A method for converting a low voltage input signal of either direct current or alternating current to a high voltage output signal.

ABSTRACT: A high voltage, low current power supply including a trigger circuit which converts direct current to a plurality of pulses. A semiconductor switch is biased to conduction by the application of pulses thereto by the trigger circuit. A capacitor is charged by a source when the semiconductor switch is nonconducting and is discharged when the semiconductor switch is conducting. A transformer converts the energy discharged by the capacitor to a high voltage.

References Cited
UNITED STATES PATENTS
2,526,763 10/1950 Miller.......................... 317/3X
3,078,391 2/1963 Bunodiere et al.................. 320/1UX
3,153,155 10/1964 Scott......................... 321/2X
3,211,989 10/1965 Mintz......................... 323/22
3,273,015 9/1966 Fisher........................ 317/3
3,350,625 10/1967 Larsen........................ 321/45S
3,392,285 7/1968 Olson.......................... 320/IX
3,348,122 10/1967 Todd.......................... 321/18
REGULATED HIGH VOLTAGE, DIRECT CURRENT POWER SUPPLY USEABLE WITH AN ELECTROSTATIC COATING DEVICE

The present invention relates to a power supply for devices requiring unidirectional current at a few milliamperes or less at a voltage of from about 30,000 volts to about 100,000 volts or higher. More particularly, the present invention relates to the combination of a trigger device generating a plurality of pulses, a capacitor and a transformer for providing a low current, high voltage output. In addition, the combination may include a means for converting an AC (alternating current) input signal to a DC (direct current) output waveform which may be rectified by a rectifier means to obtain a direct current. The air-core transformer requires a high voltage input.

Electrostatic charging and deposition of particulate coating materials has become an accepted practice in several industries such as the paint industry. Electrostatic spray painting of articles of manufacture lowers finishing cost by, among other things, reducing the amount of underspray and overspray of paint thereby resulting in a substantial cost saving by substantially preventing paint waste. In addition, electrostatic spray painting of an article usually results in a substantially uniform deposit of paint on the surface or surfaces of the article thereby providing an improved paint finish. Furthermore, the method of electrostatically charging and depositing of paints is particularly advantageous in painting articles having irregular contours in that unusually extraordinary procedures need not be resorted to in order to deposit paint in the area of the irregular contour.

Devices used to electrostatically charge and deposit materials such as paint and the like on articles of manufacture generally include a high voltage, low current DC (direct current) power supply and a means for dispensing the coating material. The device may cause electrostatic atomization, charging and depositing of the liquid coating material onto the article of manufacture or the device may cause charging and depositing of atomized particles onto the article of manufacture. Where a liquid coating material is used, it may be suitably atomized by mechanical means such as centrifugal force, hydraulic pressure, air pressure, combinations thereof and the like.

It is thought that the prior art power supplies available for use with devices for electrostatically atomizing, charging and depositing liquids or for electrostatically charging and depositing atomized particles may be divided into several classifications which include electrostatic generators, the combination of a transformer and rectifier means operated by a 60 cycle AC (alternating current) power source and the combination of a pulse generator producing pulses having a frequency of about several hundred kilocycles or higher and an air-core transformer which converts the high frequency pulses to a high voltage.

Usually, electrostatic generators are not desirable for use with electrostatic devices used to deposit coating particles onto articles of manufacture since the generators are usually larger, heavier, more expensive and possess undesirable electrical characteristics when compared to other types of available power sources providing a similar high voltage, low current output signal.

The combination of the supply frequency transformer and rectifier means has low power consumption providing satisfactory efficiency and provides a substantially steady state DC output waveform having little AC "ripple" from an AC input signal of variable magnitude. However, the combination of the supply frequency transformer and rectifier means is generally bulky and expensive. For example, the combination of the transformer and rectifier means may weigh 30 pounds or more.

The combination of a pulse generator providing an output signal at a frequency of several hundreds of kilocycles or higher and an air-core transformer provides a high voltage, low current output waveform. The high frequency pulses of the pulse generator may be converted by the air-core transformer to a high voltage, low current output waveform which may be rectified by a rectifier means to obtain a direct current. The air-core transformer requires a high frequency input signal to be impressed across the primary thereof since, among other things, the leakage flux of the transformer is high compared to the mutual flux thereof. It should also be seen that a variation in the frequency of the pulses of the pulse generator may effect the magnitude of the voltage output appearing across the secondary winding of the air-core transformer. Problems result when semiconductor rectifying devices are used at frequencies above about 5 kc. For example, the reverse recovery characteristics of the rectifying device are not satisfactory for use at high frequencies. At the high frequencies usually necessary to provide the desired high magnitude of output voltage, a small percentage change in the frequency of the pulses of the pulse generator may materially effect the magnitude of voltage appearing across the secondary winding. Variations in the magnitude of the voltage being used to energize the electrostatic equipment without compensation therefor, may result in variations in the amount of paint transferred from the paint source to the article being coated with the paint.

Therefore, it is an object of the present invention to provide a power supply for electrostatic coating devices which overcomes the above-mentioned problems.

Another object of the present invention is to provide a power supply including a trigger means which causes pulses to be provided to a transformer which converts the pulses to a high voltage.

Yet another object of the present invention is to provide a power supply including a transformer and a combination of a relaxation oscillator and energy storage means supplying pulses to the transformer.

A further object of the present invention is to provide a power supply for use with an electrostatic coating device which has a high voltage, low current output.

Another object of the present invention is to provide a power supply for use with an electrostatic coating device having a high voltage output of a type which allows the coating device to approach optimum performance.

Yet another object of the present invention is to provide a supply for use with an electrostatic coating device which is lighter, smaller, less expensive and processes more advantageous electrical characteristics than several presently available high voltage supplies.

Yet still another object of the present invention is to provide a power supply including a means for converting an AC input signal to a regulated DC signal.

Another object of the present invention is to provide a power supply including a trigger means for providing a plurality of pulses to the gate circuit of an SCR diode to thereby bias the SCR diode to conduction and a combination of inductance and capacitance for forcing commutation of the SCR diode.

A further object of the present invention is to provide a method of converting a low voltage signal to a high voltage signal.

Another object of the present invention is to provide a method of converting energy discharged by an energy storage means as a plurality of substantially equally spaced pulses to a high voltage output signal.

With the aforementioned objects enumerated, other objects will be apparent from reading the following description and appended claims.

In the drawings:

FIG. 1 is an electrical schematic illustrating the means used to provide and apply high frequency pulses to a transformer means; and

FIG. 2 is an electrical schematic of a means for converting AC signals to a DC output which may be applied to the input terminals of the circuit illustrated in FIG. 1.

Generally speaking, the present invention relates to a method for converting a low voltage input signal to a high volt-
age output signal and to a high voltage, low current power supply. The power supply includes the combination of a trigger circuit which provides a plurality of substantially equally spaced pulses, a semiconductor switch, an energy storage means and a transformer. The semiconductor switch is biased to conduction by the application thereto of the pulses provided by the trigger circuit. The energy storage means stores a charge when the switch is nonconducting and discharges the stored charge when the switch is biased to conduction. The transformer means converts the energy discharged by the capacitor to a high magnitude voltage.

Referring now to FIG. 1 of the drawing, a DC signal of substantially constant magnitude appears at terminal 10 which is connected to the input of switch means 11 of the power supply 12. The switch means is used to provide a DC actuation signal to trigger means 13 of sufficient magnitude and duration so as to cause the trigger means to function in the desired manner.

The switch means includes the series combination of blocking diode 14, current limiting resistor 15 and filter capacitor 16 connected between terminal 10 and the ground side of the circuit. As shown in the drawing, the anode of diode 14 is connected to terminal 10. A Zener diode 17 is connected in parallel across the filter capacitor 16. The DC current appearing at terminal 10 may be filtered by capacitor 16. The filter capacitor 16 is not necessary to satisfactory operation of the switch means 11 if the DC signal appearing at terminal 10 is substantially constant in magnitude. The Zener diode 17 may be used to prevent the magnitude of voltage appearing at terminal 19 from exceeding a determined value. A current limiting resistor 19 is connected in series between point 18 and one side of a suitable switch means 20 such as a deplorable switch of an electrostatic spraying device (not shown) of the type shown in U.S. Pat. No. 3,169,882; and the like. The other side of the switch means 20 is connected to the base of NPN switch transistor 21 through resistor 22. Resistor 23 is connected to a point between the other side of the switch means 20 and resistor 22 and the ground side of the circuit. Resistor 22 and resistor 23 cooperate to provide a current divider network.

Actuation of switch means 20 allows the direct current at point 18 to flow through the current limiting resistor 19 and 22 to the base of switching transistor 21. As the base of NPN switch transistor 21 is driven more positive than the emitter, which is connected to the ground side of the circuit, the transistor is biased to conduction providing a low resistance collector-to-emitter current path so that direct current may flow from point 18 to the ground side of the circuit through a relay (not shown) of relay means 24 connected between point 18 and the collector of switch transistor 21. A magnetic field developed in the coil of the relay means due to the current flow therethrough causes relay contacts 25 to engage thereby allowing direct current to flow from point 18 to trigger circuit 13 as long as the contacts 42 of the relay means 24 are engaged.

A clamping diode 25 may be connected across the relay coil of the relay means 24 so to substantially prevent transient currents which may be developed when the magnetic field of the coil of the relay means collapses from being transferred to the NPN transistor 21 which, if allowed to occur, may cause damage to the transistor. The collapse of the magnetic field is due to the cessation of current flow in the coil of the relay means 24.

The trigger circuit 13 may be a relaxation oscillator of the type which generates a plurality of output pulses in response to the DC current flowing thereto from the switch means 11. The trigger circuit includes an adjustable current limiting resistor 26 having one side thereof connected to the contacts of the relay means 24. The other side of the adjustable resistor 26 is connected to the emitter of unijunction semiconductor means 27. Current limiting resistor 28 is connected between the contacts of the relay and base 2 of the unijunction semiconductor means 27. A timing capacitor 29 is connected between the emitter of the unijunction semiconductor means 27 and the ground side of the circuit.

At the beginning of an operating cycle, current from the terminal 10 flows through the actuated switch means 11 and the current limiting resistor 26 to provide a charge across the capacitor. Prior to placement of the charge across the capacitor 29, the emitter of the unijunction means 27 is reverse-biased and hence nonconducting. As the capacitor 29 is charged through the resistor 26, the emitter voltage of the unijunction means rises exponentially toward the voltage appearing at point 18. When the emitter voltage reaches the peak point voltage, the emitter is forward biased and the dynamic resistance between the emitter and base 1 of the unijunction means 27 is reduced to a low value. The capacitor 29 discharges through the emitter and the resistor 30 to the ground side of the circuit. When the emitter voltage drops to a value where the emitter is no longer forward biased, the emitter ceases to conduct and the dynamic impedance between the emitter and base 1 increases thereby terminating the discharge of the capacitor 29 and causing the capacitor to initiate charging. It is seen that the operating cycle is repeated.

The frequency of oscillation of the trigger circuit may be governed by the RC time constant of the combination of resistor 26 and capacitor 29 and the characteristics of the unijunction means 27. The parameters of the trigger circuit illustrated in FIG. 1 cause it to oscillate or go through 1,000 operating cycles per second. The frequency of oscillation of the trigger circuit may be altered by varying one of the trigger circuit parameters such as the capacitance value of capacitor 29, the resistance value of resistor 26 and the like.

The portion of the cycle of operation or oscillation of the trigger circuit during which the unijunction means 27 conducts, a positive going pulse in the base 1 circuit of the unijunction means appears across resistor 30. The resistor 30 is connected between the base 1 circuit of the unijunction means 27 and the ground side of the circuit. The waveform of the positive pulse appearing across resistor 30 may be smoothed by filter capacitor 31 connected across the resistor 30. The filter capacitor does not appear to be necessary for successful operation of the trigger circuit, however, it is desirable.

A series combination of inductor 32, capacitor 33 and primary winding 34 of transformer 34 is connected between terminal 10 and the ground side of the circuit. Prior to the appearance of the positive going pulse across resistor 30, the capacitor 33 may have a charge placed thereacross by the application of the direct current at terminal 10 to the capacitor 33.

SCR diode 35 has the gate circuit thereof connected between base 1 of the unijunction means 27 and the resistor 30. The positive going pulse appearing in the base 1 circuit of the unijunction means 27 and across the resistor 30 is applied to the gate of the SCR diode 35 biasing the diode to conduction allowing an anode to cathode current to flow in the SCR diode. The positive going pulse appearing in the base 1 circuit of the unijunction means 27 is of sufficient magnitude to cause the SCR diode 35 to be forward biased allowing anode to cathode current to flow from the capacitor 33 through the SCR diode 35 to the ground side of the circuit and allowing current flow from capacitor 33 through the primary winding 34 to the ground side of the circuit. Current flow from terminal 10 through the SCR diode 35 to the ground side of the circuit is discouraged by the series connected inductance means 32 which is not capable of instantaneously changing its current flow thereby acting much in the same manner as a high resistance element.

When the SCR diode 35 is biased to conduction, current tends to flow through the capacitor 33 and the primary winding 34 in a direction opposite to that of the initial charge direction across capacitor 33. This tends to reverse the polarity of the charge across the capacitor 33. The current through the capacitor 33 and primary winding 34 reverses, and attempts to flow through the SCR diode 35 in a direction opposite or reverse to the current flow from terminal 10. The SCR diode is biased to nonconductive or force commutated when the reverse current is greater than the current present at terminal.
A diode 45 is connected in parallel across the SCR diode 35 in the manner illustrated in FIG. 1. Diode 45 provides a shunt path for transformer current around the commutated SCR diode 35 so as to assist the current at terminal 10 in recharging the capacitor 33. A series combination of resistor 46 and capacitor 47 is connected in parallel across the SCR diode 35 as illustrated in the drawing. The function of the series combination of resistor 46 and capacitor 47 is to critically dampen or dissipate the stored energy of the transformer 34 when the magnetic field of the transformer collapses.

The EMF of a ferrite core transformer such as transformer 34 or the like may be increased by increasing the frequency of the applied EMF for a change in frequency results in a corresponding change in the properties of the transformer which in turn results in a change in the voltage appearing across the output terminals of the transformer. This, of course, assumes that the other variables appearing in the standard transformer equation remain substantially constant. It should be seen that if the magnitude of voltage of the output wave of the power supply is to remain substantially constant, the frequency of the oscillation applied to the primary winding 34' of the transformer by the trigger circuit should be substantially constant.

A ladder type voltage-multiplier and rectifier means 36 may be connected across the secondary winding 34'' of the transformer 34. The voltage multiplier and rectifier means includes a capacitor 37 having one side connected to an end of the secondary winding 34'' and the other side connected to the anode of diode 38 and the cathode of diode 39. The other side of the secondary winding 34'' is connected to one side of capacitor 40 and to the cathode of diode 38. The other side of the capacitor 40 is connected to the anode of the diode 39. The voltage multiplier and rectifier means 36 multiplies and rectifies the voltage appearing across the secondary winding 34'' so as to provide an unidirectional, high voltage of low current across the output of the voltage-multiplier and rectifier means. The voltage is increased from about 30 kv. to about 60 kv. by the multiplier and rectifier means. Any number of such ladder type multiplier and rectifier means may be connected together so as to multiply the voltage to the desired magnitude. For illustrative purposes only, a single ladder type multiplier and rectifier means is illustrated in FIG. 1 of the drawing.

The amplified high voltage output signal is fed to a series connected high resistance resistor 41. The value of the resistor is sufficiently high so as to provide several megohms per kilowatt. The resistor 41 provides the function of limiting the current so that if the output is grounded, the diodes or rectifiers are substantially protected from overload.

The power supply of the present invention is intended to be used with electrostatic depositing devices such as those shown in U.S. Pat. No. 2,893,894; U.S. Pat. No. 3,169,882; U.S. Pat. No. 3,169,883; and the like.

If it is desired to modify the power supply 12 so as to permit the use of a 110 volt AC signal, the electrical circuitry illustrated in FIG. 2 may be connected to terminal 10 of the power supply illustrated in FIG. 1. It should be noted that the 110 volt AC signal provided by a wall socket may vary considerably in magnitude. Therefore, when a varying AC signal is used as the supply voltage to the power supply, the use of the combination of AC to DC converter 50, voltage compensator means 51 and DC regulator means 52 is suggested. If the AC input signal is substantially constant in magnitude, the voltage compensator means 51 and the DC regulator means 52 may be deleted from the power supply.

An AC signal of varying magnitude, such as that present in a wall socket, is proposed to energize the power supply, the following description serves to illustrate the operation of the modified power supply.

An AC input signal from a suitable AC power source (not shown) such as a 110 volt AC wall plug is impressed on input terminals 53 and 54 of the modified power supply. The input terminal of the modified power supply is shown in FIG. 1, whereas input terminal 54 is illustrated as being the negative input terminal of the modified power supply.

An AC (alternating current) to DC (direct current) converter 50 is connected to the input terminals 53 and 54. The AC to DC converter 50 includes a series connected combination of a transformer 55 such as a step-up transformer and a rectifying means 56 such as a full wave rectifying diode bridge.

The transformer 55 includes a primary winding 55' connected across the input terminals 53 and 54 and a secondary winding 55'' connected across the input of the rectifying means 56. The ratio of the number of turns of the primary winding 55' to the number of turns of the secondary winding 55'' is such that the transformer 55 provides a voltage of increased magnitude across the input of the diode bridge 56. The rectifying means 56 is a full wave rectifier, that is, the diode bridge rectifies the AC output wave appearing across the secondary winding 55'' of the transformer 55 so as to provide a substantially unidirectional or DC output waveform which is transferred to the input of voltage compensator means 51. The rectifier means includes a plurality of semiconductor diodes connected together as illustrated in FIG. 2.

The voltage compensator means 51 is intended to compensate for voltage magnitude variations in the waveform appearing across the output terminals of the rectifying means so that the voltage magnitude variations, if any, are not reflected at the output of the power supply. Voltage variations at the output of the power supply may cause among other things, undesirable variations in the characteristics of the equipment energized by the power supply.

The voltage compensator means 51 includes the series combination of current limiting resistor 57, full wave diode rectifier 58 and Zener diode 59 connected across the output of the rectifying means 56. The Zener diode has the cathode thereof connected to one end of the current limiting resistor 58. Capacitor 60 is connected in parallel combination with the current limiting resistor 58 and to the cathode of Zener diode 59. The series combination of current limiting resistor 61 and timing capacitor 62 is also connected across the output of the diode bridge 56. The cathode of the Zener diode 59 is connected to point 84 and to point 63, between current limiting resistor 61 and timing capacitor 62, through the series combination of resistor 64 and blocking diode 65. The cathode of the blocking diode 65 is connected to point 63. The anode of the blocking diode 65 is connected to the anode of the Zener diode 59 through resistor 66 which is variable. The combination of resistor 64 and variable resistor 66 provides an adjustable voltage divider means. Point 63 of the voltage compensator means 51 is connected to the emitter of unijunction semiconductor switching means 67. Base 2 of the unijunction semiconductor switching means 67 is connected between current limiting resistor 57 and current limiting resistor 58 through current limiting resistor 68. Base 1 of the unijunction semiconductor means 67 is connected to the anode of Zener diode 59 through winding 69' of transformer 69.

Compensation for variations in the DC voltage appearing across the output of the rectifying means 56 is obtained by the parallel combination of resistor 58 and capacitor 60 which adds to the voltage appearing across the Zener diode 59 a DC voltage which is proportional to the voltage appearing across the full wave diode bridge. The sum of the voltage appearing across the parallel combination of resistor 58 and capacitor 60 and the voltage appearing across the Zener diode is used to supply the voltage across base 1 and base 2 of the unijunction semiconductor means 67. The maximum voltage appearing across timing capacitor 62 is generally fixed by the Zener diode 59, therefore, a variation in the DC voltage appearing across the output of the rectifying means such as variation in the AC source voltage results in a reduction of the interbase voltage, that is, the voltage across base 1 and base 2 of the unijunction semiconductor means and a reduction in the emitter peak point voltages of the unijunction means thereby allowing the unijunction means to be biased to conduction by a lower value of voltage. An increase in the voltage across the output of the full wave diode bridge due to an increase in the AC source voltage results in an increase of the voltage across
base 1 and base 2 of the unijunction means 67, and an increase in the emitter peak point voltages of the unijunction means requiring a higher voltage to bias the unijunction means 67 to conduction.

The timing capacitor 62 is primarily charged through resistor 64. When capacitor 62 is charged to a determined voltage level so that the emitter voltage of the unijunction means is about equal to the peak point voltage and the emitter current is greater than the peak point current of the unijunction means, the unijunction means is forward biased and current flows between base 1 and the emitter. The current flow between the emitter and base 1 of the unijunction semiconductor reduces the resistance of the unijunction device allowing the charge across capacitor 62 to be discharged to the ground side of the circuit through the primary winding 69' of transformer 69. When the emitter voltage is no longer greater than the emitter peak voltage due to the resultant discharge of capacitor 62 through the primary winding 69 to the ground side of the circuit, the emitter is reversed biased and the capacitor 62 begins to store a charge thereacross.

When current flows in the primary winding 69' of the transformer, a magnetic flux may be developed in the transformer which causes a current to flow in the secondary winding 69". One side of the secondary winding 69" is connected to the gate of SCR diode 70 while the other side of the secondary winding 69" is connected to the cathode of the SCR diode 70. The anode of the SCR diode is connected to an output terminal of the bridge 56. The current flow in the primary winding 69' of the transformer causes a pulse to be applied to the gate of the SCR diode 70 by the secondary winding 69" of the transformer. The pulse applied to the gate of the SCR diode 70 is of such polarity and magnitude so as to cause the SCR diode to be forward biased, that is, the high positive resistance of the diode drops to about a zero resistance voltage appearing at point 76 regardless of the magnitude of voltage appearing at the input to the DC regulator means.

A pair of NPN transistors 80 and 81 are connected in cascade in the manner illustrated in FIG. 2 of the drawing. The base of NPN transistor 80 is connected to point 76. As the current at point 76 is driven more positively by the accumulation of charge by the capacitor 79, the base of NPN transistor 80 is driven more positive, reducing the transistor's collector-to-emitter voltage and the transistor 80 conducts more current. The collector of transistor 80 is connected to a point between the current limiting resistors 78 and 77. The emitter of transistor 80 is connected to the base of NPN transistor 81. The emitter current conducted by transistor 80 is also the base current of transistor 81. As the emitter of transistor 80 becomes more positive, because of the reduced voltage drop across the transistor, the base of transistor 81 also becomes more positive reducing the transistor's collector-to-emitter voltage and the transistor 81 conducts more current. The current applied to the base of transistor 80 is amplified by NPN transistors 80 and 81 and appears at point 39 of the DC regulator means 52. The collector of the NPN transistor 81 is connected to the collector of transistor 80 through current limiting resistor 78 and emitter of the transistor is connected to terminal 10. A filter capacitor 82 is connected in parallel across the emitter of transistor 81 and one side of filter capacitor 83 as illustrated in FIG. 2 of the drawing.

The DC regulator means provides a DC signal which is substantially constant because of, among other things, the maintenance of the voltage at point 76 substantially constant and the operation of the voltage compensation means 51. It is seen that any variations in the AC voltage which may appear at the output terminals (not shown) of the AC source (not shown) are substantially removed by the combination of voltage compensation means 51 and DC regulator means 52 so that the DC voltage appearing at terminal 10 is substantially independent of AC input signal variations.

The present invention is not intended to be limited to the disclosure herein, and changes and modifications may be made by those skilled in the art without departing from the spirit and the scope of the present invention. Such modifications are considered to be within the purview and the scope of the present invention and the appended claims.

We claim:
1. A substantially constant high voltage, low current direct current power supply comprising:
   a direct current means providing a substantially constant direct current output voltage, the direct current means including an input adapted to be connected to an alternating current source and including means compensating for alternating current voltage magnitude variations appearing at the input;
   means including a trigger circuit having an input connected to the direct current means and an output, the trigger circuit capable of converting the direct current output voltage to a plurality of pulses provided at the output of the trigger circuit;
   means including a semiconductor switch connected to the output of the trigger circuit whereby the application of a pulse from the trigger circuit biases the semiconductor switch to conduction;
   means including an energy storage device connected to the source of direct current and adapted to be charged thereby when the semiconductor switch is nonconducting and adapted to be discharged when the semiconductor switch is conducting;
   means including a transformer having one end of a winding connected to the energy storage device, the other end of the winding connected to the semiconductor switch whereby discharging of the energy storage device provides pulses to the winding of the transformer which are converted to a high voltage by the transformer, and means connected to the transformer for converting the voltage of the transformer to a high voltage, low current direct current output.
2. An apparatus including the power supply of claim 1 and an electrostatic coating device connected to the high voltage, low current, direct current output of the power supply.
3,567,996

3. The power supply of claim 1, wherein the trigger means is a relaxation oscillator including:
   a unijunction transistor having an emitter and base 1 and base 2;
   a resistance-capacitance timing means connected to the emitter of the unijunction transistor and to the source whereby the timing means charges causing the emitter to forward biased so as to bias the unijunction transistor to conduction; and
   a resistance means connected to base 1 of the unijunction transistor providing a discharge path for the charge carried by the capacitor whereby discharging of the capacitor biases the unijunction transistor to nonconduction.

4. The power supply of claim 3, wherein the oscillation frequency of the relaxation oscillator is about 1,000 cycles per second or more.

5. The power supply of claim 3, wherein the transformer includes a ferrite core.

6. The power supply of claim 3, wherein the semiconductor switch includes an SCR diode having the gate thereof connected to base 1 of the unijunction semiconductor whereby positive-going pulses bias the SCR diode to conduction.

7. The power supply of claim 6, wherein the energy storage means and the winding of the transformer cooperate to force commutate the SCR diode upon about cessation of each positive-going pulse.

8. The power supply of claim 7, further including NPN transistor means and relay means adapted to be actuated when the NPN transistor means is biased to conduction connected between the source of direct current and the trigger circuit, actuation of the relay means causing the trigger circuit to be connected to the source of direct current.

9. The power supply of claim 7, wherein the source of direct current includes a direct current regulator means including cascade transistors and a Zener diode connected to the base of the first one of the cascade transistors, the Zener diode maintaining the voltage at the base of the first transistor substantially constant whereby the regulator means provides a substantially constant direct current output.

10. The power supply of claim 9, wherein the source of direct current further includes a voltage compensation means connected to direct current regulator means.

11. A high voltage, low current power supply comprising:
   a source of direct current including voltage compensation means and a direct current regulator means connected to the voltage compensation means, the voltage compensation means including a parallel combination of a resistor and a capacitor, a Zener diode connected in series with the parallel combination and a unijunction transistor having the emitter thereof connected to the cathode of the Zener diode whereby the parallel combination adds to the Zener voltage a direct current voltage proportional to the supply voltage which is fed to the bases of the unijunction transistor thereby regulating biasing of the unijunction transistor in accordance with the variations in the supply voltage, the regulator means including cascade transistors and a Zener diode connected to the base of the first one of the cascade transistors, the Zener diode maintaining the voltage at the base of the first transistor substantially constant whereby the regulator means provides a substantially constant direct current of output;
   means including a relaxation oscillator having an input connected to a source of direct current and an output, the oscillator capable of converting the direct current to a plurality of positive-going substantially spaced pulses provided at the output of the oscillator, the oscillator including a unijunction transistor having an emitter and base 1 and base 2, the pulses being taken from base 1, a resistance-capacitance timing means connected to the emitter of the unijunction transistor and to the source whereby the timing means charges the emitter to be forward biased so as to bias the unijunction transistor to conduction, and a resistance means connected to base 1 of the unijunction transistor providing a discharge path for the charge carried by the capacitor whereby discharging of the capacitor biases the unijunction transistor to conduction;
   means including a semiconductor switch connected to the output of the oscillator whereby the application of a pulse from the oscillator biases the semiconductor switch to conduction, the semiconductor switch including an SCR diode having the gate thereof connected to base 1 of the unijunction semiconductor whereby the positive-going pulse bias the SCR diode to conduction;
   means including an energy storage device connected to the source of direct current and adapted to be charged whereby the semiconductor switch is nonconducting and adapted to be discharged when the semiconductor switch is conducting; and
   means including a transformer having one end of a winding connected to the energy storage device, the other end of the winding connected to the semiconductor switch whereby discharging of the energy storage device provides pulses to the winding of the transformer which are converted to a high voltage by the transformer, the energy storage means and the winding of the transformer cooperating to force commutate the SCR diode upon cessation of each positive-going pulse.

12. The power supply of claim 11, wherein the source of direct current further includes a step-up transformer connected to a source of alternating current and a rectifying means connected to the step-up transformer for rectifying the alternating current, the rectifying means connected to the voltage compensation means so that the rectified alternating current is fed to the voltage compensation means.

13. A method of converting a low voltage alternating current input signal to a high voltage direct current output signal comprising:
   compensating for alternating voltage magnitude variations appearing at an input to an alternating current to direct current converting means;
   providing a plurality of substantially equally spaced pulses from a trigger means upon the application of direct current voltage from the direct current means;
   biasing a semiconductor switch means to conduction by the application of pulses thereto;
   charging an energy storage means when the semiconductor switch means is nonconducting and discharging the energy storage means when the semiconductor switch means is conducting; and
   converting energy discharged by the energy storage means to a high direct current voltage.

14. The method of claim 13, including the further step of commutating the semiconductor switch at about the conclusion of each substantially equally spaced pulse.

15. The method of claim 14, including the further steps of, prior to the step providing a plurality of pulses, converting an alternating current input signal to direct current and compensating for variations in the magnitude of the input signal whereby the plurality of substantially equally spaced pulses are provided.