terminal 34' of secondary winding 28' and consists of diode rectifiers 56-58, capacitors 60, 62, 64 and a resistor 63. Such combination operates as a conventional voltage multiplier which produces a positive DC voltage approximately equal to the peak-to-peak voltage across the terminals 34'-38' of the secondary winding 28'. As is well known, the diodes 56, 58 can be reversed to provide a negative DC voltage at the output terminal C, or additional diodes to form a full-wave bridge voltage doubler.

The alternating transcendental waveform at terminal 36' is half-wave rectified-filtered by rectifier-filter

combination 25' including rectifier diode 6', capacitors 7', 8', 12', 28 (capacitor 28 provides an AC path across the resistor 13') and the resistors 9', 13'. A rectified alternating negative voltage across the capacitor 8' is applied directly to the cathode 42 and also to isolation shield 45 and focus electrode 44 through a series connected resistive divider consisting of resistors 80-82-84-86 referenced to the anode voltage of the diode 88. In the conventional mode, the diode is conducting current via a resistance network including the resistors 90, 91 and 92 connected to source voltages V and -V. Thus, in a conventional mode, output terminal A at -1,500 volts, the focus electrode 44 of the cathode-ray-tube 40 is adjustable as the resistor 82 is of variable resistance whereas shield electrode 45 is fixed. When the present invention is employed, output terminal A at -3,000 volts, diode 88 is reversed biased hence the adjustment of resistor 92 precisely adjusts the vertical gain of the cathode-ray-tube 40.

The cathode 42 is also connected to the reference source V''REF via feed back resistors 19' and 20' as previously explained. In this embodiment, however, capacitors 39 and 50 in parallel with resistors 19' and 20' respectively form a capacitive divider to insure that the error amplifier 21' operates properly under transient conditions. Similarly, coil 4' diodes 5'-10' and switches 14'-22' are connected as described in FIG. 1. An exception however, is that a resistor 27 has been added in series with the diode 10'. Resistor 27 therefore prevents alternating current variations at terminal 38' of the transformer 2' from entering the source V'''REF. The output terminal B is connected directly to second grid 43 of the cathode-ray-tube 40, such voltage obtained as previously explained. Consequently, the total circuitry operates as previously explained so that a fixed cathode potential such, for example, as -1,500 volts is maintained despite the beam intensity of the cathode-ray-tube 40 due to a control signal being applied to a first grid of such tube. (The control signal is deemed obvious and has not been shown.) Thus, the post acceleration anode 46 also remains constant such, for example, 7,000 volts. This maintains a constant deflection sensitivity of the electron beam of the cathode-ray-tube.

In order to reduce the deflection sensitivity by a fixed factor, say by two, the switch 14' is caused to close by energizing coil 4' via current from the reference source V via the switch 22'. Switch 14' connects the rectifier 5' and the capacitor 12' across the secondary winding 28 defined by terminals 36' and 38'. Thus, the capacitor 12' is charged to the maximum voltage during the half cycle when the terminal 36' is positive relative to the terminal 38'. During the next half cycle, the diode 6' becomes conductive, diode 5 reverse biases, and charges the capacitor 7' to the peak-to-peak voltage of the voltage developed across the secondary winding 28' defined by the terminals 36' and 38'. Thus, the capacitor 8' is also charged to this amount and provides the elevated potentials to the cathode 42, focus electrode 46 and deflection shield 45. Similarly, the output terminal B will be one-half the voltage potential at the output terminal A. Thus, output terminal A is -3,000 volts and output terminal B is -1,500 volts. This reduces the deflection sensitivity to one-half the previous value when the cathode was -1,500 volts.

As the current to error amplifier 21' should be identical whatever the cathode potential selected, employed

is the current source network for maintaining equal sensing current regardless of the cathode potential. Such network is connected to the input of the error amplifier 21' and is similar to the resistor network of FIG. 1 consisting of the resistors 16', 17' and 18'. The terminal D between resistor 16' and 22 is returned to ground through the parallel combination of the coil 4' and the diode 24. Diode 24, resistor 22 and the capacitor 23 are included in the preferred embodiment of FIG. 2 so that correction current to error amplifier 21' is delayed slightly so that switching from one set of rectified alternating voltages to another is actually accomplished before correction begins.

As understood from the above description, the power supply according to the present invention can control the deflection sensitivity precisely by controlling the cathode potential without employing a complex circuit arrangement and eliminates the disadvantages of the conventional method of controlling the deflection sensitivity.

While there has been shown and described the preferred embodiment of the present invention, it will be apparent to those skilled in the art that many changes and modifications may be made without departing therefrom in its broader aspects. Therefore, the appended claims are intended to cover all such modifications as fall within the true spirit and scope of the invention.

We claim:

1. A power supply circuit for providing a plurality of selected output voltages to a utilization device, comprising;

means for generating a transcendental waveform of constant peak amplitude, said means including input means and output means;

means for converting said transcendental waveform, said means including an input means connected to output means of said means for generating a transcendental waveform and output means;

first rectifier means for rectifying said converted transcendental waveform,

said means including an input means connected to output means of said means to convert said transcendental waveform and output means;

second rectifier means for rectifying said converted transcendental waveform, said means including an input means connected to output means of said means to convert said transcendental waveform and output means;

comparison means for comparing said rectified converted transcendental waveform from said second rectifier means and a reference signal, said means including first input means connected to output means of said second rectifier means, second input means connected to said reference signal and output means;

amplifier means for amplifying said compared rectified converted transcendental waveform and said reference signal, said means including input means connected to output means of said comparison means and output means connected to input means of said means for generating said transcendental waveform;

control means for changing said second rectifier means, said means including output means connected to said input means of said second rectifier; source means for generating an additional reference signal means, said means including input means

connected to said output means of said control means and output means connected to input means of said amplifier means; and
utilization means connected to said output terminals of said first rectifier means and said second rectifier means.

2. The power supply circuit according to claim 1 wherein said means for generating a transcendental waveform defines a controllable oscillator.

3. The power supply circuit according to claim 1 wherein said means to convert said transcendental waveform defines a step-up transformer or equivalent.

4. The power supply circuit according to claim 1 wherein said first and said second rectifier means defines diode rectifier means.

5. The power supply circuit according to claim 1 wherein said comparison means defines a passive means.

6. The comparison means according to claim 5 wherein said passive means defines a resistance divider network.

7. The power supply circuit according to claim 1 wherein said amplifier means defines an operational amplifier.

8. The power supply circuit according to claim 1 wherein said utilization circuit defines a voltage component.

9. The power supply according to claim 1 wherein said control means further comprises:
first switch means for switching a potential, said means having an open position and a closed position; and
second switch means for switching said converted transcendental waveform at said second rectifier means input to cause said rectified converted transcendental waveform to have a substantially higher constant peak value.

10. The control means according to claim 9 wherein said second switch means defines a reed relay operating between an open position and a closed position dependent upon the said position of said first switch means.

11. The second switch means according to claim 10

wherein said relay defines a single-pole single throw switch.

12. A power supply for a cathode-ray-tube comprising:

a transformer means having a secondary winding, said secondary winding having at least one additional terminal between a pair of end terminals;
a first rectifier means for rectifying a voltage developed between said pair of end terminals to produce a first voltage for the cathode ray tube;
a second rectifier means for rectifying a voltage developed between one of said pair of end terminals and said one additional terminal to produce at least a second voltage for the cathode ray tube;
selectable rectifier means for additionally rectifying said voltage developed between one of said pair of end terminals and said one additional terminal to change said second voltage for the cathode-ray-tube; and
control means for changing said second voltage independent of said first voltage.

13. The power supply according to claim 12 wherein said transformer defines a step-up transformer or equivalent.

14. The power supply according to claim 12 wherein said first, second and selectable rectifier means defines diode rectifiers.

15. The power supply according to claim 12 wherein said selectable rectifier means further comprises a switch means for selectably causing said selectable rectifier means to change said second voltage.

16. The power supply according to claim 12 wherein said a selectable rectifier defines a voltage multiplier.

17. The second rectifier according to claim 15 wherein said switch means defines a single-pole, single-throw switch having an open position for inhibiting said voltage multiplication and a closed position to enable said voltage multiplication.

18. The switch means according to claim 17 wherein said single-pole, single-throw switch defines a reed relay in series with said third rectifier means.

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