(54) Title: METHOD AND CIRCUIT FOR OPERATION OF A HIGH-PRESSURE DISCHARGE LAMP

(57) Abstract:
To increase the operating efficiency of an operating circuit for a high-pressure discharge lamp (LP), current is supplied to the discharge lamp in discontinuous mode, that is, in pulses which start from a zero or null current level when the lamp is operating in normal state. Current flow through a choke coil (LD), which alternately stores and releases energy, is sensed, and a new energy pulse is supplied only when the current through the choke coil has decayed to zero or null, by controlling a pulse width modulation circuit (P2) which, in turn, controls a transistor (T2) which, in turn controls current flow through the coil (LD). The transistor (T2) is a field effect transistor which has its source terminal connected to the negative terminal of an intermediate coupling capacitor (C1) forming part of the power supply for the lamp. A free wheeled diode (D1) is provided, connected to the positive terminal of the intermediate circuit capacitor (C1). After energization, and ignition of the lamp, the lamp is operated in continuous mode, with continuous current flow, to shorten the run-on or warm-up period thereof, switch-over to the discontinued mode operation being gradual as voltage and current supplied to the lamp reach normal operating state.
ABSTRACT OF THE DISCLOSURE

To increase the operating efficiency of an operating circuit for a high-pressure discharge lamp (LP), current is supplied to the discharge lamp in discontinuous mode, that is, in pulses which start from a zero or null current level when the lamp is operating in normal state. Current flow through a choke coil (LD), which alternately stores and releases energy, is sensed, and a new energy pulse is supplied only when the current through the choke coil has decayed to zero or null, by controlling a pulse width modulation circuit (P2) which, in turn, controls a transistor (T2) which, in turn controls current flow through the coil (LD). The transistor (T2) is a field effect transistor which has its source terminal connected to the negative terminal of an intermediate coupling capacitor (C1) forming part of the power supply for the lamp. A free wheeling diode (D1) is provided, connected to the positive terminal of the intermediate circuit capacitor (C1). After energization, and ignition of the lamp, the lamp is operated in continuous mode, with continuous current flow, to shorten the run-on or warm-up period thereof, switch-over to the discontinued mode operation being gradual as voltage and current supplied to the lamp reach normal operating state.
"METHOD AND CIRCUIT FOR OPERATION OF A HIGH-PRESSURE DISCHARGE LAMP"

Reference to related patent and applications, assigned to the assignee of the present invention:

U.S. Patent No. 5,198,728, Bernitz et al;
U.S. Patent No. 4,792,887, Bernitz et al;

Reference to related publication, assigned to the assignee of the present invention:
European 0 485 865 A1, Bernitz et al.

Reference to related literature:

FIELD OF THE INVENTION

The present invention relates to a method and a circuit to operate a high-pressure discharge lamp, for example a metal-halide high-pressure discharge lamp, in which the operating circuit includes a boost converter and a power control circuit to provide for essentially uniform power to the lamp, in spite of possible variations in supply or in lamp voltage.

BACKGROUND

Various circuits to operate high-pressure discharge lamps, and more particularly metal halide high-pressure discharge lamps are known from the literature, and U.S. Patents 4,792,887, Bernitz et al., and U.S. Patent 5,198,728, Bernitz et al., are here referred to. Another example of a published circuit is found in the publication by C. H. Sturm and E. Klein, published by Siemens AG, Sixth revised edition 1992, pages 217, 218, entitled "Betriebsgeräte und Schaltungen für elektrische Lampen" (operating, apparatus and circuits for electrical lamps). The circuit described and shown in a diagram of the latter publication has, starting from a supply terminal adapted for connection to a network power circuit, a radio noise suppression filter, a bridge rectifier, a boost converter, that is, a voltage boosting or voltage enhancing circuit, an intermediate circuit capacitor, and a buck converter, that is, a circuit which provides for power control of the power supplied to the lamp. The lamp has a variable...
impedance, and should be supplied with power permitting uniform power consumption by the lamp in spite of supply and lamp voltage variations. The buck converter senses
current supplied to the lamp and compensates for lamp voltage and current changes in case of voltage variations, for example if there should be fluctuation in the original network voltage being supplied to the overall circuit. The buck converter is then coupled to a full wave bridge inverter which includes in its circuit also an ignition circuit for a metal vapor halide high-pressure discharge lamp. The halogen metal vapor high-pressure discharge lamp, in accordance with the literature reference, is operated with, effectively, rectangular current pulses at an operating frequency of about 500 Hz.

The circuit, including the boost converter insures that the power taken from the network is of essential sinusoidal wave shape. By pulse width modulation control of a transistor in the boost converter, it is possible to control the time period during a half wave of network power supply in which the transistor is conductive, in such a manner that the envelope of the current taken up is essentially sinusoidal. The output voltage at the intermediate capacitor of the boost converter then provides the voltage supply for the subsequently connected buck converter.

The buck converter includes a field effect transistor (FET) which has its drain connection coupled to the positive terminal of the intermediate capacitor, and its source connection to a choke or ballast coil which, in turn, is connected to the lamp. The anode of a free-wheeling diode, integrated with the FET is connected to ground or chassis, whereas its cathode is connected to the lamp choke or ballast and to the source connection. The transistor of the buck converter is also controlled by pulse width modulation signals in such a manner that the electrical power consumed by the lamp will be constant, and independent of
variations in network voltage, or lamp voltage. The output voltage of the buck converter is applied to the halogen metal vapor high-pressure discharge lamps through a full wave transistorized inverter. The transistor pairs of the inverter switch at a comparatively low frequency, about 500 Hz, in order to reverse the direction of the lamp current. Reversal of lamp voltage or, rather, of lamp current, prevents breakdown of the fill mixture, or dissociation of the fill mixture or components thereof, and non-symmetrical operation which, otherwise, might occur if the lamp were operated by direct current.

The circuit above described uses a buck converter which operates in continuous mode. Continuous mode operation means that the transistor of the buck converter is connected to be ON or conductive before current flow through the free-wheeling diode connected thereacross has completely decayed. The efficiency of such a circuit, operated in continuous mode is, usually, between about 82% to 86%.

THE INVENTION

It is an object to provide a method and a circuit to operate a high-pressure discharge lamp with better efficiency than heretofore possible.

Briefly, the buck converter is operated after a run-on, and during a warm-up phase of the lamp, subsequent to initial firing of the lamp upon energization thereof, in a discontinuous mode; during the run-on phase, the buck converter is operated in continuous mode, however, to insure fast warming up of the lamp.

Operating the switching transistor of the buck converter in discontinuous mode means that the switching transistor is
switched to the low resistance state or ON only when current flow through the associated free-wheeling diode, e.g., integrated with the switching transistor, has dropped to zero or null. In this operating mode, effectively no switching losses will result, independently of the free-wheeling diode which is used.

In accordance with a feature of the invention, the FET and the free-wheeling diode associated therewith are so connected that the source terminal is coupled to the negative terminal of the intermediate circuit capacitor, and the cathode of the free-wheeling diode is connected to the positive terminal of the intermediate circuit capacitor. This connection simplifies control of the FET, since it is no longer necessary to separate the FET galvanically, for example by using a transformer. The operating method and circuit improves the efficiency of operation of the entire circuit to well over 90%.

During the run-on phase of the lamp, the buck converter is preferably operated in continuous mode, since this permits a substantially high lamp current and, thus, decreases the warm-up time of the lamp. The term "run-on time" relates to that period or time interval of discharge lamp operation after ignition and before stable operating conditions have been reached. During the run-on and then warm-up time, the components of the lamp fill which take part in a discharge vaporize, and the vapor pressures of these components tend to assume a new balanced state. The light output of the lamp increases to its maximum value during the warm-up phase.
In accordance with one aspect of this invention, there is provided a method of operating a high-pressure discharge lamp (LP) by means of a circuit having: a radio noise suppression filter (FE) coupled to a source of electrical energy; an intermediate circuit smoothing capacitor (C1); a buck converter circuit (TS) having its input connected in parallel to said smoothing capacitor (C1); an inverter (WR) connected to said lamp and coupled to and receiving energy from said buck converter (TS) and comprising, in accordance with the invention, the steps of: operating said buck converter (TS) in continuous mode during the run-on phase of the lamp (LP) and operating said buck converter (TS) in discontinuous mode after the run-on phase of said lamp (LP) subsequent to initial firing upon energization of the lamp.

In accordance with another aspect of this invention, there is provided a circuit for operating a high-pressure discharge lamp (LP) having: a radio noise suppression filter (FE) adapted to be coupled to a source of electrical energy; an intermediate smoothing capacitor (C1); a buck converter circuit (TS) having its input connected in parallel to said smoothing capacitor (C1), said buck converter circuit including a field effect transistor (FET) (T2) and a free wheeling diode (D1) connected to said FET (T2); an inverter (WR) connected to said lamp (LP) and coupled to and receiving electrical energy from said buck converter (TS); and an ignition circuit (ZE) coupled to the lamp for firing the lamp upon energization of said operating circuit, and wherein, in accordance with the invention, the source terminal of the FET (T2) of said buck converter (TS) is connected to the negative terminal of the intermediate
circuit capacitor (C1) and the cathode of the free wheeling diode (D1) is connected to the positive terminal of the intermediate circuit capacitor (C1).
DETAILED DESCRIPTION

Referring first to Fig. 1: the circuit is adapted for connection to an alternating current power network, shown only schematically. It includes a radio noise suppression filter $FE$, a network supply rectifier $GL$, a boost converter $HS$, a buck converter circuit $TS$, a full bridge inverter $WR$, and an ignition circuit $ZE$, all connected to operate a discharge lamp $LP$. The inverter $WR$ has four switching transistors $T3$, $T6$, $T4$, $T5$. They are controlled to switch by a switching signal generator $RG$ which generates a low frequency square wave voltage of about 120 Hz, so that the current supplied to the lamp $LP$ will have the frequency
determined by the generator RG.

The radio noise suppression filter FE, as known, includes a current uncompensated filter choke and a current compensated filter choke, each having two blocks of windings. The respective
terminals of the power supply are integrated with a respective winding block. Two filter capacitors are also provided, so connected to the chokes that the customary arrangement of a LC low pass filter results, see, for example, the referenced U.S. Patent 4,792,887, Bernitz et al.

The boost converter HS connected to the rectifier GL is connected to a sinusoidal current control circuit SV. A pulse width modulation unit P1 controls the time period during which transistor T1 of the boost converter HS is conductive, or ON, that is, of low resistance. The control is so arranged that the envelope of the current received is at least essentially sinusoidal. The pulse width modulation unit P1 operates with intermediate frequency control signals of about 50 kHz. Control of a boost converter of this type is well known, see, for example, European Patent Disclosure Document 0485865A1, Bernitz et al., assigned to the assignee of the present application.

The output of the boost converter HS includes an intermediate network capacitor C1, connected between terminals A1 and A2 of the boost converter HS. The voltage across capacitor C1 will depend on the level of the input network voltage, and will be between about 280 V to 440 V. The capacitor C1 is an electrolytic capacitor of high capacity value. It supplies the buck converter TS and the inverter WR with energy when the network voltage passes through zero or null. The buck converter TS is controlled by a further pulse width modulation control unit P2 and a power control regulator PE in such a manner that the lamp power will be independent of stray variations of the network voltage and of the lamp voltage.
The pulse width modulation unit P2 is controlled by control signals above about 20 kHz. The output voltage of the buck converter TS is connected across terminals A3 and A4 to capacitor C2, and forms the input voltage for the inverter WR. The pairs of transistors T3, T6, and T4, T5 of the inverter are controlled by the square wave generator RG to be alternately of low resistance or ON, so that the lamp LP will receive a current of about 120 Hz frequency, controlled by essentially square wave signals. The basic principle of a full bridge inverter is well known, and the article of J. Beckmann, Franzis Workbook 1990, page 32, is an example.

A control unit TI monitors the operation of the high-pressure discharge lamp LP, and, specifically, that it is operating normally. The control unit TI includes a timing circuit to control timing intervals and a monitoring circuit which monitors the voltage drop on the buck converter capacitor C2 during lamp operation, and further controls the control units P1, P2 of the boost converter HS and the buck converter TS, respectively, if the operation of the lamp is abnormal.

Fig 2 illustrates details of the buck converter circuit TS, and the control thereof. The buck converter TS essentially includes a field effect transistor T2, a free wheeling diode D1, which can be integrated therewith, a lamp choke or ballast LD and an output capacitor C2. Terminals, or junctions A1 to A6 correspond to similar terminals or junctions of Fig. 1, and have been added to the drawings for
identification. The terminals, together with the symbolic representation of the circuit, clearly show the interconnection of the circuit elements shown in Fig. 2, and their connection with other components of the circuit in accordance with the present invention.

The source connection of the FET T2 is connected over an ohmic resistor R1 to the negative terminal of the intermediate circuit capacitor C1.

In accordance with a feature of the invention, the drain connection of FET T2 is connected with the anode of the free wheeling diode D1 and also to the lamp choke LD, the other terminal of which is connected to the lamp circuitry via output A4 and to the capacitor C2. The cathode of the free wheeling diode D1 is connected to the positive terminal of the intermediate circuit capacitor C1 via junction A1, and to the other terminal of output capacitor C2. As can be seen, the free wheeling diode D1, capacitor C2 and the lamp choke LD form a closed current loop. A voltage divider, formed by the ohmic resistors R2, R3 is connected in parallel to the series circuit of free wheeling diode D1 and the drain-source path of the FET T2. A junction or tap point V1 is connected between the drain connection of the FET T2, the anode of the free wheeling diode D1 and the lamp choke LD. Junction or tap point V1 is connected through a RC circuit formed by resistor R4 and capacitor C3 with an input A6 of the pulse width modulator P2. The pulse width modulator unit P2 is connected through a totem pole amplifier T7, T8, R6 to the gate terminal.
or junction A5 of the FET T2. The pulse width modulation unit P2 includes a voltage limiter assembly formed by two diodes D, three Schmitt-trigger circuits S1, S2, S3, a capacitor C4 and an ohmic resistor R5. Resistor R5 is a feedback resistor which is coupled from the output of the first Schmitt-trigger S1 to its input. The capacitor C4 is connected between the output of the second Schmitt-trigger S2 and the input of the third Schmitt-trigger S3. The circuit of the pulse width modulation unit P1 (Fig. 1) of the boost converter is identical to that of the pulse width modulation unit P2 of the buck converter; only the dimensioning of the individual components differs, in view of the difference in operating frequency.

A junction V2 between the voltage divider resistors R2, R3 is connected to the input of the power control unit PE. The output of the power control unit PE is connected through the capacitor C4 at a junction V4, and thus to the input of the third Schmitt-trigger S3 of the pulse width modulation unit P2.

The power control unit PE is formed by an operational amplifier IC1, capacitors C5, C6 and ohmic resistors R7, R8, R9, R10, R11, R12, and diodes D2, D3. The voltage divider resistors R7, R8 provide, together with an auxiliary voltage, for example 10V, a reference voltage for the inverting input of the operational amplifier IC1, which has a feedback connection from its output via the RC elements R10, C6. The direct input of the operational amplifier IC1 is
connected via resistor R9 with the junction or terminal V2. For a detailed description of the power control unit PE, reference is made to the referenced Patent 5,198,728, Bernitz et al., assigned to the assignee of the present application.

The buck converter TS also includes a current limiting unit SB which is connected to a tap or junction V3 between the voltage divider resistors R1, R3. The current limiting circuit SB has been left off Fig. 1 for clarity, and is formed essentially by two bipolar transistors T9, T10, two diodes D4.
D5, a capacitor C7 and resistors R13 to R17. The output of the current limiting circuit SB is connected to the junction V4, and hence to the capacitor C4 and the input of the third Schmitt-trigger S3 of the pulse width modulation unit P2.

Attached hereto and forming part of the specification is a table which provides illustrative dimensions for the various components and elements of the buck converter TS suitable for operation of a 150 W metal halide high-pressure discharge lamp.

**OPERATION:**

When the transistor T2 of the buck converter TS is ON, that is, the drain-source path is of low resistance, a linearly rising current will flow from the intermediate circuit capacitor C1 over the output capacitor C2 of the buck converter TS and through the lamp choke LD, and over the source resistor R1. When the transistor T2 is OFF, that is, the drain-source path is of high resistance, the magnetic field within the choke LD will decay and provide a linearly decreasing current through the lamp choke LD and the free wheeling diode D1. The buck converter TS is controlled to provide constant output power, and thus constant lamp power, by means of the circuit units PE and P2, that is, the power control circuit and the pulse width modulation circuit. The duty cycle of the transistor T2 is thus controlled by means of the pulse width modulation unit P2 and the power control unit PE to provide such constant lamp power.

The instant of time that transistor T2 becomes ON is determined by detecting the passage of the lamp choke current through zero or null by the pulse width modulation unit P2 over its components R4, C3 of the RC unit. The power control unit PE
monitors at its input, that is, the direct input of the operational amplifier IC1, the voltage drop across the serially connected resistors R1 and R3. Since the resistor R1 carries the lamp choke current, its voltage drop is proportional to the lamp choke current. The voltage drop across resistor R3, however, is proportional to the output voltage U2 across capacitor C2 of the buck converter. The resistance values of resistors R1, R2, R3 are so dimensioned that, at the working point of the power control unit PE, the voltage drop over the resistors R1 and R3 is equal, so that voltage and current signals can be equally used as control parameters for the power control unit of the lamp LP. The voltage drop across the resistors R1, R3, hence, at the working point of the power control unit PE, is proportional to lamp power. It is compared in the operational amplifier IC1 with a reference voltage, derived from the voltage divider R7, R8. The output voltage of the operational amplifier IC1, or of the power control unit PE, respectively, is applied to the capacitor C4 of the pulse width modulation unit P2, and thus influences the charge state thereof.

The current limiting unit SB monitors the voltage drop of the source resistor R1, which carries current flowing through the lamp choke, since the input to the current supply monitoring unit is connected to the junction V3. If the lamp choke current exceeds a predetermined permissible maximum value, transistors T9, T10 become conductive, that is, are turned ON and, over the connection to the capacitor C4,
control the pulse width modulation unit P2 to turn the buck converter OFF.

In accordance with a feature of the present invention, the buck converter is operated in discontinuous mode after the
initial ignition and run-on phase of the lamp has ended, that is, after the lamp LP or, respectively, the operating parameters of the lamp LP have reached a stable balanced state.

Fig. 3 illustrates the current flow through the lamp choke during operation in the discontinuous mode. Transistor T2 is turned ON only when the current through the lamp choke LD has decayed to zero or null. The passage of the lamp choke current through null is signaled to the pulse width modulation unit P2 over the RC unit R4, C3. When the lamp choke LD is demagnetized, the voltage at junction or tap V1 decreases and, by means of the RC unit R4, C3, provides a LOW input signal to the Schmitt-trigger S1. The output of the Schmitt-trigger S1, and hence the input of the Schmitt-trigger S2, will thus have a HIGH signal which is again inverted by Schmitt-trigger S3 into a LOW signal, so that, after one further inversion by Schmitt-trigger S3, the gate of the transistor T2 will have a HIGH signal thereat, which then turns the transistor T2 to the ON state.

The duration during which the transistor T2 is ON or, respectively, the TURN-OFF point of the transistor T2 depends on the charge time of the capacitor C4 which, in turn, is influenced by the control units PE and SB. When the capacitor C4 has a HIGH voltage thereat, the output of the Schmitt-trigger S3 generates a LOW signal, and the buck converter transistor T2 is turned OFF. The OFF time duration of the transistor T2 is not controlled by the pulse width modulation unit P2. Rather, it depends on the demagnetization of the lamp choke LD. The maximum OFF time is limited by the ohmic resistor R5 to about 30 µs so that the lowest operating frequency of the buck converter TS will be about 30 kHz. If the RC circuit unit R4, C3 does not detect a
passage of the lamp choke current through null within 30 µs, the output of the Schmitt-trigger S1, which has the feedback connection through the resistor R12, is set by means of this feedback to HIGH state, which then will connect the transistor T2 again to ON, although the choke current has not yet dropped to null or zero.

Fig. 3 illustrates schematically the temporal dependence of current flow through the lamp choke after the initial warm-up phase of the high-pressure discharge lamp has ended. At time $t_1$, lamp choke current $I_1$ has dropped to null, and the pulse width modulation unit P2 again turns transistor T2 ON. The lamp choke current $I$ then rises up linearly to the turn-OFF time instant $t_2$ of the transistor T2, to a maximum value $I_{\text{max}}$, which, customarily, is below the turn-OFF threshold of the current limiting unit SB of, for example, 5.5 A. The turn-ON period $t_2-t_1$ depends on the power control unit. It computes the maximum value of the lamp current $I_{\text{max}}$ based on the voltage drop $U_1$ of the intermediate circuit capacitor C1, the voltage drop $U_2$ across the output capacitor C2 and the inductance $L$ of the lamp choke LD, in accordance with the relationship:

$$t_2-t_1 = \frac{I_{\text{max}} L}{U_1 - U_2} \quad (1)$$

When transistor T2 is OFF, the lamp choke current $I$ decays linearly and at time $t$, reaches the value of zero or null; the turn-OFF duration $t_1-t_2$ of the transistor is computed:
\[ t_2 - t_1 = \frac{I_{\text{max}} L}{U_2} \quad (2) \]

The value of the average lamp current \( I_L \), after termination of the warm-up phase, is half the value as the above-mentioned maximum value \( I_{\text{max}} \) of the lamp choke current, namely

\[ I_L = \frac{I_{\text{max}}}{2} \quad (3) \]

The direction of current flow, of course, changes in accordance with the frequency of the inverter WR, for example at 120 Hz in accordance with its switching frequency.

Fig. 4 illustrates the current through the lamp choke LD during the run-on or warm-up phase of the lamp LD. During this run-on phase, the buck converter operates in continuous mode, that means that the transistor T2 is turned ON before the lamp choke current has decayed to zero. This operating mode has the advantage that the lamp, during the warm-up or run-on phase, receives a higher average current than that when the transistor operates in discontinuous mode, which decreases the duration of the warm-up phase. The value of the average lamp current \( I_L \) during the warm-up phase is calculated:

\[ I_L = \frac{I_{\text{max}} + I_{\text{ch}}}{2} \quad (4) \]
$I_{\text{min}}$ represents the current level of the remaining current through the lamp choke LD until the turn-ON instant of time $t_3$.

The output voltage $U_2$ from the buck converter TS, during the run-on phase, is only about 15 V to 20 V, in contrast to about 50 V to 130 V at the end of the run-on phase. According to the equation (2) above, this rather low output voltage $U_2$ would result in substantial increase of the turn-OFF duration of the transistor T2. The turn-OFF duration of the transistor T2, however, is limited by the resistor R5 to, at the most, 30 $\mu$s. Thus, the transistor T2 is turned ON by the pulse width modulation unit P2 even before the lamp choke current has completely decayed. Consequently, the buck converter operates continuously, that is, in continuous mode, the current of which is illustrate in Fig. 4. The transition from continuous-mode operation to discontinuous-mode operation of the buck converter TS is smooth.

The invention is not limited to the circuit described in detail, or to the system above described. For example, the method of operating the lamp in first continuous and then discontinuous mode can also be carried out by circuits which do not have a boost converter HS, or other circuit components and elements not necessary for the continuous-discontinuous mode of operation as described.

The circuits of the invention can be implemented in several ways. For example, individual sub-circuits, circuits shown in discrete form or in blocks, or groups of blocks, can
be implemented by suitable composite circuits, in particular by integrated circuits. It is also possible to implement many of the functions, and the signal processing of the circuits shown in
digital form. At a high level of integration, it is possible to implement the entire signal processing, especially digital signal processing, of the circuit by one or more integrated circuits. Signal processing steps, for example filtering, comparing, weighting, which may be linear or non-linear, timing, or counting, can be performed digitally by arithmetic calculations. It is also possible to dispose digital as well as analog signal processors and other circuits, such as shift registers, flip-flops, Schmitt-triggers, operational amplifiers and the like, within integrated circuits for the implementation of the overall circuit of the present invention, or sub-circuits thereof.

Various other changes and modifications may be made within the scope of the inventive concept.
**TABLE OF COMPONENTS**

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CLAIMS:

1. Method of operating a high-pressure discharge lamp (LP) by means of a circuit having:

   a radio noise suppression filter (FE) coupled to a source of electrical energy;

   an intermediate circuit smoothing capacitor (Cl);

   a buck converter circuit (TS) having its input connected in parallel to said smoothing capacitor (Cl);

   an inverter (WR) connected to said lamp and coupled to and receiving energy from said buck converter (TS) and comprising, in accordance with the invention, the steps of:

      operating said buck converter (TS) in continuous mode during the run-on phase of the lamp (LP) and operating said buck converter (TS) in discontinuous mode after the run-on phase of said lamp (LP) subsequent to initial firing upon energization of the lamp.

2. The method of claim 1, wherein said circuit includes a lamp current choke (LD) through which flows current supplied to the lamp, and said method includes the step of:

    sensing when current through said choke has decayed to zero or null and controlling current supply to said lamp (LP) by said buck converter (TS), to supply current only after said zero or null current condition through said choke has been sensed.
3. A circuit for operating a high-pressure discharge lamp (LP) having:
   a radio noise suppression filter (FE) adapted to be coupled to a source of electrical energy;
   an intermediate smoothing capacitor (C1);
   a buck converter circuit (TS) having its input connected in parallel to said smoothing capacitor (C1),
   said buck converter circuit including a field effect transistor (FET) (T2) and a free wheeling diode (D1)
   connected to said FET (T2);
   an inverter (WR) connected to said lamp (LP) and coupled to and receiving electrical energy from said buck converter (TS); and
   an ignition circuit (ZE) coupled to the lamp for firing the lamp upon energization of said operating circuit, and
   wherein, in accordance with the invention,
   the source terminal of the FET (T2) of said buck converter (TS) is connected to the negative terminal of the intermediate circuit capacitor (C1) and the cathode of the free wheeling diode (D1) is connected to the positive terminal of the intermediate circuit capacitor (C1).

4. The circuit of claim 3, further including a boost converter circuit (HS) having its input coupled, optionally through a rectifier (GL), with the output of the radio noise suppression filter (FE), and
   the output of said boost converter is connected to said intermediate circuit capacitor (C1).
5. The circuit of claim 3, including means (R3) for sensing output voltage (U2) of the buck converter (TS), and means (R1) for sensing current flow to the lamp (LP), said voltage and current sensing means being connected to and controlling said buck converter (TS) to operate in, respectively, discontinuous mode when the output voltage of the buck converter has a first level corresponding to stable lamp operation, and for controlling said buck converter to operate in continuous mode when the output voltage of the buck converter (TS) is sufficiently below said first level, indicative of starting, or run-on operating condition of the lamp.

6. The circuit of claim 5, wherein said buck converter includes a choke coil (LD) in circuit with the lamp and supplying said coil, and hence said lamp, with current pulses; and means for sensing when the output current from the buck converter through the choke coil decays to zero or null; and

   means (R5) for preventing drop of output current from the buck converter to reach zero or null if the time of decrease of current through the choke coil exceeds a predetermined limit.