United States Patent [19]

Kahanic

[11] **3,720,861**

[45] **March 13, 1973**

[54] **FLUORESCENT LAMP IGNITING CIRCUIT**

[75] Inventor: **Francis P. Kahanic,** Arlington Heights, Ill.

[73] Assignee: **Teletype Corporation,** Skokie, Ill.

[22] Filed: **Dec. 21, 1970**

[21] Appl. No.: **99,934**

[52] **U.S. Cl.** **315/101,** 315/102, 315/107, 315/307, 315/310, 307/305

[51] **Int. Cl.**.....**H05b 37/00,** H05b 41/14

[58] **Field of Search**.....315/99, 101, 102, 103, 107, 315/100 U, 307, 310; 307/88.5, 305, 252 J, 284, 310

[56] **References Cited**

UNITED STATES PATENTS

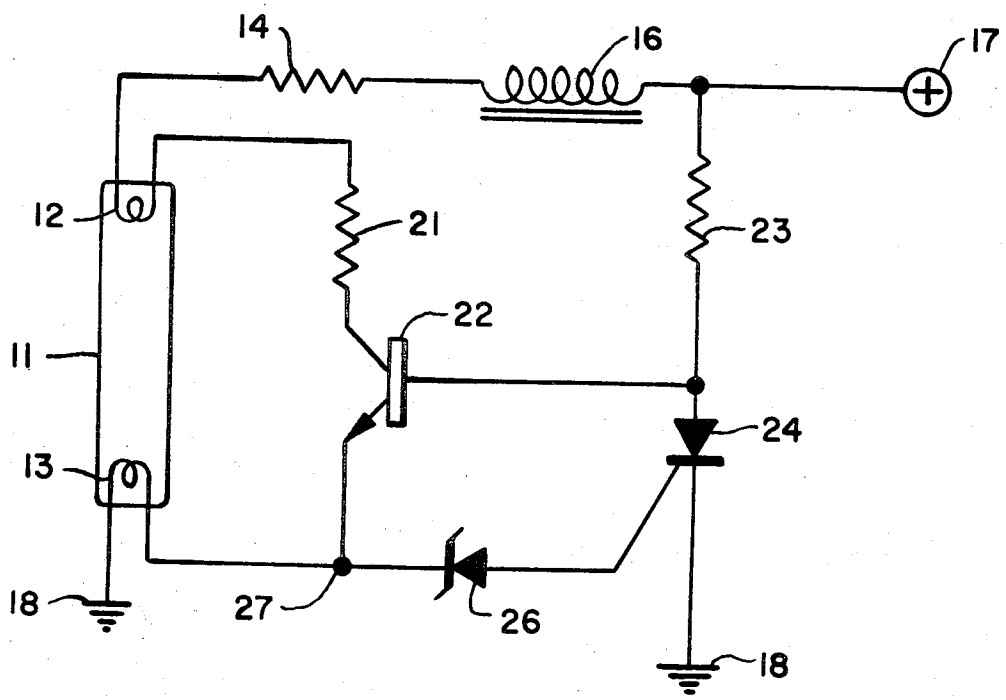
3,588,592	6/1971	Brandstadter	315/99
3,525,901	8/1970	Sammis	307/305 X
3,066,241	11/1962	Palmer	315/107 X
3,505,562	4/1970	Engel	315/99 X
3,165,668	1/1965	Hardley	315/307 X
3,265,930	8/1966	Powell, Jr.	315/100 U

Primary Examiner—Herman Karl Saalbach
Assistant Examiner—Saxfield Chatmon, Jr.
Attorney—J. L. Landis and R. P. Miller

[57] **ABSTRACT**

A transistor is between, and in series with, the heating filaments of a fluorescent lamp, to allow current flow therethrough when power is initially applied to the circuit. A predetermined time after power is applied to the circuit, determined either by the time required to charge a capacitor to a predetermined potential or by the time required to increase the impedance of one of the heating filaments to a predetermined impedance as a result of heating caused by I^2R losses, the transistor is rendered nonconductive. When the transistor is rendered nonconductive an induction coil, in series with the filaments, provides a momentary additive transient voltage to ignite the lamp.

14 Claims, 3 Drawing Figures



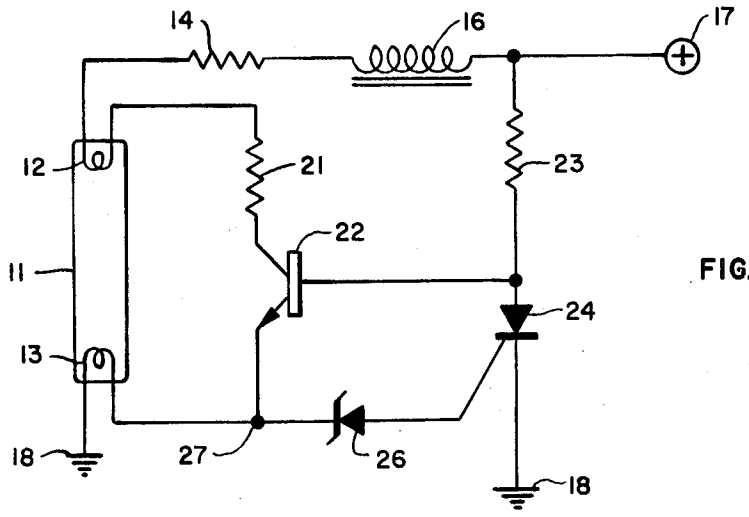


FIG. 1

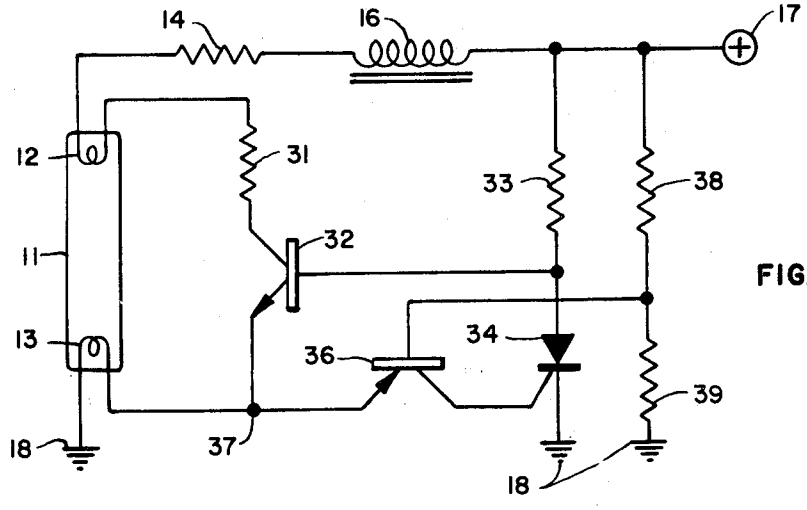


FIG. 2

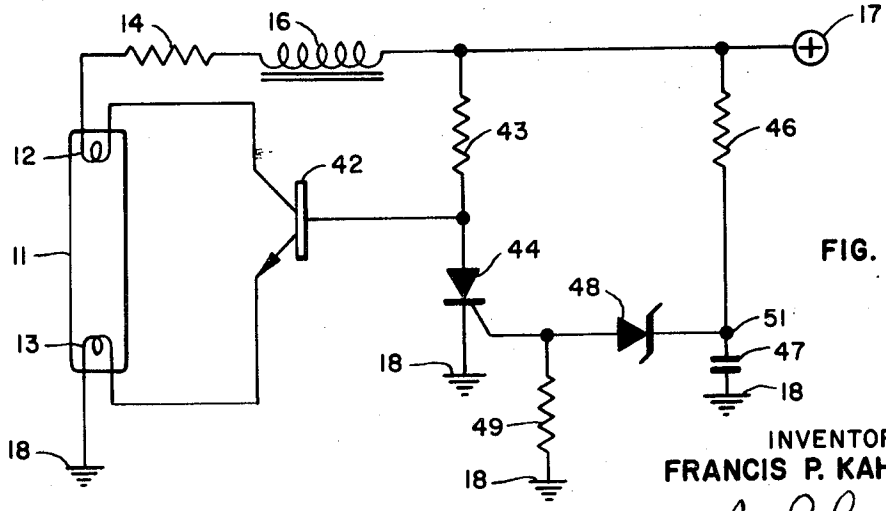


FIG. 3

INVENTOR
FRANCIS P. KAHANIC
BY J. L. Landis
ATTORNEY

FLUORESCENT LAMP IGNITING CIRCUIT

BACKGROUND OF THE INVENTION

The present invention relates to fluorescent lamp ignition circuits, and in particular to circuits employing semiconductive devices to ignite a fluorescent lamp.

In igniting fluorescent lamps having heating filaments, there is a need for circuitry to provide ignition when the heating filaments are at the proper temperature to support ignition of the lamp. If ignition is provided before the filaments are at the proper temperature, the lamp will be unable to sustain the ignition; while if ignition is provided when the temperature of the filaments has risen above the proper temperature, the filaments will have reduced life.

An object of the invention is to provide fluorescent lamp ignition circuitry wherein ignition is provided to the lamp when the heating filaments reach the proper temperature to allow the lamp to sustain ignition.

SUMMARY OF THE INVENTION

The foregoing and other objects of the invention are accomplished by providing means for applying a first potential to a first terminal of a first filament of a fluorescent lamp, the lamp having both first and second electrically conductive filaments with each filament having a first and a second terminal, and a second potential to the first terminal of the second filament. A first transistor switching device is connected between the second terminal of the first filament and the second terminal of the second filament, and is responsive to the application of the first and the second potentials to become conductive. Second and third means are provided, the second means being responsive to the application of the first and the second potentials to render the first semiconductive device nonconductive a predetermined time after the application of the potentials, and the third means being responsive to the transistor switching device being rendered nonconductive to ignite the fluorescent lamp.

Preferrably, an induction coil is provided in series with the two filaments of the lamp, and with the transistor switching device, to provide a momentary additive transient voltage, or inductive voltage kick, to ignite the lamp when the transistor switching device is rendered nonconductive. The conduction of the transistor switching device is determined by a silicon controlled rectifier connected to the base of the transistor, such that when the silicon controlled rectifier is conducting the transistor is rendered nonconductive, and when the silicon controlled rectifier is nonconductive the transistor is rendered conductive. The conduction of the silicon controlled rectifier is in turn controlled by other semiconductor means.

Other objects, advantages and features of the invention will be apparent from the following detailed description of the specific embodiments thereof, when taken in conjunction with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a circuit diagram of a first embodiment of the invention.

FIG. 2 is a circuit diagram of a second embodiment of the invention.

FIG. 3 is a circuit diagram of a third embodiment of the invention.

DETAILED DESCRIPTION

Referring to FIGS. 1 through 3 of the drawings, there are shown three embodiments of a fluorescent lamp ignition circuit for igniting a fluorescent lamp 11 having two heater filaments 12 and 13. In each of the embodiments a resistor 14 and an induction coil 16 are connected in series between an input to the heater filament 12 and a source of positive potential 17, while an input to the heater filament 13 is connected directly to a source of ground potential. When a current flow from the source of positive potential 17, through the induction coil 16, the resistor 14 and the heater filaments 12 and 13 to the source of ground potential 18 is interrupted, as will be described later, the induction coil 16 provides a momentary inductive voltage kick to ignite the fluorescent lamp 11. In the description of the operation of the circuit shown in the drawings, reference will be made to positive and to ground potential. These terms for defining the potentials used in the circuit are relative terms used to illustrate the operation of the circuit and are not to be considered limiting, since any other two potentials could be used, the potential being substituted for the positive potential referred to in the specification being merely more positive than the potential being substituted for the ground potential.

FIRST EMBODIMENT

The embodiment of the fluorescent lamp ignition circuit shown in FIG. 1 of the drawings also includes a resistor 21 connected between the heater filament 12 and the collector of a transistor 22, the emitter of the transistor 22 being connected to the heater filament 13, so that when the transistor 22 is rendered conductive a series circuit is established from the source of positive potential 17, through the induction coil 16, the resistor 14, the heater filament 12, the resistor 21, the transistor 22 and the heater filament 13 to the source of ground potential 18. The base of the transistor 22 is connected both to the source of positive potential 17, through a resistor 23, and to the anode of a silicon-controlled-rectifier 24, the cathode of the silicon-controlled-rectifier 24 being connected to the source of ground potential 18. The gate of the silicon controlled rectifier 24 is connected to the anode of a Zener diode 26, the cathode of which is connected to the emitter of the transistor 22, and therefore to the heating filament 13.

When the potentials 17 and 18 are initially applied to the circuit, the transistor 22 is rendered conductive by the application of the positive potential 17 at its base through the resistor 23, establishing a current flow through the series connected elements, as recited above, comprising the induction coil 16, the resistor 14, the heating filament 12, the resistor 21, the transistor 22 and the heating filament 13. As a result of the current flow through the heating filaments 12 and 13, the temperature of the heating filaments 12 and 13 increases from I^2R losses therein, causing an increase in the impedance of the filaments 12 and 13 which is commensurate with the rise in the temperature of the filaments, the filaments 12 and 13 being of a conventional type having a positive temperature coefficient of resistivity. As the impedance of the filaments 12 and 13 increases with the rise in temperature, the voltage at a junction point 27, defined by the juncture of the

emitter of the transistor 22, the heating filament 13, and the cathode of the Zener diode 26, increases as a result of a voltage divider effect.

The potential at the junction point 27, when the potentials 17 and 18 are initially applied to the circuit, is below the breakdown voltage of the Zener diode 26, the anode of which is tied at the ground potential 18 through the gate of the silicon-controllED-rectifier 24, and therefore the Zener diode 26 initially remains nonconductive. As the temperatures of the heating filaments 12 and 13 continues to rise as a result of the I^2R losses therein, the voltage at the junction point 27 continues to increase until the breakdown voltage of the Zener diode 26 is exceeded, causing the Zener diode 26 to conduct and to trigger the silicon-controlled-rectifier 24, which in turn carries the ground potential 18 to the base of the transistor 22, thereby rendering the transistor 22 nonconductive and disrupting the current flow through the path established by the induction coil 16, the resistor 14, the heating filament 12, the resistor 21, the transistor 22 and the heating filament 13. Disruption of the current flow through the induction coil 16 causes the induction coil to provide an inductive voltage kick therefrom which is applied to the filament 12 of the lamp 11, thereby igniting the lamp 11 as a result of the ionization of the gases therein caused by the large potential difference between the heating filaments 12 and 13. The resulting current flowing through the induction coil 16, the resistor 14, and the heating filaments 12 and 13 is sufficient to maintain ignition of the lamp.

It is to be noted that the potential at the junction point 27 when the sources of potentials 17 and 18 are initially applied to the circuit is a function of the effective impedance of the induction coil 16, the resistors 14 and 21, and the heating filaments 12 and 13; and that rise in potential at the junction point 27 as a result of a voltage divider effect is a function of the effective increase in impedance of the heating filaments 12 and 13 resulting from I^2R losses therein. Therefore, ignition of the lamp 11 can be made to occur when the heating filaments 12 and 13 are at any desired temperature by adjusting the values of the resistors 14 and 21 to provide the breakdown potential of the Zener diode 26 at the junction point 27 when the heating filaments 12 and 13 have reached the desired temperature. It is understood, of course, that the potential at the junction point 27 required to ignite the lamp 11 may also be determined by choosing a Zener diode 26 having the required breakdown voltage.

SECOND EMBODIMENT

The embodiment of the fluorescent lamp ignition circuit shown in FIG. 2 of the drawings is substantially identical in configuration and operation with the circuit shown in FIG. 1, the difference being in that a transistor 36 has replaced the Zener diode 26 of FIG. 1, and in that two series connected resistors 38 and 39 have been connected between the two sources of potential 17 and 18 to provide an input to the base of the transistor 36 from their juncture. The emitter of the transistor 36 is connected to a junction point 37, which is common with the emitter of a transistor 32 and the heating filament 13, and the collector of the transistor 36 has been connected to the gate of a silicon-controlled-rectifier 34.

When the potentials 17 and 18 are initially applied to the circuit, the potential at the junction point 37 is below the potential at the junction of the resistors 38 and 39, so that the emitter-base voltage of the transistor 36 is initially insufficient to allow the transistor 36 to conduct. As the potential at the junction point 37 increases with a corresponding temperature increase in the heating filaments 12 and 13, as described above for the circuit of FIG. 1, the emitter-base voltage of the transistor 36 eventually becomes sufficient to allow the transistor 36 to conduct and to trigger the silicon-controlled-rectifier 34. Conduction of the silicon-controlled-rectifier 34 carries the ground potential 18 to the base of the transistor 32, thereby rendering the transistor 32 nonconductive and providing an inductive voltage kick from the induction coil 16 to ignite the lamp 11 as described above.

It is to be noted that the fluorescent lamp 11 is ignited when the transistor 36 is rendered conductive, which occurs when the potential at the junction 37 is equal to the potential existing at the juncture between the resistors 38 and 39. Therefore, ignition of the fluorescent lamp 11 may be provided when the heating filaments 12 and 13 are at any desired temperature by adjusting the value of the resistors 14 or 31 to control the potential at the junction point 37 when the heating filaments 12 and 13 are at the desired temperature, or by adjusting the values of the resistors 38 and 39 so that potential at their jucture is equal to the potential at the junction point 37 when the heating filaments 12 and 13 are at the desired temperature. It is to be further noted that, as with the circuit of FIG. 1, ignition of the lamp 11 is provided only when the heating filaments 12 and 13 are at a desired, or optimum, temperature, to assure a reliable and spontaneous ignition of the lamp.

THIRD EMBODIMENT

The embodiment of the circuit shown in FIG. 3 of the drawings includes a transistor 42, connected as a shunt between the heating filaments 12 and 13, and a series connected resistor 43 a silicon-controlled-rectifier 44 connected between the source of positive potential 17 and the source of ground potential 18 such that the cathode of the silicon-controlled-rectifier 44 is connected to the source of ground potential. An input is provided to the base of the transistor 42 from the anode of the silicon-controlled-rectifier 44. Also connected in series and between the sources of positive and ground potential is a resistor-capacitor network comprised of a resistor 46 and a capacitor 47, such that the capacitor 47 is connected to the source of ground potential. A Zener diode 48 is connected between the gate of the silicon-controlled-rectifier 44 and the juncture between the resistor 46 and the capacitor 47, the cathode of the Zener diode 48 being connected to the juncture between the resistor 46 and the capacitor 47. A resistor 49 is connected between the anode of the Zener diode 48 and the source of ground potential 18.

When the potentials 17 and 18 are initially applied to the circuit, a current flow is established through the heating filaments 12 and 13, as described for the embodiments of the circuits shown in FIGS. 1 and 2, through the series circuit comprising the resistor 14, the induction coil 16, the heating filament 12, the transistor 42 and the heating filament 13, providing for an increase in temperature of the heating filaments 12

and 13 through I^2R losses. Also, the potential at a junction point 51 between the resistor 46 and the capacitor 47 begins to increase as the charge on the capacitor 47 increases, the potential at the junction point 51 initially being below the breakdown voltage of the Zener diode 48, the anode of which is held at a ground potential through the gate and cathode of the silicon-controlled-rectifier 44. When the voltage at the junction point 51 reaches a predetermined potential, which potential is equal to the breakdown voltage of the Zener diode 48 and is determined by the amount of time required for the heating filaments 12 and 13 to reach a desired temperature, the Zener diode 48 conducts and triggers the silicon-controlled-rectifier 44, which in turn carries a ground potential to the base of the transistor 42. The ground potential at the base of the transistor 42 renders the transistor 42 non-conductive, providing an inductive voltage kick from the induction coil 16 to ignite the lamp 11.

It is to be noted that in this embodiment of the circuit the ignition time of the circuit is not a function of the impedance of the heating filaments 12 and 13, but rather is a function of the R-C time constant of the resistor 46 and the capacitor 47 as as well as the breakdown voltage of the Zener diode 48. The resistor 46, the capacitor 47 and the Zener diode 48 are chosen to provide ignition upon the application of a potential to the circuit only after the heating filaments 12 and 13 have had an opportunity to reach a desirable and optimum ignition temperature.

While three embodiments of the invention have been described in detail, it will be obvious that various modifications may be made from the specific details described without departing from the spirit and scope of the invention.

What is claimed is:

1. A circuit for igniting a fluorescent lamp, the lamp having a first and a second electrically conductive filament and each filament having a first and a second terminal, which comprises:

means for applying a first potential to the first terminal of the first filament and a second potential to the first terminal of the second filament;

a first semiconductive device, connected between the second terminal of the first filament and the second terminal of the second filament, and responsive to the application of the first potential to become conductive to complete a path for a flow of current through the first and second filaments;

means responsive to the application of the first and the second potentials to render the first semiconductive device nonconductive a predetermined time after the application of the potentials to interrupt the flow of current through the first and second filaments; and

means responsive to the interruption of the current flow through the first and second filaments to ignite the fluorescent lamp.

2. A circuit for igniting a fluorescent lamp, the lamp having a first and second electrically conductive filament and each filament having a first and a second terminal, the second filament being characterized in that it exhibits a gradually increasing impedance as it is heated by I^2R losses in response to the application of a potential thereacross, which comprises:

means for applying a first potential to the first terminal of the first filament and a second potential to the first terminal of the second filament;

a first semiconductive device, connected between the second terminal of the first filament and the second terminal of the second filament, and responsive to the application of the first potential to become conductive to apply a potential across the second filament to gradually increase the potential at the connection between the first semiconductive device and the second terminal of the second filament as a result of a voltage divider effect as the second filament exhibits the increasing impedance in response to the application of the potential thereacross;

a second semiconductive device, connected to the connection between the first semiconductive device and the second terminal of the second filament, and responsive to a predetermined potential at the connection to render the first semiconductive device nonconductive; and

means responsive to the first semiconductive device being rendered nonconductive to ignite the fluorescent lamp.

3. A circuit as recited in claim 2, wherein: a silicon-controlled-rectifier is connected to the first semiconductive device to control the conduction thereof; and

the second semiconductive device is also connected to the silicon-controlled-rectifier to control the conduction thereof, such that nonconduction of the silicon-controlled-rectifier allows the first semiconductive device to conduct and such that conduction of the silicon-controlled-rectifier prevents the first semi-conductive device from conducting.

4. A circuit as recited in claim 3, wherein:

the first semiconductive device is a transistor switching device, the base of the transistor being connected to the silicon-controlled-rectifier;

the second semiconductive device is a Zener diode having a breakdown potential equal to the predetermined potential; and

the means for igniting the lamp includes an induction coil connected in series with the first terminal of the first filament.

5. A circuit as recited in claim 3, further including:

first and second series connected resistors connected between the first and the second potentials, the resistors being of such a value that the potential at the connection between them is equal to the predetermined potential; and wherein

the first semiconductive device is a transistor switching device;

the second semiconductive device is a transistor switching device, the emitter of the transistor being connected to the connection between the first transistor and the second terminal of the second filament and the base of the transistor being connected to the connection between the first and the second resistors, so that when the potential at the emitter reaches the predetermined potential the transistor is rendered conductive to render the silicon-controlled-rectifier conductive; and

the means for igniting the lamp includes an induction coil connected in series with the portion of the cir-

cuit including the means for applying the first potential and the first terminal of the first filament, so that when the first transistor is rendered nonconductive an inductive voltage kick is provided to ignite the lamp.

6. A circuit for igniting a fluorescent lamp, the lamp having a first and a second electrically conductive filament and each filament having a first and a second terminal, which comprises:

means for applying a first potential to the first terminal of the first filament and a second potential to the first terminal of the second filament;

a first semiconductive device, connected between the second terminal of the first filament and the second terminal of the second filament, and responsive to the application of the first potential to become conductive;

a resistor-capacitor network, connected in series between the means for applying the first potential and the means for applying the second potential;

a second semiconductive device, connected to the connection between the resistor and the capacitor of the resistor-capacitor network for sensing the potential on the capacitor, and responsive to a predetermined potential on the capacitor to render the first semiconductive device nonconductive, the potential on the capacitor being below the predetermined potential when the first potential is initially applied and gradually rising to the predetermined potential in response to the application of the first and the second potentials; and

means responsive to the first semiconductive device being rendered nonconductive to ignite the fluorescent lamp.

7. A circuit as recited in claim 6 wherein:

a silicon controlled rectifier is connected to the first semiconductive device to control the conduction thereof; and

the second semiconductive device is connected to the silicon-controlled-rectifier to control the conduction thereof, such that nonconduction of the silicon-controlled-rectifier allows the first semiconductive device to conduct and such that conduction of the silicon-controlled rectifier prevents the first semiconductive device from conducting.

8. A circuit as recited in claim 7, wherein:

the first semiconductive device is a transistor switching device, the base of the transistor being connected to the silicon-controlled-rectifier;

the second semiconductive device is a Zener diode, the breakdown potential of the diode being equal to the predetermined potential; and

the means for igniting the lamp includes an induction coil connected in series with the first terminal of the first filament.

9. In a fluorescent lamp igniting circuit, the lamp having at least one filament responsive to the application of a voltage to generate heat through I^2R losses, the filament exhibiting a first impedance prior to the application of the voltage and being characterized in that it exhibits a gradually increasing impedance as its temperature increases in response to the application of the voltage, the improvement which comprises:

an impedance coupled in series with the filament to form a voltage divider;

a transistor switching device connected in series with the impedance and the filament to control the conduction of current therethrough;

a semiconductor device for sensing the potential between the impedance and the filament, and responsive to the potential reaching the predetermined potential as a result of the impedance of the filament reaching a predetermined impedance to render the transistor switching device nonconductive; and

means, responsive to nonconduction of the transistor switching device, to ignite the lamp.

10. A circuit as recited in claim 9, wherein:

a silicon-controlled-rectifier is connected to the base of the transistor switching device to control the conduction thereof; and

the semiconductor device is a Zener diode connected to the silicon-controlled-rectifier to control the conduction thereof.

11. A circuit as recited in claim 9, wherein:

a silicon-controlled-rectifier is connected to the base of the transistor switching device to control the conduction thereof; and

the semiconductor device is a transistor switching device connected to the silicon-controlled-rectifier to control the conduction thereof.

12. A circuit for igniting a fluorescent lamp, the fluorescent lamp having an input terminal and an output terminal, which comprises:

a resistor-capacitor network;

means for applying a voltage across the network to thereby increase the potential at the connection between the resistor and the capacitor;

a transistor switching device, connected between the input and the output terminals, and responsive to the application of the voltage to become conductive to complete a path for a flow of current between the input and the output terminals;

means, responsive to the potential between the resistor and capacitor reaching a predetermined potential, to render the transistor nonconductive to interrupt the flow of current between the input and the output terminals; and

means, responsive to the interruption of the flow of current between the input and the output terminals, to ignite the lamp.

13. In a circuit for igniting a fluorescent tube having a pair of spaced filaments that exhibit an increased impedance upon application of current therethrough;

a transistor having its collector connected to a first one of the filaments and its emitter connected to the second one of the filaments;

means for applying operating current through the filaments and the base of the transistor to initiate conduction therethrough;

a semiconductive device having three electrodes, one of which controls conduction between the other two electrodes, and then relinquishes control of conduction between the other two electrodes;

means, responsive to a predetermined increase in impedance of the filaments, for applying a conduction potential to the control electrode to render conductive the semiconductive device; and

means, responsive to the conduction of the semiconductive device, to interrupt conduction of the transistor and to generate and apply a pulse to ignite the fluorescent tube.

14. A circuit for igniting a fluorescent lamp, the fluorescent lamp having an input terminal and an output terminal, which comprises:

a resistor-capacitor network;

means for applying a voltage across the network to thereby increase the potential at the connection between the resistor and the capacitor;

a transistor switching device, connected between the input and the output terminals, and responsive to the application of the voltage to become conductive;

means, responsive to the potential between the resistor and capacitor reaching a predetermined potential, to render the transistor nonconductive;

an inducation coil in series with the input to the lamp;

a Zener diode, having a breakdown potential equal to the predetermined potential, for sensing the potential at the connection between the resistor and the capacitor;

a silicon-controlled-rectifier, connected to the transistor switching device to control the conduction thereof; and

means for connecting a Zener diode to the silicon-controlled-rectifier to control the conduction thereof, so that sensing by the Zener diode of the predetermined potential operates to render the silicon-controlled-rectifier conductive which in turn operates to render the transistor switching device nonconductive, so that an inductive kick is provided from the induction coil to ignite the lamp.

* * * * *