United States Patent

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[15] **3,675,078**

[45] **July 4, 1972**

[54] ELECTRONIC LAMP DRIVING CIRCUIT FOR HAND HELD LAMP

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[22] Filed: **May 8, 1969**

[21] Appl. No.: **822,962**

[52] **U.S. Cl.** **315/289**, 315/103, 315/DIG. 5

[51] **Int. Cl.** **H05b 41/26**

[58] **Field of Search**.....315/289, 103, DIG. 5

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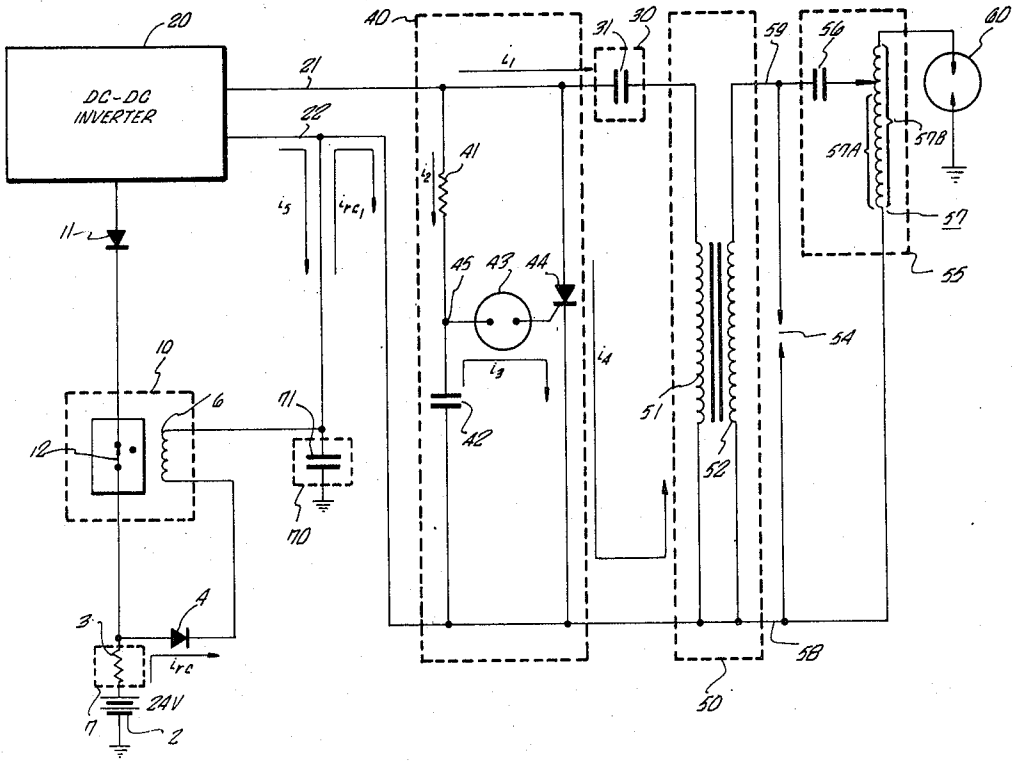
[57] **ABSTRACT**

An electronic gaseous discharge lamp ignition and running circuit is described which employs a relatively low voltage supply to provide high frequency starter pulses in conjunction with high energy starter circuit pulses and the proper low running voltage. A trigger circuit is provided which assures that the high frequency starter pulse supply is fully energized before application to the lamp. A sensing circuit disconnects the ignition circuit from the low voltage supply once the lamp has started.

13 Claims, 3 Drawing Figures



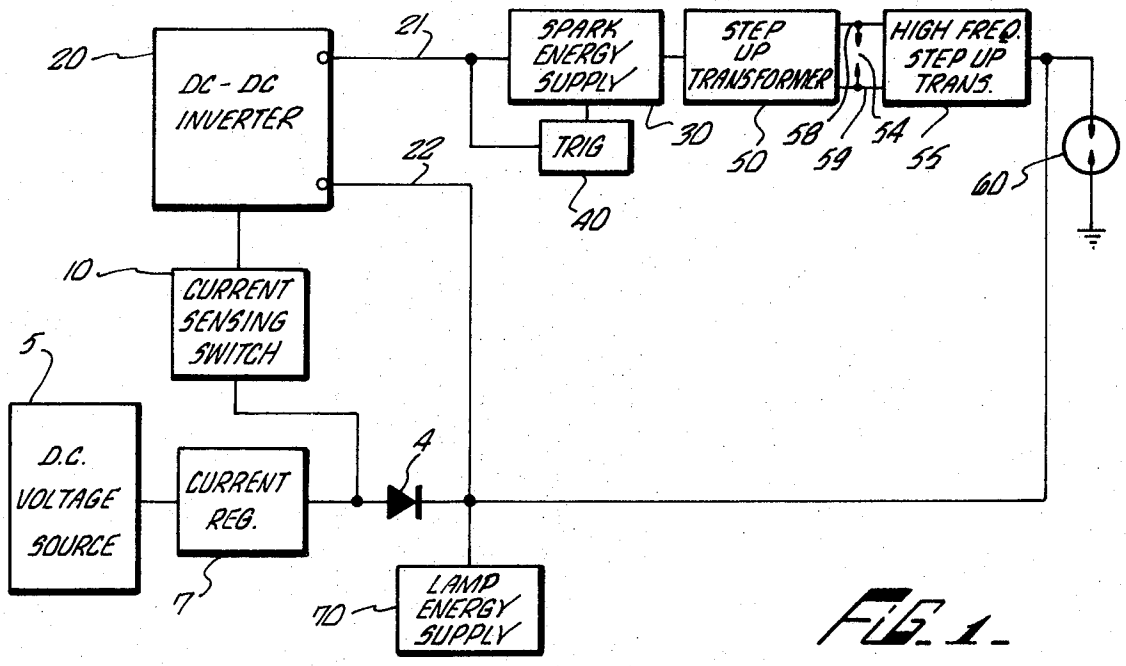


FIG. 1

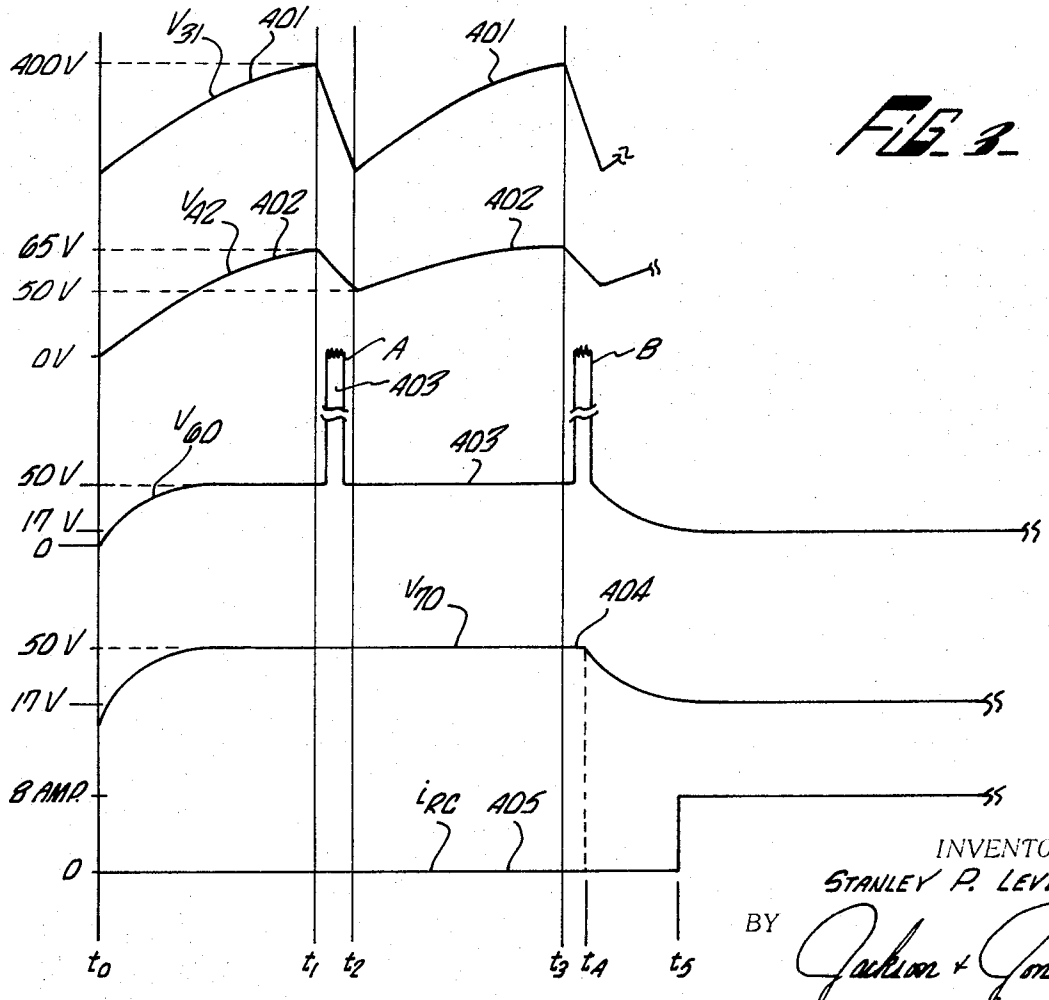


FIG. 3

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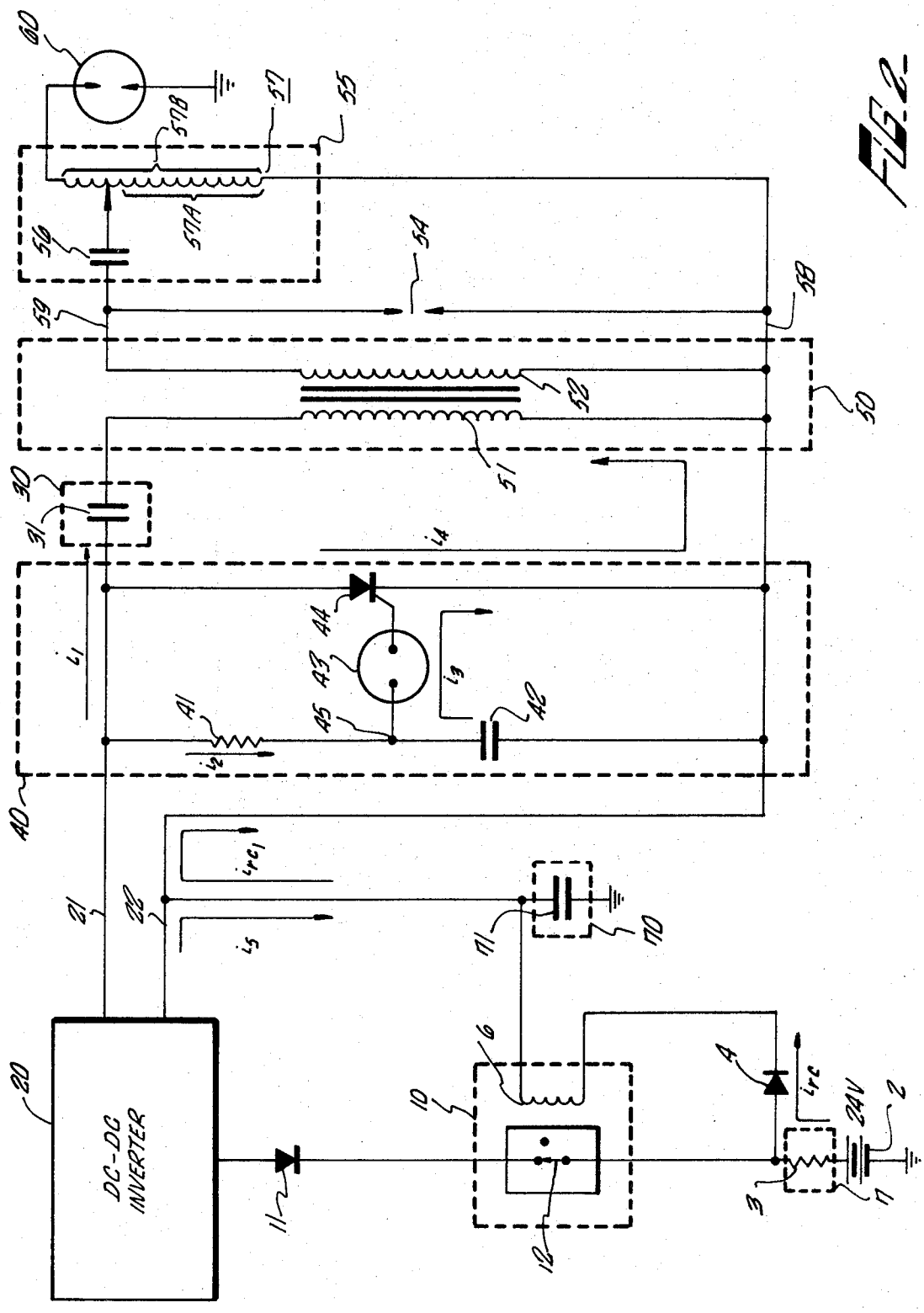

FIG. 2

ELECTRONIC LAMP DRIVING CIRCUIT FOR HAND HELD LAMP

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electronic power supply circuitry for lamp systems, and more particularly to a starting and running drive circuit for xenon arc lamps or the like.

2. Description of the Prior Art

Arc lamp ignition circuits typically require a source of high voltage direct current to provide the high current pulse required for lamp ignition. Once the lamp starts it has heretofore been necessary to insert a large ballast resistance in series with the high voltage supply in order to limit the running voltage applied to the lamp. The ballast, although serving to operate the lamp within proper limits, results in the useless dissipation of a considerable amount of energy. Further, the increased energy requirement necessitates large battery supplies. Such large batteries are bulky, unwieldy, and otherwise detrimental to portable lamp systems. It is thus desirable to start and run a lamp from a lightweight low voltage battery.

SUMMARY OF THE INVENTION

In accordance with the present invention, these and other problems have been overcome. Briefly described, the present invention provides a lamp ignition and running circuit which is energized from a low voltage DC supply. To initiate lamp operation, the low voltage supply is first stepped up to a high voltage. One stepped up voltage is used to charge a spark energy source, and another stepped up voltage charges a lamp energy source. Means are provided to assure that the spark energy source has been fully charged before it is applied to a spark producing means such as an ignition coil. A spark, when created, includes high frequency components, which components are isolated and are further stepped up and applied to the lamp. During the time when the high frequency components are being applied to the lamp, the lamp energy source provides a high direct current potential across the lamp electrodes. As the lamp ignites it draws an extremely high current surge in accordance with its well-known starting characteristics. This high ignition current is referred to hereinafter as a high DC current pulse provided by the lamp energy source.

Once the lamp has been started means are provided for removing the ignition system and the lamp energy source from the circuit. Thereafter, the lamp is run from a constant current source which is simply and readily provided by the low voltage supply and a series resistor.

Other features and intended advantages of the present invention will become apparent to those skilled in the art from a reading of the following detailed description of a preferred embodiment constructed in accordance therewith taken in conjunction with the accompanying drawings and wherein:

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a block diagram of an ignition and running system in accordance with the principles of this invention;

FIG. 2 is an electrical schematic drawing of the system of FIG. 1; and

FIG. 3 is a waveform chart useful in understanding the operation of the circuit of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a block diagram of one embodiment of a lamp driving circuit in accordance with this invention for both starting and running an arc lamp such as an xenon arc lamp **60** from a low voltage source **5**.

A spark energy supply **30** and lamp energy supply **70** are energized from a DC to DC inverter **20** which, in turn, is energized from a relatively low DC voltage source **5**. The DC to DC inverter **20** steps up the voltage received from the DC voltage source **5** in a conventional manner. It establishes on line **22** a DC voltage of approximately 50 volts which is applied to lamp energy supply **70**. It establishes on line **21** a DC voltage of approximately 400 volts which is applied to the spark energy supply **30**.

Connected to the spark energy supply **30** is a trigger circuit **40** which serves to trigger the spark energy supply **30** when it has been fully energized to a predetermined level. The spark energy supply **30** provides a high energy pulse to voltage step-up transformer **50** which creates a spark at gap **54** connected across output lines **58** and **59**. The high frequency components of the spark thus created are applied to high frequency step-up transformer **55** which passes and steps up the high frequency components and applies them to the xenon arc lamp **60**. During the time when the high frequency components are being applied to the anode of lamp **60**, lamp energy supply **70** is applying a high DC starter current pulse to the anode of lamp **60** thus satisfying the starting requirement for lamp **60**.

Once xenon arc lamp **60** has been started by the application of the high frequency component energy surge and the DC starter current pulse, it is thereafter run from the relatively low DC voltage source **5**. The running current for lamp **60** is via a current regulator **7** and a diode **4**. A current sensing switch **10** senses the lamp running current and automatically disconnects the DC to DC inverter. Power is therefore removed from the starting circuit free of any manual operation by the unique features of my invention.

FIG. 2 is a schematic circuit diagram of the starter and running circuit of FIG. 1. FIG. 3 is a waveform chart useful in understanding the operation of the circuit of FIG. 2.

Referring now to FIG. 2, a DC voltage source or battery **2** is connected in series relationship with a resistor **3**, diode **4**, reed switch coil **6**, autotransformer **57** and xenon arc lamp **60**. The DC to DC inverter **20** is connected via diode **11** (which may preferably be a zener diode), contact **12** of switch **10**, and resistor **3** to battery **2**. Voltage drop diode **11** assures the application of a standardized voltage to the input of the DC to DC inverter **20**. Spark energy supply **30** comprises an ignition storage capacitor **31** having one plate connected to inverter **20** by lead **21** and having the other plate connected to inverter **20** by primary winding **51** and lead **22**. The spark energy supply trigger circuit **40** allows capacitor **31** to charge to a predetermined level before it triggers to discharge capacitor **31**. This predetermined level is approximately the 400 volts differential between lines **21** and **22** of inverter **20**.

Trigger circuit **40** includes a resistor **41** connected in series with trigger capacitor **42**, which combination is in parallel circuit configuration with a silicon controlled rectifier **44**. Connected between the resistor-capacitor terminal **45** and the control terminal of silicon controlled rectifier **44** is a neon lamp **43** which remains non-conductive until its breakdown voltage level is established at terminal **45** by charge on capacitor **42**.

A secondary winding **52** of step-up transformer **50** is connected via capacitor **56** to the primary **57A** of autotransformer **57**. The secondary **57B** of autotransformer **57** is connected to the anode of xenon arc lamp **60**. Capacitor **56** and autotransformer **57** serve to step up the high frequency components of the spark created at gap **54** when capacitor **31** is discharged into primary **51**.

In the operation of the circuit thus described, battery **2** which may preferably be a 24 volt DC battery applies a DC potential via voltage drop diode **11** to DC to DC inverter **20**. Inverter **20** steps up the voltage thus applied and provides a 450 volt and a 50 volt output on lines **21** and **22**, respectively. The output on line **21** starting at time t_o, FIG. 3, charges ignition storage capacitor **31** via current i_1 and charges trigger capacitor **42** via current i_2. The voltages appearing across capacitors **31** and **42** are represented by waveforms **401** and **402**, FIG. 3. Neon lamp **43** will remain non-conductive until the voltage level at point **45** reaches approximately 65 volts at time t_1 when neon lamp **43** breaks down. Capacitor **42** at time t_1, FIG. 3, discharges upon breakdown of neon **43** to establish current i_3. Current i_3 is the gate current of silicon controlled

rectifier **44**. The flow of current i_3 causes silicon controlled rectifier **44** to conduct, thus discharging capacitor **31** to ZERO. When rectifier **44** conducts a current surge i_4 is produced through primary winding **51** of ignition coil **50**. Ignition coil **50** steps up the voltage established by the current surge, and causes a spark to occur between output lines **58** and **59** at spark gap **54**.

The high frequency components produced by the spark are applied via capacitor **56** to the primary **57A** of autotransformer **57** which steps up the high frequency components and applies them to xenon arc lamp **60**. The voltage applied to lamp **60** is shown by waveform **403**, FIG. **3**.

As previously described, in order to start a xenon arc lamp it is necessary to apply a DC current pulse through the lamp in addition to a high frequency component pulse. This current resulting from voltage pulses **403**, FIG. **3**, is supplied by energy storage capacitor **71** which produces current i_{rct} as shown in FIG. **2**.

If the xenon arc lamp **60** starts on application of the first high frequency pulse thereto, the ignition system is disconnected from the running circuit, in the manner described hereinafter. If, however, the lamp fails to start, the silicon controlled rectifier **44** will be shut off when current i_4 falls below the required holding current. Thereafter, capacitors **31** and **42**, starting at time t_2, will again be charged by current i_1 and i_2 to repeat the above-described sparking sequence. It should be noted that the values of resistor **41** and capacitor **42** are chosen to allow capacitor **31** to substantially fully charge to its required 400 volts before capacitor **42** turns on neon lamp **43**.

In order to understand how the ignition circuit is automatically disconnected when the lamp **60** starts, assume first that lamp **60** is non-conductive. Capacitor **71** via current i_5 has been previously charged from line **22** of DC to DC inverter **20** to **50** volts as shown by waveform **404**, FIG. **3**. The charge on capacitor **71** serves to reverse bias diode **4** during the time when lamp **60** is not running to assure that current will not flow through coil **6**. Inverter **20** establishes an output voltage on lead **22** under load conditions, as represented by ignition in lamp **60**, which is lower than the 24 volts of battery **2**. Thus when the lamp **60** ignites, capacitor **71** discharges, the voltage across capacitor **71** drops sufficiently to remove the reverse bias on diode **4**. Diode **4** becomes conductive. Thereafter, at time t_5 battery **2** will supply the running current i_{rc}, FIG. **3**, for the xenon arc lamp **60**. The running current i_{rc} through coil **6** of reed switch **10** opens contact **12** to automatically disconnect the DC to DC inverter **20**. The starter circuit is thus disconnected from the running circuit upon ignition. Concurrently with the disconnection the arc lamp is left in a running circuit with the low voltage supply **2**. When the lamp is on the inverter is off and its output voltage is ZERO.

Resistance **3** serves as a current regulator limiting the current flow in lamp **60**. The voltage drop across resistor **3** prevents excessive current flow in lamp **60**. Resistor **3** and battery **2** form a constant current source providing the rated running current for lamp **60**. Lamp **60** determines its own running voltage at rated running current.

By proper selection of components the starter circuit may be shut off without requiring a switch **10**. If the running voltage drop across resistor **3** and voltage drop diode **11** is equal to the battery supply **2**, a zero input will be seen by inverter **20** when the lamp is running.

The subject invention has been described with reference to certain preferred embodiments; it will be understood by those skilled in the art to which this invention pertains that the scope and spirit of the appended claims should not necessarily be limited to the embodiments described in detail herein.

What is claimed is:

1. A circuit for igniting and operating a gaseous discharge lamp adapted for use in a portable hand held illuminator, said gaseous discharge lamp including a xenon arc lamp, the circuit comprising:

means for providing a DC battery source and an associated current path from said battery source to said lamp for supplying rated running current to said xenon lamp once it is ignited and operating at a running voltage less than the output voltage of said D.C. battery source;

a DC to DC inverter circuit for igniting said xenon lamp by employing two different voltage signals supplied as first and second inverter output voltages at respective first and second output terminals of said inverter;

means connecting said inverter to said DC battery source and enabling said inverter to supply said second inverter output as a low voltage signal which is selected in a range to be at least equal to the running voltage and less than four times the running voltage for the xenon lamp, and to supply said first inverter output as a high voltage signal selected in a range of four to 20 times as great as said second inverter output voltage;

first energy storage means responsive to said high voltage signal for storing energy to at least a predetermined level;

means responsive to said first energy storage means for producing a spark;

trigger means responsive to said high voltage signal from said inverter for applying said stored energy to said spark producing means when said stored energy reaches a predetermined level;

means for applying high frequency components created by said spark to said gaseous discharge lamp tending to produce ignition thereof; and

means operatively coupling the low voltage signal from said second output terminal of said inverter to said xenon lamp for heating the cathode of said lamp to assist in said ignition operation.

2. The ignition circuit of claim **1** further comprising:

means responsive to rated running current from said battery to said xenon lamp when said lamp is ignited for automatically disconnecting said inverter from said D.C. battery providing means.

3. The ignition circuit of claim **1** wherein said trigger means includes a resistor and timing capacitor in series charging relationship between said high voltage signal output terminal and said low voltage signal terminal, further comprising means responsive to the voltage level across said timing capacitor for applying the stored energy of said first energy storage means to said spark producing means.

4. The ignition circuit of claim **3** wherein said timing capacitor voltage level responsive means comprises:

a three terminal silicon controlled rectifier the anode and cathode terminals of which are in series electrical connection with said at least one capacitor and said spark producing means; and

means responsive to the voltage level across said timing capacitor for discharging said timing capacitor through the gate circuit of said rectifier when said timing capacitor voltage level reaches a predetermined level thereby rendering said silicon controlled rectifier conductive.

5. The ignition circuit of claim **4** wherein said timing capacitor voltage level responsive means comprises a gaseous tube responsive to and adapted to conduct when said timing capacitor voltage level reaches said predetermined level.

6. The ignition circuit of claim **1** wherein said spark producing means comprises an ignition coil in series electrical connection with a capacitor, said ignition coil having first and second output terminals and adapted to produce a spark across said output terminals responsive to the discharging of said capacitor.

7. The ignition circuit of claim **6** wherein said high frequency component applying means includes:

a filter capacitor in series electrical connection with said first output terminal of said ignition coil; and

an autotransformer having its primary winding connected between said second output terminal and said filter capacitor, and hAving its secondary winding connected to said gaseous discharge lamp.

8. A circuit for starting and running a gaseous discharge lamp of xenon operating characteristics in a portable illuminator, the circuit comprising:

a DC battery and an associated current path for said battery for supplying rated running current to said xenon lamp once it is ignited and operating at a running voltage less than the output voltage of said DC battery;

a DC to DC inverter circuit for igniting said xenon lamp by employing two different voltage levels supplied as first and second inverter output voltages at respective first and second output terminals of said inverter;

means connecting said inverter to said DC battery and enabling said inverter to supply said second inverter output as a low voltage level which is selected in a range to be at least equal to the running voltage and less than four times the running voltage for the xenon lamp, and to supply said first inverter output as a high voltage level selected in a range of four to 20 times as great as said second inverter output voltage level;

voltage step-up means responsive to said high voltage level from said inverter for providing a second higher DC voltage level;

first energy storage means responsive to said high inverter output level for storing potential energy;

means responsive to said second higher DC voltage level for producing a high frequency pulse;

means including said voltage step-up means for applying said stored potential energy to said high frequency pulse producing means when said stored potential energy in said first energy storage means reaches a predetermined level;

means for applying the high frequency pulse to said gaseous discharge lamp;

means operatively coupling the low voltage level from said second output terminal of said inverter to said xenon lamp for heating the cathode of said lamp to assist in said ignition operation; and

means responsive to the starting of said lamp and its running current from said DC battery providing means for disconnecting the DC battery from said DC to DC inverter to render the inverter inoperative.

9. The ignition circuit of claim **8** further comprising:

switching means automatically responsive to the lamp running current for disconnecting said means connecting said battery to said inverter.

10. The combination of claim **9** wherein said automatic disconnecting means comprises a switch in series connection between said DC battery and said DC to DC inverter, the switch being normally closed and adapted to be opened by said running current.

11. The combination of claim **10** wherein said switch is a reed switch the coil of which is in series electrical connection with said DC battery and said lamp.

12. The combination of claim **9** wherein said running current path for said xenon lamp includes:

a voltage drop diode; and

a resistor in series electrical connection between said DC battery and said lamp.

13. An ignition circuit for a xenon gaseous discharge lamp adapted to be employed in a portable hand held illuminating device, the circuit comprising:

a low voltage DC battery for establishing at the lamp a running voltage of approximately 17 volts for said lamp;

a DC to DC inverter circuit connected to said running voltage source and having first and second output terminals, said first output terminal adapted to provide a high voltage signal approximately 450 volts DC, said second output terminal providing a low voltage signal approximately 50 volts DC

pulsing means operably coupled to said first output terminal;

control means operably coupled to said pulsing means to provide a high frequency pulse to said discharge lamp tending to produce ignition thereof, said second output terminal being operably coupled to said discharge lamp for heating the cathode of said discharge lamp to assist in ignition of said lamp; and

means connecting said running voltage source to said lamp to provide operating current to said discharge lamp once it is ignited.

* * * * *