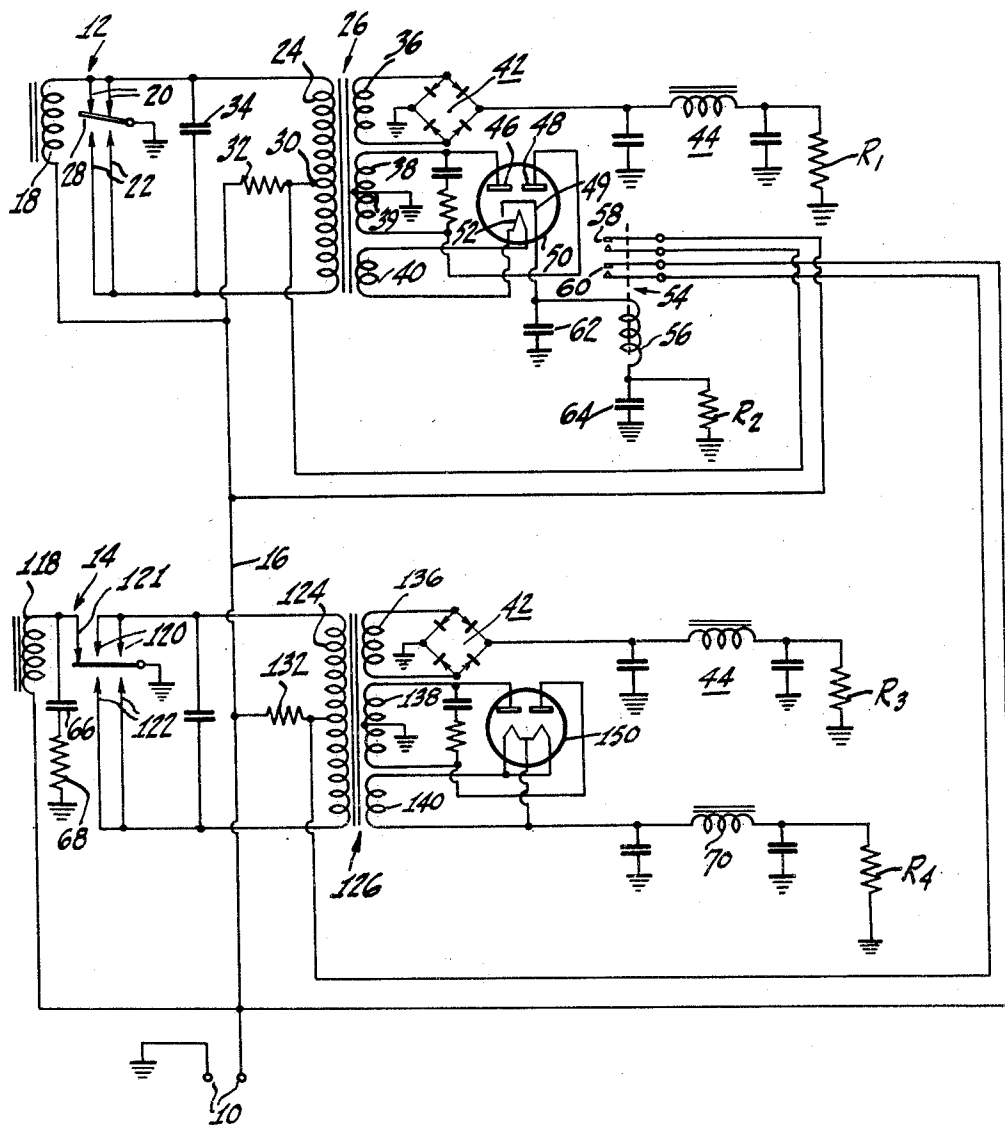


Feb. 27, 1951

T. P. DILLON
VIBRATOR POWER SUPPLY
Filed Dec. 22, 1949

2,543,232



Inventor
THOMAS P. DILLON
Morris A. Rabkin
Attorney

UNITED STATES PATENT OFFICE

2,543,232

VIBRATOR POWER SUPPLY

Thomas P. Dillon, Yeadon, Pa., assignor to Radio Corporation of America, a corporation of Delaware

Application December 22, 1949, Serial No. 134,516

5 Claims. (Cl. 171-97)

1

This invention relates to improvements in electrical power supply systems, and particularly to so-called vibrator power supplies for converting low voltage direct current into relatively high voltage direct current.

Vibrator power supplies usually include a vibratory reed which is actuated by an electromagnet and which bears contacts for alternately establishing a current path through each of two sections of the primary winding of a transformer. Alternate flow of current through the two transformer primary sections causes a change of magnetic flux which induces a voltage in the secondary voltage step-up winding of the transformer, and this secondary voltage usually is rectified to provide a relatively high voltage direct current output.

One of the principal difficulties encountered in such power supply systems arises from the fact that when the vibrator first is energized, the oscillations of the reed do not immediately build up to their normal full amplitude and frequency. As a result, the contact between the reed and the transformer primary sections lasts somewhat longer than during normal operation, so that the current from the voltage source through the transformer primary and the reed contacts reaches an excessive value. When the contacts of the vibrator open, an excessive counter electromotive force is set up which causes arcing and rapid deterioration of the contacts.

To avoid this difficulty, it has previously been proposed to connect a current limiting resistor in series between the transformer primary winding and the low voltage source, and to provide a relay having its operating winding energized by the low voltage source to actuate a pair of contacts for short-circuiting the current limiting resistor after the vibrating reed has reached normal oscillating condition (see e. g. U. S. Patent 2,435,515). While this expedient has proved helpful in alleviating the difficulty, it has been found that the amount of delay which can be "built in" to a relay is not sufficient to protect the vibrator contacts fully. For example, the maximum delay action that can be conveniently provided in conventional relays may be of the order of 1 or 1½ seconds, while the time required for the vibrating reed to reach full oscillation may be of the order of 4 or 5 seconds. Consequently, the foregoing expedient sometimes is not adequate to provide full protection of the vibrator contacts.

It is, accordingly, a principal object of the present invention to provide an improved arrange-

2

ment for protecting the contacts of a vibrator in a power supply system.

A further object of the invention is to provide an improved vibrator power supply system.

In accordance with the invention, the foregoing and other related objects and advantages are attained in a vibrator power supply system having a thermionic rectifier tube in the output section thereof, and with a relay, controlled by the output current of the system, for short-circuiting a current limiting resistor in the input circuit. In such an arrangement, the relay will remain inoperative until sufficient time has elapsed for the electron emitter in the thermionic rectifier tube to become heated to operating condition, thereby adding the heating time of the rectifier to any delay time inherent in the relay operation and insuring that the vibrator reed will be operating normally before the protective resistor is removed from the circuit. Also, the relay winding can be utilized as an inductance element in a filter circuit, thereby reducing the total number of parts required.

A more complete understanding of the invention can be had by reference to the following description of an illustrative embodiment thereof, when considered in connection with the accompanying drawing, the single figure of which is a schematic diagram of a power supply system arranged in accordance with the present invention.

The apparatus shown in the drawing comprises a multiple output vibrator power supply providing 4 different output voltages to load circuits, shown schematically as resistors R_1 , R_2 , R_3 , R_4 , from a single relatively low voltage source. Such a system may be used to advantage in connection with a combined transmitter-receiver apparatus, for example. A pair of input terminals 10 are adapted to be connected to a low voltage direct current source (not shown) to energize a relatively low voltage electromechanical vibrator 12 and a relatively high voltage vibrator 14 through an input lead 16. The return connections to the terminals 10 are shown by conventional "ground" symbols.

The vibrator 12 comprises a reed actuating coil 18 connected to the input lead 16, two pairs of contacts 20, 22, which are connected to the end terminals of the center-tapped primary winding 24 of a transformer 25, and a reed 28 which is adapted alternately to ground the end terminals of the two primary winding sections through the contacts 20, 22 upon actuation of the reed 28.

The center tap 30 of the primary winding 24 is connected to the input lead 16 through a cur-

3

rent limiting resistor 32, and a capacitor 34 is connected across the transformer primary winding 24 to serve as a buffer in reducing arcing during normal operation of the vibrator 12.

The transformer 26 is provided with three secondary windings 36, 38, and 40, across each of which alternating voltages are developed during normal operation of the system. One of the windings, 36, is connected across a full wave rectifier bridge 42 to provide a very low voltage direct current through a filter network 44. The second secondary winding, 38, is a voltage step-up winding connected to the anodes 46, 48 of a thermionic rectifier 50, and a center tap 39 of the winding 38 is connected to the cathode 49 of the rectifier 50 through "ground" so that the rectifier 50 is connected for full wave rectification. The other secondary winding 40 of the transformer 26 is connected across the heater-filament 52 of the rectifier 50 in order to heat the electron emitting cathode 49.

A relay 54 has an operating winding 56 connected in circuit with the rectifier 50, and is provided with two sets of contacts 58, 60 which are adapted to close in response to current flow through the relay winding 56. The contacts 58 are connected across the current limiting resistor 32 so that the resistor 32 will be short-circuited upon energization of the relay 54, while the contacts 58 are connected to perform a similar function in a portion of the apparatus to be described hereinafter. In accordance with an important feature of the invention, a pair of capacitors 62, 64, together with the relay winding 56, form an "L-C" filter network for smoothing out ripples in the rectified voltage developed by the tube 50.

In the portion of the apparatus thus far described, when a low voltage direct current source, say of the order of 24 volts, is connected to the terminals 10, the reed 18 will be in its rest position, as shown, touching the contacts 20. This will allow current to flow through the coil 18, drawing the reed away from the contacts 20, and breaking the circuit through the coil 18. The reed 18 then will return to the contacts 20, and repetition of the same action soon will cause the reed alternately to touch the contacts 20, 22, thereby causing current to flow alternately through the two sections of the primary winding 24. During the first several cycles of operation of the reed, the current limiting resistor 32 will hold the current flowing through the contacts 20, 22 to a value sufficiently small to prevent excessive arcing between the reed and the contacts. The alternate flow of current through the transformer primary winding sections will produce an alternating voltage across the secondary windings 36, 38 and 40, and after a few seconds the cathode 49 of the tube 50 will be heated sufficiently by the filament 52 to allow current to flow in the tube 50. Thereupon, the relay 54 will be energized, closing the contacts 58, 60, and short-circuiting the resistor 32, so that full current can flow through the primary winding 24 of the transformer 26. Inasmuch as the contacts 58 cannot close until after the tube 50 becomes conductive, the current limiting resistor 32 will remain in the circuit long enough to insure that the reed 18 will have reached normal oscillating conditions before the resistor 32 is removed from the circuit. Consequently, arcing at the contacts 20, 22 due to excessive current flow therethrough will be positively prevented during the warm-up time of the tube 50,

4

and this time interval will be more than sufficient to allow the reed 18 to reach normal oscillation.

The high voltage vibrator 14 is connected in a circuit quite similar to that already described for the vibrator 12, with the exception that the vibrator 14 is provided with an auxiliary starting contact 121, and a capacitor 66 and a resistor 68 are connected between the contact 121 and ground to reduce "hash" voltages generated due to slight arcing which may occur at the starting contact 121. A current limiting resistor 132 is connected between the input lead 16 and the primary winding 124 of a transformer 126 to reduce the initial input current to the vibrator 14.

The contacts 60 of the relay 54 are connected to short-circuit the resistor 132 in the manner already described for the resistor 32. The output circuits for the section of the apparatus energized by the vibrator 14 correspond to those already described for the section energized by the vibrator 12, with the exception that an inductor 70 is connected in the filter circuit for the thermionic rectifier 150, rather than a relay winding as in the filter circuit for the rectifier 50.

It can be seen that the apparatus described embodies means for protecting the contacts in each of two vibrator circuits during initial energization of the vibrators, and that the delay provided by the heating time of the electron-emitting electrode in a thermionic rectifier will insure protection of the vibrator contacts beyond the time provided by any delay action of a relay alone. Also, it is evident that the arrangement shown can be used to particular advantage where a cold-cathode rectifier and a thermionic rectifier are used with separate vibrators in the same power supply system, since the delay time provided by the thermionic rectifier can be utilized to protect both vibrators. It will, of course, be understood that any number of vibrators in a power supply system can be protected with a single relay connected in the manner shown and described herein. A further feature to be noted resides in the saving of an element in the filter for the thermionic rectifier, since the relay winding can be used in place of the usual inductor in the filter.

What is claimed is:

1. In a power supply system, in combination, a transformer having a primary winding and a secondary winding, a voltage input network comprising (1) a pair of input terminals, (2) a resistor connected between a terminal of said primary winding and one of said input terminals, and (3) a vibratory current interrupter connected between the other of said input terminals and said primary winding to pass cyclically interrupted current through said primary winding upon connection of said terminals to a source of unidirectional voltage, a relay having an operating winding and a pair of contacts adapted to be closed upon energization of said relay, an output network comprising, in series, (1) one of said secondary windings, (2) a rectifier tube having anode and cathode electrodes and a heater filament for said cathode, and (3) said operating winding, connections from said relay contacts to the terminals of said resistor for short-circuiting said resistor upon energization of said relay, and connections from said filament to said other secondary winding.

2. In a system as defined in claim 1, an inductance-capacitance filter circuit in said output network and wherein the inductance element in

5

said filter circuit comprises said relay winding.

3. A vibrator-contact protective apparatus for a power supply system of the type comprising a transformer having a primary and a secondary winding with a vibratory current interrupter connected to cyclically interrupt current flow through said primary winding and an output network including a thermionic rectifier tube connected to said secondary winding to develop a direct current voltage from alternating voltage developed across said secondary winding by said primary current interruption, said protective apparatus comprising a resistor connected in series with said primary winding to limit the current flowing therein, a relay having contacts and having an operating winding connected in circuit with said thermionic rectifier to close said contacts in response to current flow through said relay winding and said rectifier, and connections from said resistor to said contacts to short-circuit said resistor upon closing of said contacts.

4. A power supply system comprising a pair of input terminals adapted to be connected to a source of unidirectional voltage, a transformer having a center-tapped primary winding and a plurality of secondary windings, a resistor, the center tap of said primary winding being connected to one of said input terminals through said resistor, a vibratory current interrupter having a vibratory contact reed connected to the other of said input terminals and having a pair of stationary contacts alternately engaged by said vibratory contact during vibration thereof, said stationary contacts being connected one to each end of said primary winding, a thermionic rectifier tube having an anode and a cathode and having a filament for heating said cathode,

6

said filament being connected across one of said secondary windings, a relay having an operating winding and having contacts arranged to close in response to current flow through said winding, a filter network comprising the series combination of a first capacitor, said relay winding, and a second capacitor, a connection between said cathode and the junction of said relay winding and one of said capacitors, said capacitors each having a terminal connected to said other input terminal, a connection from one terminal of another of said secondary windings to said anode, a connection from another terminal of said another secondary winding to said other input terminal of said voltage source, and connections from said relay contacts to said resistor for short-circuiting said resistor in response to current flow through said winding.

5. A power supply system as defined in claim 4 including a second transformer having primary and secondary windings, a second resistor connected between a terminal of said second transformer primary winding and one of said input terminals, a second vibratory current interrupter connected between said input terminals and said primary winding to pass cyclically interrupted current through said primary winding upon connection of said terminals to a source of unidirectional voltage, a second pair of contacts associated with said relay and adapted to be closed upon energization of said relay, and connections from said second resistor to said second pair of contacts for short-circuiting said resistor upon closing of said second pair of contacts.

THOMAS P. DILLON.

No references cited.