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[54] **FLUORESCENT LAMP APPARATUS INCLUDING
INVERTER CIRCUIT AND REFLECTOR**
3 Claims, 8 Drawing Figs.

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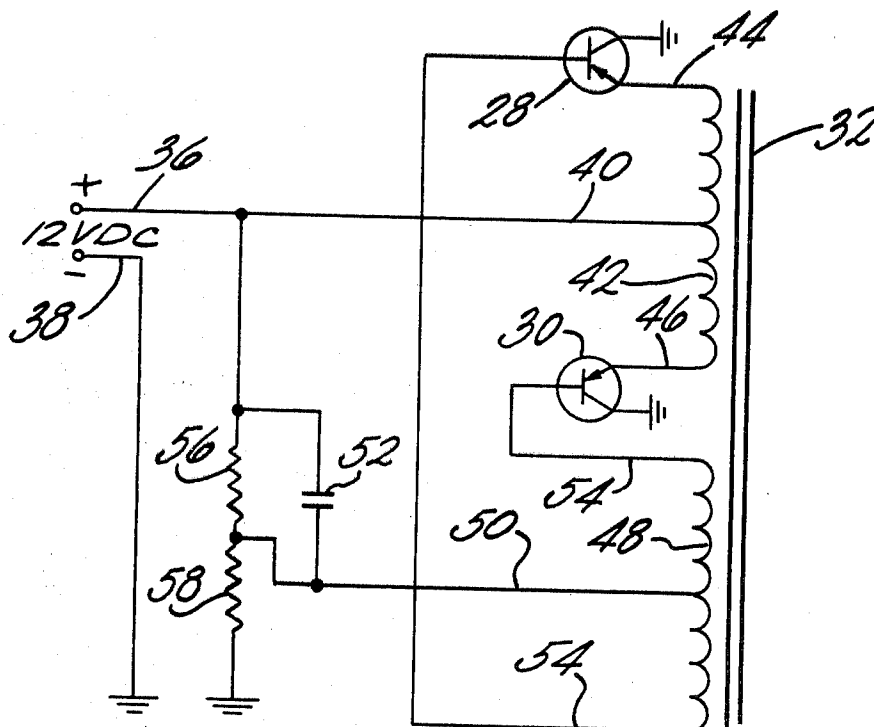
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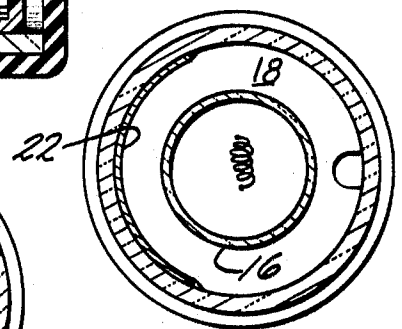
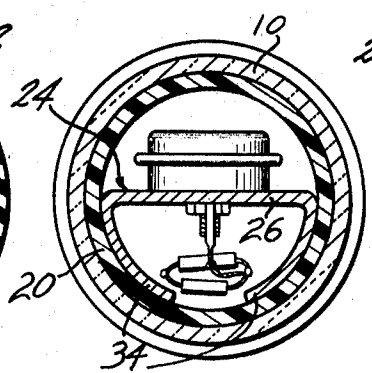
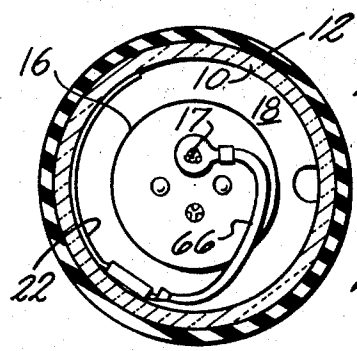
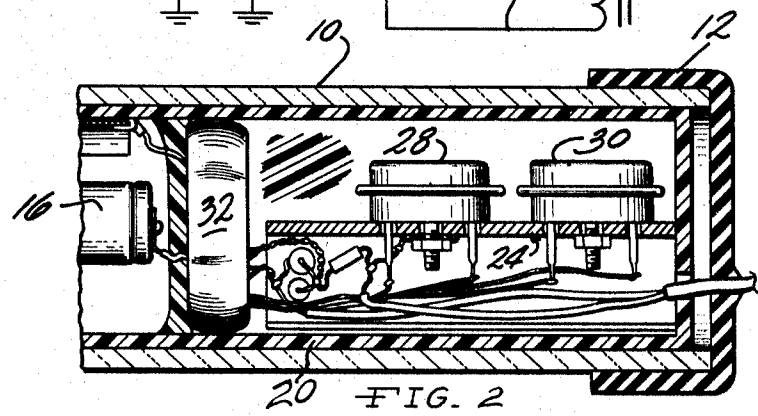
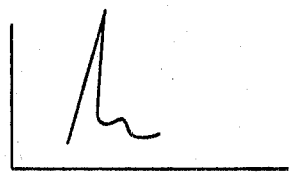
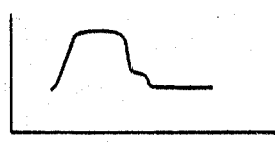
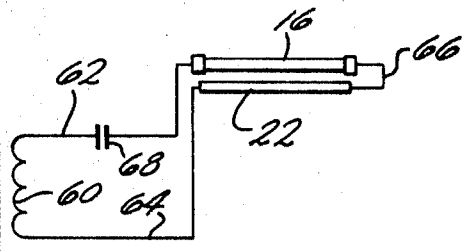
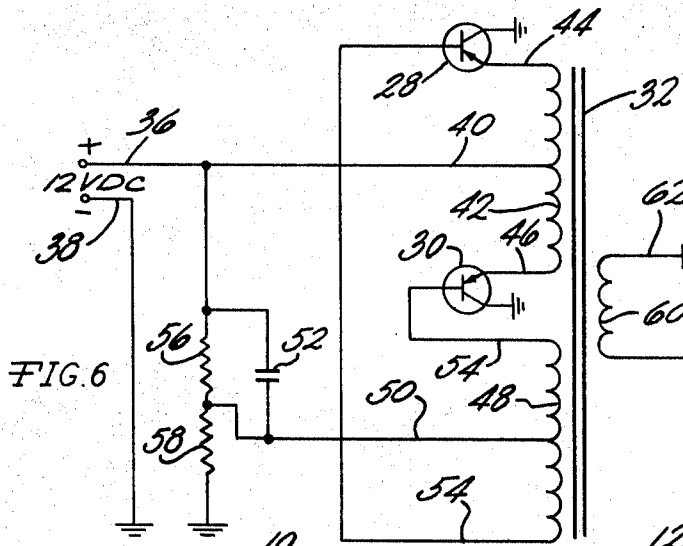
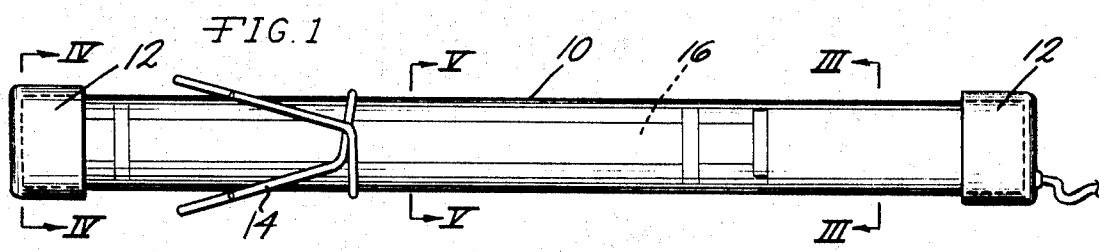
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ABSTRACT: An electronic inverter circuit particularly suitable for energizing fluorescent lamps from a direct current power supply wherein transistors are employed as switches in a self-excited oscillator circuit. The circuitry includes a transformer core alternately saturable at a high frequency under the control of the transistor switches, the transformer including a feedback winding controlling operation of the transistors. A transformer secondary winding supplies a high voltage output to the fluorescent lamp, and the high voltage output includes a conductor disposed adjacent the lamp to reduce the voltage required to initiate an arc therein.





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FLUORESCENT LAMP APPARATUS INCLUDING INVERTER CIRCUIT AND REFLECTOR

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is related to U.S. Ser. No. 814,630, filed Apr. 9, 1969.

BACKGROUND OF THE INVENTION

The invention pertains to the field of art of electronic inverter circuits of the self-excited oscillator type utilizing transistor switches controlled by a biasing voltage network, and particularly relates to this type of circuit as utilized with a direct current powered fluorescent lamp energizing circuit.

The energization and operation of fluorescent lamps from direct current sources has not enjoyed widespread use due to several reasons, including cost, problems encountered in starting such direct current powered lamps under various temperature conditions, and because of the cost and complexity of the circuitry required with such lamps as compared with incandescent lighting systems. With the widespread use of recreational vehicles, such as travel trailers, campers, self-contained mobile units, boats, and the like, there is a growing market for the efficient light produced by a fluorescent lamp as powered from direct current sources, such as an automobile battery. Previous circuitry for energizing a fluorescent lamp from a direct current source was expensive, subject to damage, bulky, and unreliable and it is a purpose of the invention to overcome the objections of previous circuits used for such purposes.

SUMMARY OF THE INVENTION

It is a purpose of the invention to provide a practical, economical, reliable, electronic circuit for energizing and operating fluorescent lamps from a direct current power supply. The practice of the invention utilizes a self-excited oscillator circuit utilizing a pair of transistor switches controlling the energization of the primary winding of the transformer, and a feedback winding is utilized to sense the saturation of the transformer core and selectively control the transistor switches to produce a high frequency wherein the secondary winding produces a high frequency and a high voltage capable of energizing and sustaining fluorescent lamp operation.

A further object of the invention is to provide a circuit meeting the aforementioned requirements wherein the circuit is so designed as to permit instant starting of all manufacturer's lamps between the temperature range of -10° F. to 100° F. Furthermore, the circuit includes means for eliminating high voltage "spikes" and other objectional electrical characteristics from occurring in the transistors.

In order to reduce the voltage required to start the operation of the fluorescent lamp the striking of its arc is facilitated by the proximity of a secondary winding high voltage conductor to the lamp thereby reducing the necessary initial voltage requirements. If desired, this conductor may take the form of a metallic reflector to minimize wiring, and to produce an attractive, clean appearance.

The circuit employed to accomplish the purposes of the invention is of a relatively simple, the inexpensive nature, and is capable of providing dependable fluorescent lamp operation in a wide variety of applications.

BRIEF DESCRIPTION OF THE DRAWING

The objects and advantages of the invention will be appreciated from the following description and accompanying drawings wherein, for purpose of illustration only, the circuit of the invention is illustrated as used in conjunction with a portable fluorescent lamp as follows:

FIG. 1 is an elevational view of a fluorescent lamp device utilizing the circuit of the invention,

FIG. 2 is an elevational, sectional, enlarged detail view of the arrangement of the circuitry components within the device of FIG. 1,

FIG. 3 is an elevational, sectional view taken along Section III-III of FIG. 1,

FIG. 4 is an elevational, sectional view taken along Section IV-IV of FIG. 1,

FIG. 5 is an elevational, sectional view taken along Section V-V of FIG. 1,

FIG. 6 is a diagram of the circuit used in conjunction with the invention,

FIG. 7 is a diagram of the waveform as occurring across the output of the secondary winding, and

FIG. 8 is an illustration of the waveform of the voltage supplied to the fluorescent lamp.

DESCRIPTION OF THE PREFERRED EMBODIMENT

It is to be understood that the circuit of the invention is not to be limited to any particular usage of the fluorescent lamp energized, and the circuit may be used in any fluorescent lamp application wherein the power supply is a direct current. For purpose of illustration only, the invention is illustrated as being utilized with a portable illuminating device, more fully described in the aforementioned application which forms one commercial usage of the invention.

As apparent in FIG. 1 the illuminated device takes the form of a portable cylindrical housing 10 constructed of a clear plastic material. The ends of the cylindrical housing are closed and protected by means of rubber or plastic boots 12 firmly placed upon the housing ends, and a wire hook device 14 may be placed upon the housing 10 for facilitating the support thereof.

A fluorescent lamp 16 is supported within the housing 10 by a pair of annular resilient spacers 18 which firmly engage the lamp, and press against the inner cylindrical wall of the housing. The lamp 16 is provided with an electrode terminal 17 at each end, and the length of the lamp is shorter than that of the housing 10 whereby a circuit casing member 20 may be disposed within the housing adjacent one end as apparent in FIG. 2. The circuit casing 20 is of a cylindrical configuration adapted to be closely received within the housing 10.

A metal reflector 22, formed of a reflective electrical conductive material such as aluminum, is disposed within housing 10 adjacent the lamp 16 to reflect light, serve as a portion of a high voltage conductor to a lamp terminal and aid in initiating the lamp arc, as will be later described.

Within the casing 20 is a heat sink 24 of metal, such as of aluminum, having a configuration as will be apparent from FIGS. 2 and 3, which includes a flat portion 26 upon which a pair of power transistors 28 and 30 are mounted by appropriate threaded studs.

An annular ferrite core 32 is located within the casing 20 having an axis coaxial with the axis of the housing 10 and casing, and primary, secondary and feedback windings are wound upon the core. The necessary resistances and capacitors required for the circuit may be interposed between the arcuate legs 34 of the heat sink 24 as apparent in FIGS. 2 and 3.

In order to minimize electrical problems due to weather conditions and moisture the casing 20 may be "potted," or filled with a sealing material such as urethane, as is a common practice in the electric circuit art.

One of the features of the invention lies in the placing of a high voltage conductor adjacent the fluorescent lamp, and in the illustrated embodiment this portion of the conductor consists of the arcuate metallic reflector 22, located between the lamp and the housing 10. As will be later described one end of the metal reflector 22 is attached to a capacitor and through the capacitor to the secondary winding, while the other end of the reflector is connected to the lamp terminal removed from the casing.

With reference to FIG. 6, the preferred circuit will be explained.

The direct current supply is represented by conductors 36 and 38. These conductors may be connected to the direct current supply of the associated vehicle, boat, or other apparatus from which the lamp is to be powered. For instance, the conductors 36 and 38 could be connected to a plug which may be inserted into the cigarette lighter of an automobile. Conductor 38 is grounded, and conductor 36 is connected to the center tap 40 of the primary winding 42. The primary winding 42 may constitute 74 turns of No. 24 wire, as an example, wherein a 12 volt DC supply is used to illuminate a 15 watt lamp 16. The primary winding 42 includes end taps 44 and 46 which are connected to the emitters of transistors 28 and 30, as illustrated. The collectors of the transistors are grounded.

The transistors 28 and 30 may be of the power type having a 15 amp capacity at 50 volts, and may be of the type manufactured by Delco DS 501. These transistors could be of the 2N173, 2N443 or 2N278 type, if desired.

The feedback winding 48 includes a center tap 50 connected to the conductor 36 through a 1 mfd., 50 volt, capacitor 52 and through 100 ohm resistor 56. The purpose of the capacitor 52 is to eliminate high voltage "spikes" from occurring between the emitter and the bases of the transistors. The feedback winding 48 also includes end taps 54 connected to the base terminals of the transistors.

The purpose of the feedback winding 48 is to form a biasing network to control the selective operation of the transistors to produce the desired cycling. In the commercial embodiment of the circuit the feedback winding 48 has 96 turns of No. 30 wire.

The transistor biasing network also includes resistors 56 and 58 connected in series between the conductor and ground. Resistor 56 has a value of 100 ohms, one-half watt, and resistor 58 has a value of 220 ohms. The purpose of these resistors is to insure a starting of the transistor operation under low temperatures, and the presence of these resistors produces a reliability and dependability to the circuit that is highly desirable.

The secondary winding 60 consists of 800 turns of No. 34 wire which will produce 375 volts, peak to peak. The output conductors 62 and 64 of the secondary winding having a waveform as is apparent in FIG. 7, and the conductor 64 is connected to one end of the reflector 22 as illustrated in FIG. 6. The other end of the reflector 22 is connected to a lamp terminal 17 by conductor 66. The conductor 62 is connected to a capacitor 68 having a 0.047 mfd. rating, 200 volts, and the purpose of this capacitor is to produce a phase shift of the output voltage which will limit the current to the lamp to 360 MA.

The aforesaid circuit constitutes a self-excited oscillator circuit wherein the two transistor switches will alternately, and very rapidly, switch on and off under the control produced by the feedback network. In the designed circuit the cycle is approximately 2,500 times per second, and to produce this desired frequency a ferrite core is used having a magnetic flux density of 4900 Gauss and a 15 watt capacity. A 13 watt input is fed into the circuit at 1.1 amps, and 12 watts of output are obtained for a 90 percent efficiency.

As the annular core 32 is saturated through the circuit produced in the primary winding by one of the transistors, the feedback winding will turn that transistor off and turn the other on. This cycling will start in that one transistor will always have a lower resistance than the other, and will therefore conduct first. In the colder weather, such as that approaching 0° Fahrenheit, and below, the provision of the resistances 56 and 58 provide the highest voltage to start the transistor switching.

As previously mentioned objectionable high voltage problems within the transistors can be suppressed by utilizing the capacitor 52.

The waveform occurring at the lamp is illustrated in FIG. 8, and the difference between the waveforms of FIGS. 7 and 8 is due to the presence of the capacitor 68. Before the lamp ignites a high resistance is present therein, and capacitor 68 is very nearly a short circuit such that the full peak to peak voltage of 375 volts will appear across the lamp terminals 17. As soon as the lamp ignites its resistance lowers and capacitor 68 will limit the current to the lamp by producing an out of phase relationship with the secondary winding.

The circuit can be substantially simplified, and costs reduced, by using the reflector 22 as a portion of the high voltage conductors in that the proximity of the reflector to the lamp tube will decrease the voltage required to start an arc in the lamp. For instance, with the aforescribed circuit, any make of 15 watt lamp can be started and maintained with a 375 volt output, while if the reflector 22 were not used as a conductor it would require 850 volts to start the lamp arc.

The high frequency of operation produces an effective illumination of the fluorescent lamp, and the power requirements are not great whereby an efficient lighting is produced. In that the circuitry is of a simple, and relatively inexpensive design, the invention provides a practical means for using fluorescent lighting with direct current power sources, and it is intended that a circuit of this type can be utilized through a rather large direct current range, such as from 6 through 72 volts.

It will be appreciated that modifications to the inventive concept may be apparent to those skilled in the art without departing from the inventive concept, and it is intended that the invention be limited only by the following claims:

I claim:

1. A circuit for energizing a fluorescent lamp from a direct current power supply comprising, in combination, an elongated fluorescent lamp having an electrode at each end, a pair of switching transistors each having base, emitter and collector terminals, a ferrous core, primary and secondary windings wound on said core, said transistors being connected in parallel with said primary winding and selectively controlling energization thereof, a feedback winding wound on said core connected to said transistors controlling operation of said transistors, lamp output conductors connected to said secondary winding and said lamp electrodes, an elongated concave-convex metallic reflector disposed adjacent said lamp substantially parallel and concentric thereto, said reflector forming a series portion of said lamp output conductors and the proximity thereof to said lamp decreasing the voltage required to initiate an arc within said lamp, direct current supply conductors connected to said primary winding through said transistors, resistor means connected to said feedback winding and interposed between said direct current power supply conductors having a value sufficient to start said transistors conducting under low temperature conditions.

2. In a fluorescent lamp circuit is in claim 1, a capacitor connected in series between said secondary winding and said lamp within one of said lamp output conductors limiting the current to said lamp and modifying the phase of the voltage supplied to said lamp with respect to the secondary winding phase.

3. In a fluorescent lamp circuit as in claim 1 wherein said primary winding includes a center tap and equal voltage end taps, said center tap being connected to a first direct current supply conductor and said end taps each being connected to a transistor emitter terminal, said feedback winding including a center tap and equal voltage end taps, said feedback winding center tap being connected to said first direct current supply conductor and said end taps thereof each being connected to a transistor base terminal, and a capacitor interposed between said feedback winding center tap and said first direct current supply conductor.