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Kriege

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[54] **INVERTER BALLAST CIRCUIT**

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[52] **U.S. Cl.** ..... **315/219**, 315/DIG. 5, 315/94, 315/105, 315/276, 313/113 A

[51] **Int. Cl.** **H05b 37/02**

[58] **Field of Search** ..... 315/DIG. 5, 94, 105, 315/219, 276; 331/113 A

[56] **References Cited**

UNITED STATES PATENTS

2,964,676 12/1960 Davies et al. ..... 315/105 X

3,619,713 11/1971 Biega et al. 315/105

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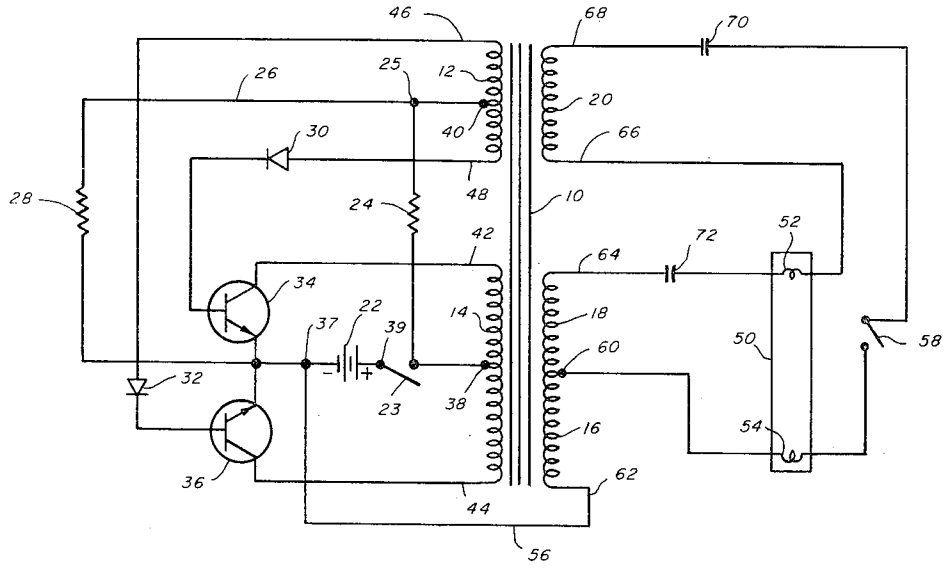
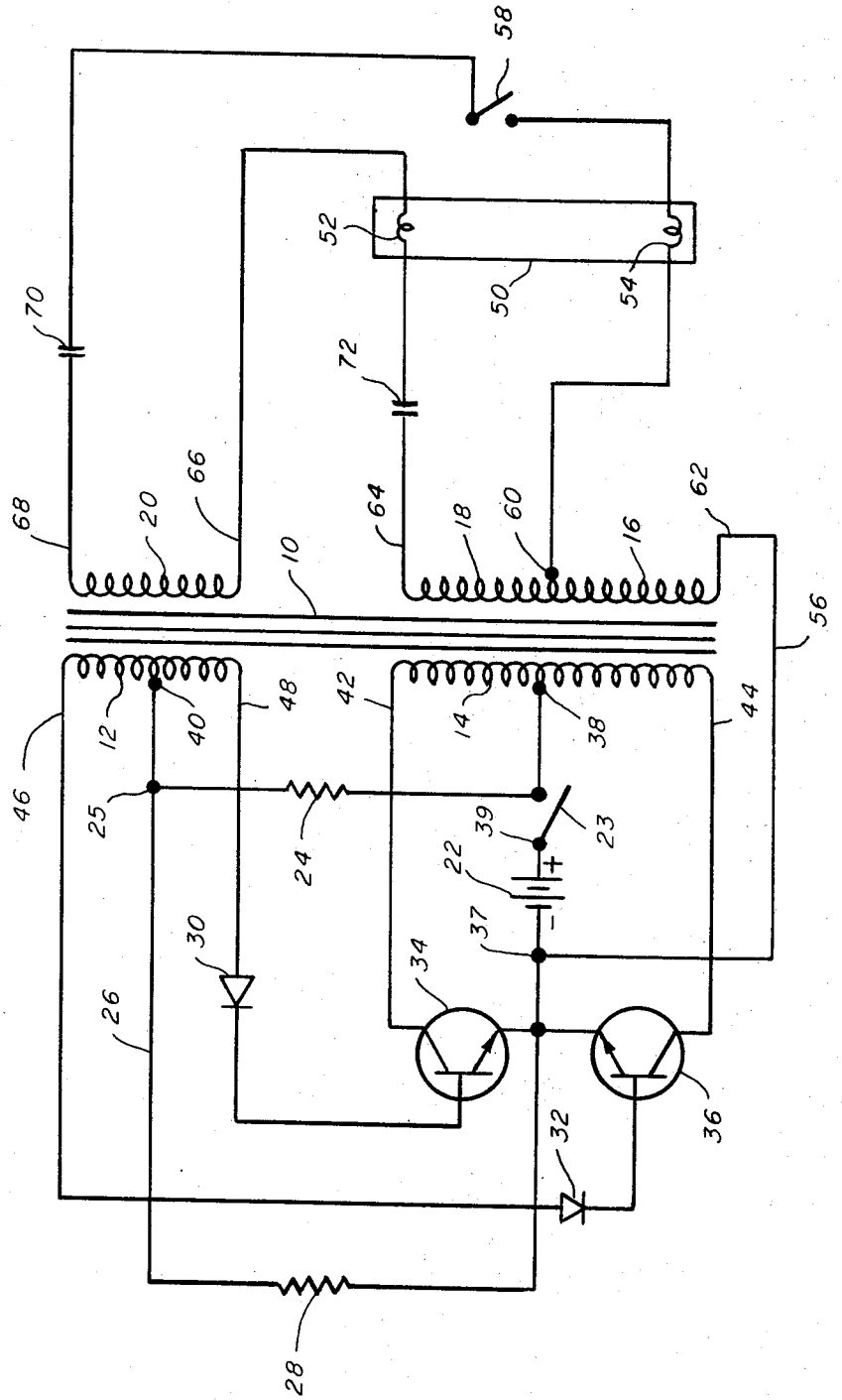
Attorney—James R. Head et al.

[57] **ABSTRACT**

This invention describes a circuit for providing high voltage A.C. potential for the initiation of discharge, and for powering a fluorescent lamp, from a low voltage battery. A principal improvement lies in the use of an additional secondary winding to raise both filaments of the fluorescent lamp to a high voltage A.C. above the ground plane of the battery. This induces ionization inside of the lamp tube by capacitive coupling to the ground plane, and permits more prompt initiation of the discharge in the lamp.

4 Claims, 1 Drawing Figure

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INVERTER BALLAST CIRCUIT

BACKGROUND OF THE INVENTION

This invention lies in the field of inverter voltage generators for providing high voltage A.C. potential from a low voltage D.C. source. More particularly this invention relates to providing a high voltage A.C. potential for lighting a low wattege fluorescent lamp from a low voltage D.C. source. Still more particularly it involves a feature for enhancing the initiation of the discharge in the lamp.

In the prior art devices, use has been made of a multivibrator type of inverter operating from a low voltage battery, and providing an alternating current through the primary of a step-up transformer. The secondary of the transformer in the prior art was connected between the two filaments of the tube, to initiate and maintain a gas discharge in the tube. In the prior art low wattage lamps, use is generally made of filament type lamps, which require a short starting period, during which heating current is passed through the filaments at each end of the tube. In other types, a very high starting voltage is applied across the tube which initiates a glow discharge by the acceleration of ions in the gas. In the process of heating the filaments by this discharge under the extra high voltage, metal is sputtered off the filaments. This reduces their efficiency in providing free electrons. Also, the material that is sputtered off of the filaments gathers on, and blackens the inside surface of the tube, and therefore reduces the lighting efficiency of the lamp.

SUMMARY OF THE INVENTION

It is a principal object of this invention to provide a voltage supply utilizing a low voltage D.C. source of power, to provide a continuing discharge in a low wattage fluorescent lamp. It is a further object to provide more rapid starting of the discharge than is possible in the prior art systems. These and other objects are realized and the limitations of the prior art are overcome in this invention by using an inverter type circuit to provide the primary current to a step-up transformer. The transformer has three secondary windings. One of these windings is used to provide the continuing discharge in the lamp. A second winding, of equal voltage, is used for starting purposes so that by passing current from these two windings in series through the two filaments, they can be heated more rapidly than would otherwise be the case. After the filaments are heated and a glow discharge is started, the second transformer secondary is disconnected, and the glow discharge continues with the first winding alone.

There is a third secondary winding which is of twice the voltage of the first and second secondary windings, which is connected between one end of the first secondary winding and the battery, and therefore to a ground plane at the potential of the negative end of the battery. This high voltage, when added, as it is, to the first secondary voltage gives a very high A.C. voltage (of the order of 500 volts) on one of the filaments. This filament is capacitively coupled to the ground plane and can start ionization inside the lamp. This third secondary winding is not connected into the gas discharge circuit, and is only effective when the lamp is being started. In this respect it is different from the prior art in which the high voltage used to start the lamp is continued with series impedance in the circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of this invention and a better understanding of the principles and details of the invention will be evident from the following description taken in conjunction with the appended drawing which illustrates a circuit diagram, including a power transformer, with plural primaries and plural secondaries. The primary windings are supplied with power from an inverter source, and the secondary windings supply power to the fluorescent lamp.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, numeral 10 indicates a transformer which is the heart of the circuit. This transformer 10 has two primary windings 12 and 14, each of which have center taps 40 and 38 respectively. The voltage of primary winding 14 is approximately five-thirds the voltage of the primary winding 12. A battery 22, which is normally of eight volts, is shunted by two series resistors 24 an 28. The mid-point 25 of these resistors is connected to the mid tap 40 of primary 12. The two terminals 46 and 48 of primary 12 are connected through diodes 32 and 30 respectively to the bases of two transistors 36 and 34 respectively. The resistor shunt provides a biasing voltage on the transistor bases, so as to make them conducting under normal conditions.

The battery at its positive terminal is connected, through switch 23, to the center tap 38 of the primary 14. The two terminals 42 and 44 of the primary 14 go to the collectors of the transistors 34 and 36, while the emitters of the two transistors are connected to the negative terminal of the battery.

The transformer 10 is special in one important respect. It is of the type that has a high hysteresis loss. That is, the hysteresis curve of the core material is a square one, which rises rapidly with exciting current and then flattens off rapidly. This makes the secondary windings saturate and provide a square wave of current. This is important in the action of the inverter.

Referring now to the circuit, when the switch 23 is closed, positive potential appears on both terminals 42 and 44 of the transformer primary 14, and on the collectors of the transistors 34 and 36. Potential is applied to the bases of the transistors by means of the potentiometer composed of resistors 24 and 28. Statistically, one of the other of the transistors will conduct first. Consider that transistor 36 starts first. As it does, current builds up in the winding of the primary. This build up of current between 38 and 44 generates a reactive voltage in the windings which is in the direction from 44 to 42 in winding 14, and correspondingly, in the direction from 48 to 46 in winding 12. Therefore the potential at 48 is lowered and the base potential on transistor 34 is lowered to the point where it cannot conduct. This, the current in 36 continues to increase. At a selected value of current through the winding 38–44, the transformer core saturates, and the current through the collector of transistor 36, through the emitter back to the battery, reaches a constant valve. When it does, the reactive voltages generated in the transformer primaries drop to a very low voltage. The potential on the base of transistor 36 (which is assumed to be conducting) then drops back to the bias value set by the potential at 25. With this lower base potential transistor 36

then starts to decrease in current. This decrease in current sets up a reactive voltage in the opposite direction, that is, from 42 to 44 and from 46 to 48. This raises the base potential on transistor 34 and causes it to start conducting. This further lowers the base potential on transistor 36 and causes it to discontinue conducting.

The current then in transistor 34 increases to the point where it flattens off due to the saturation of the core, and there is a repetition of this action. The base potential on 34 lowers, and transistor 34 starts to decrease in current. This provides a higher base potential on the transistor 36 which causes it to conduct, and there is a continuing flip-flop action, first one transistor conducting, then the other conducting. This provides a very high frequency alternating current through the primary coil 14 of the transformer. This frequency may rise as high as 40,000 Hz. This high frequency is very desirable since it improves the light efficiency of the lamp. This frequency is normally determined by the hysteresis characteristic of the transformer core. When saturation is obtained rapidly, the frequency increases.

The reactive voltages which are generated on the primaries are correspondingly generated on the secondaries, and therefore alternating voltages are obtained which are approximately 30 to 50 times the voltage across the primary windings.

The fluorescent lamp is indicated by the numeral tube 50. It has filament windings 52 and 54, one in each end of the tube. The transformer winding 18, with terminals at 60 and 64 is connected through a series capacitor 72 to one end of the filament 52 and to one end of the filament 54. Another secondary winding 20, which has substantially equal voltage winding 18, is likewise connected between the second ends of filaments 52 and 54, with a series capacitor 70 and a switch 58. The capacitors 70 and 72 are for current limiting purposes. When the switch 58 is closed, current then will flow through winding 18, through capacitor 72, filament 52, winding 20, capacitor 70, switch 58, filament 54 and back to the winding 18. Now with double voltage across the two filaments in series, there is substantially double current through the filament and they will preheat rapidly to the point where they will emit electrons. Under the voltage of the coil 18, the gas in the lamp will begin to conduct current, and the lamp will glow. At this time the switch 58 is opened and the normal operation of the lamp is obtained, with lamp current supplied by winding 18.

However, there is another important feature of this circuit. There is a winding 16 on the secondary, which is roughly twice the voltage of the windings 18 and 20. One end of winding 16 is connected to the winding 18 and therefore to the filament 54. The other end of winding 16 is connected to the negative terminal 37 of the battery, which represents the ground plane of the device. Between the ground plane and the terminal 64 there is a voltage which is roughly three times the voltage of winding 18, which is connected between the filament 52 and capacitively to the ground plane around the lamp. This high voltage of up to 500 volts to ground, high frequency, will initiate ionization in the vicinity of the filaments and will therefore more rapidly provide a starting of the fluorescent lamp. Instead of having simply the voltage of 18 across the two filaments, there is a voltage of approximately three times operating voltage between one filament and the ground plane. As the filaments are heated by holding the switch 58 closed, they will soon provide sufficient ionization to start the discharge.

Typically capacitors 72 and 70 can be approximately 0.0015 microfarad and 0.1 microfarad respectively, Windings 12 and 14 comprise three bifilar turns and five bifilar turns respectively. Windings 16, 18 and 20 comprise 200, 100 and 100 turns respectively. The diodes are for the purpose of protecting the transistors. They may be left out if the transistors have sufficient base emitter breakdown voltage.

While the invention has been described with a certain degree of particularity it is manifest that many changes may be made in the details of construction and the arrangement of components. It is understood that the invention is not to be limited to the specific embodiment set forth herein by way of exemplifying the invention, but the invention is to be limited only by the scope of the attached claim or claims, including the full range of equivalency to which each element or step thereof is entitled.

What is claimed:

1. An inverter-transformer system for a low-wattage fluorescent lamp having two isolated filaments, comprising:
   a. a D.C. voltage supply;
   b. a transformer comprising
      1. a core having square hysteresis effect, providing saturation at low exciting current;
      2. two primary windings;
      3. first and second secondary windings of substantially equal voltage;
      4. a third secondary winding of voltage approximately twice the voltage of each of said first and second windings;
   c. transistor flip-flop means connected to said D.C. voltage supply and to said primary windings to provide a high frequency A.C. current to said primary windings;
   d. said first secondary winding connected between one end of each of said filaments;
   e. said second secondary winding connected through switch means between the second ends of said filaments; and
   f. said third secondary winding connected between one end of said first secondary winding and said D.C. power supply.

2. The system as in claim 1 including current limiting means in series with each of said first and second secondary windings.

3. The system as in claim 1 in which said D.C. supply is a battery.

4. The system as in claim 3 including a first and a second transistor, their emitters connected to the negative pole of the battery, their collectors connected to the terminals of a first primary winding, the midpoint of said first primary winding connected through a switch to the positive pole of said battery, the bases of said transistors connected through diodes to the terminals of the second primary winding, the midpoint of said second primary connected through potentiometer means to said battery.

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