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Wyland

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[54] **CONTROL SYSTEM FOR A FUEL BURNER**

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[73] Assignee: **General Electric Company,** Fort Wayne, Ind.

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[52] **U.S. Cl.** **431/79;** 431/69

[51] **Int. Cl.²** **F23H 5/08**

[58] **Field of Search** 431/69, 79, 80, 78, 71

[56] **References Cited**

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Primary Examiner—Edward G. Favors

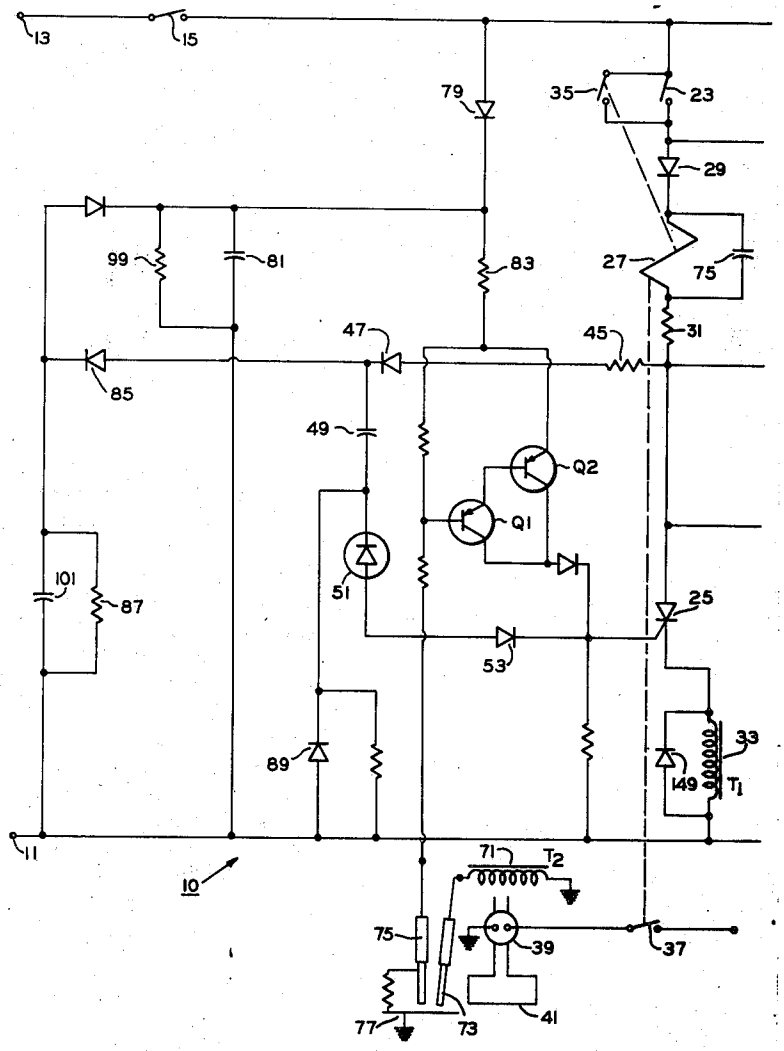
Attorney, Agent, or Firm—Joseph E. Papin

[57] **ABSTRACT**

An electrically energizable control system for a fuel burner where a fuel valve is opened on thermostatic demand and closed a predetermined time thereafter if ignition fails. In the control system, a Darlington amplifier is provided for flame detection, and a spark igniter supply circuit has a transformer coupled first and second gate controlled switches. A second transformer is coupled to the second gate controlled switch for providing a source of sparks for igniting fuel.

A spark igniter supply circuit, a flame detector circuit as well as several other safety features are also disclosed.

18 Claims, 4 Drawing Figures



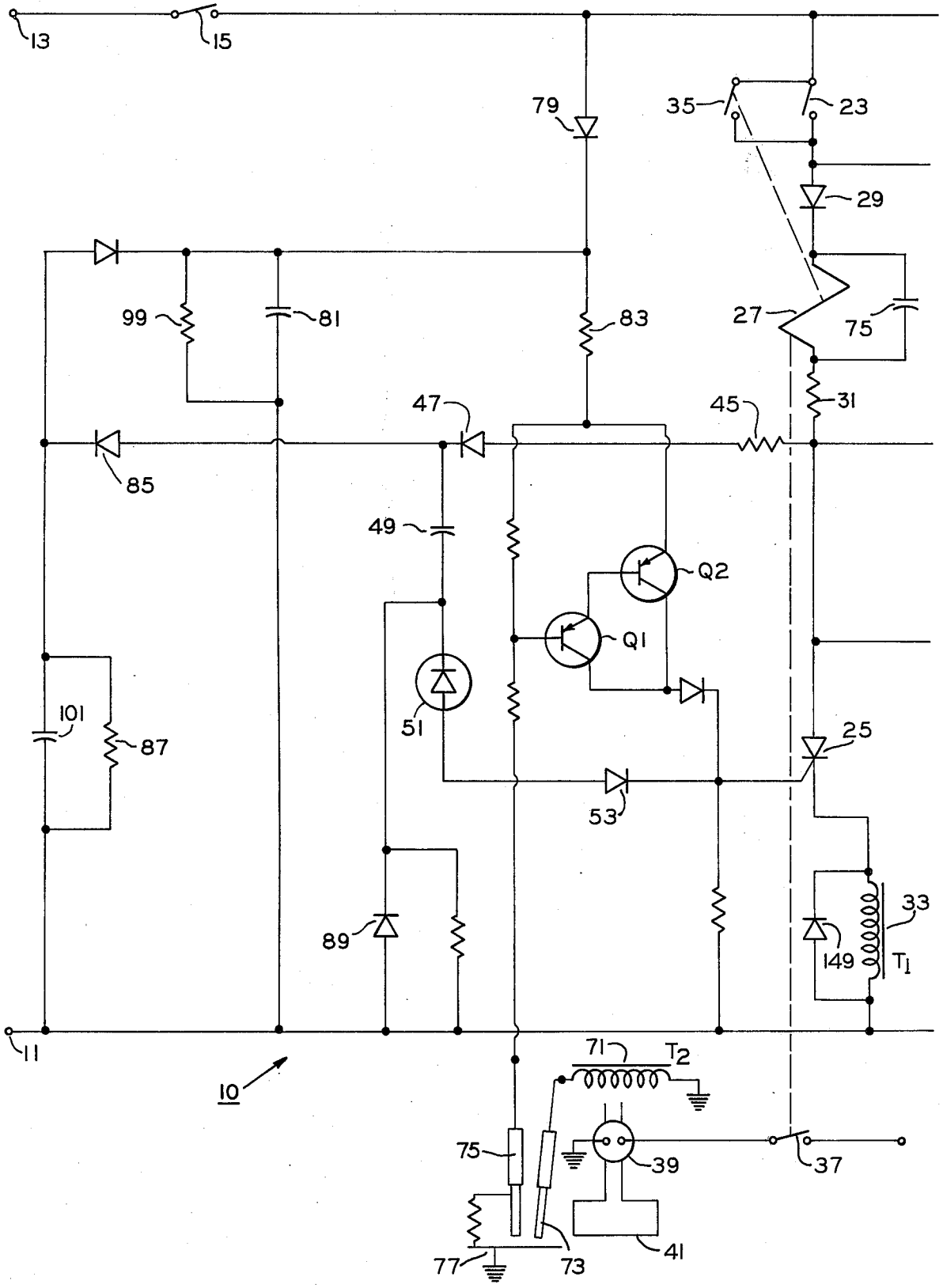

13
15
79
35
23
29
99
81
83
27
75
31
47
45
85
49
Q2
Q1
101
87
51
25
53
89
33
149
T1
11
10
71
T2
75
39
37
77
73
41

FIG. 1a

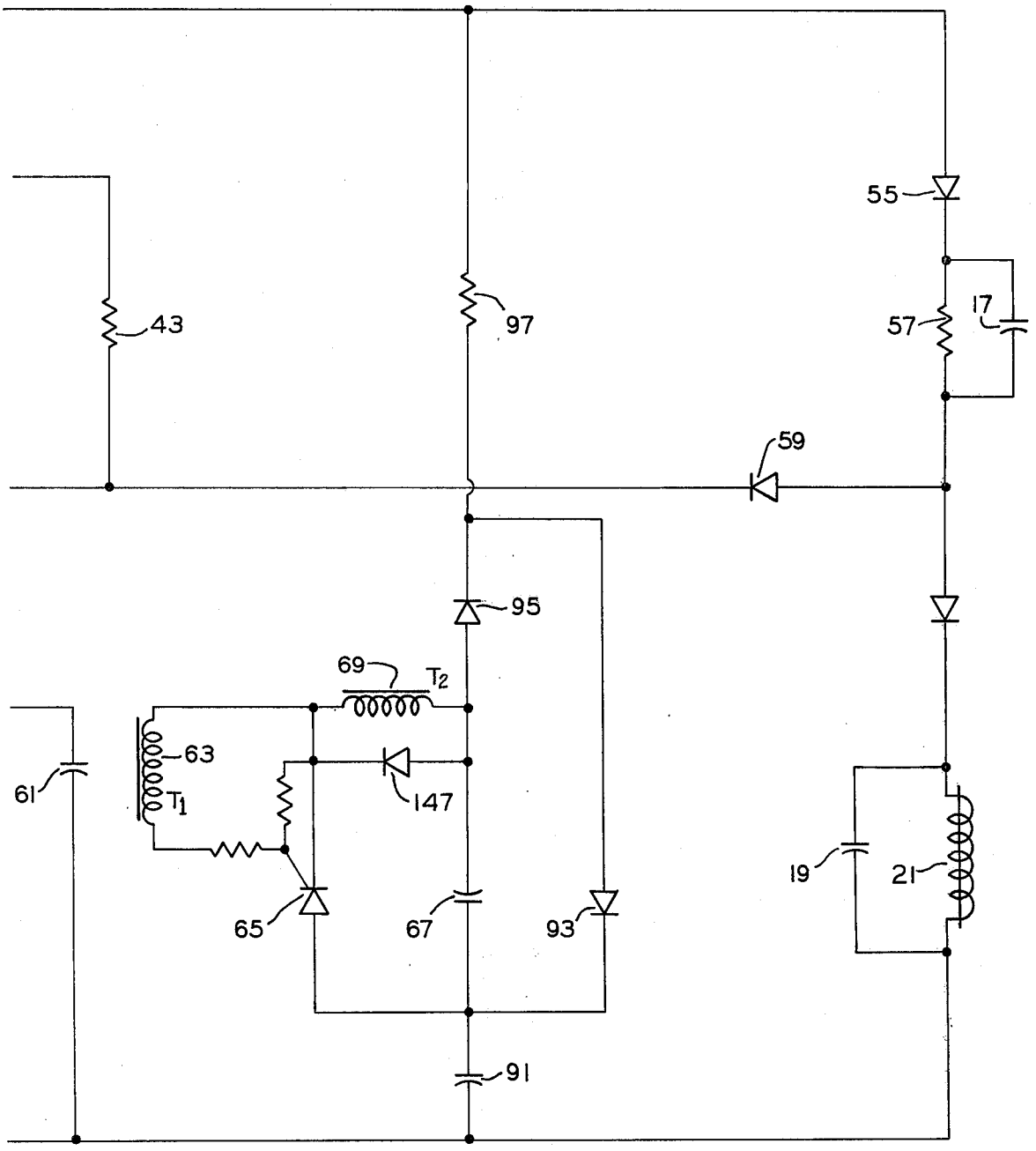


FIG. 1b

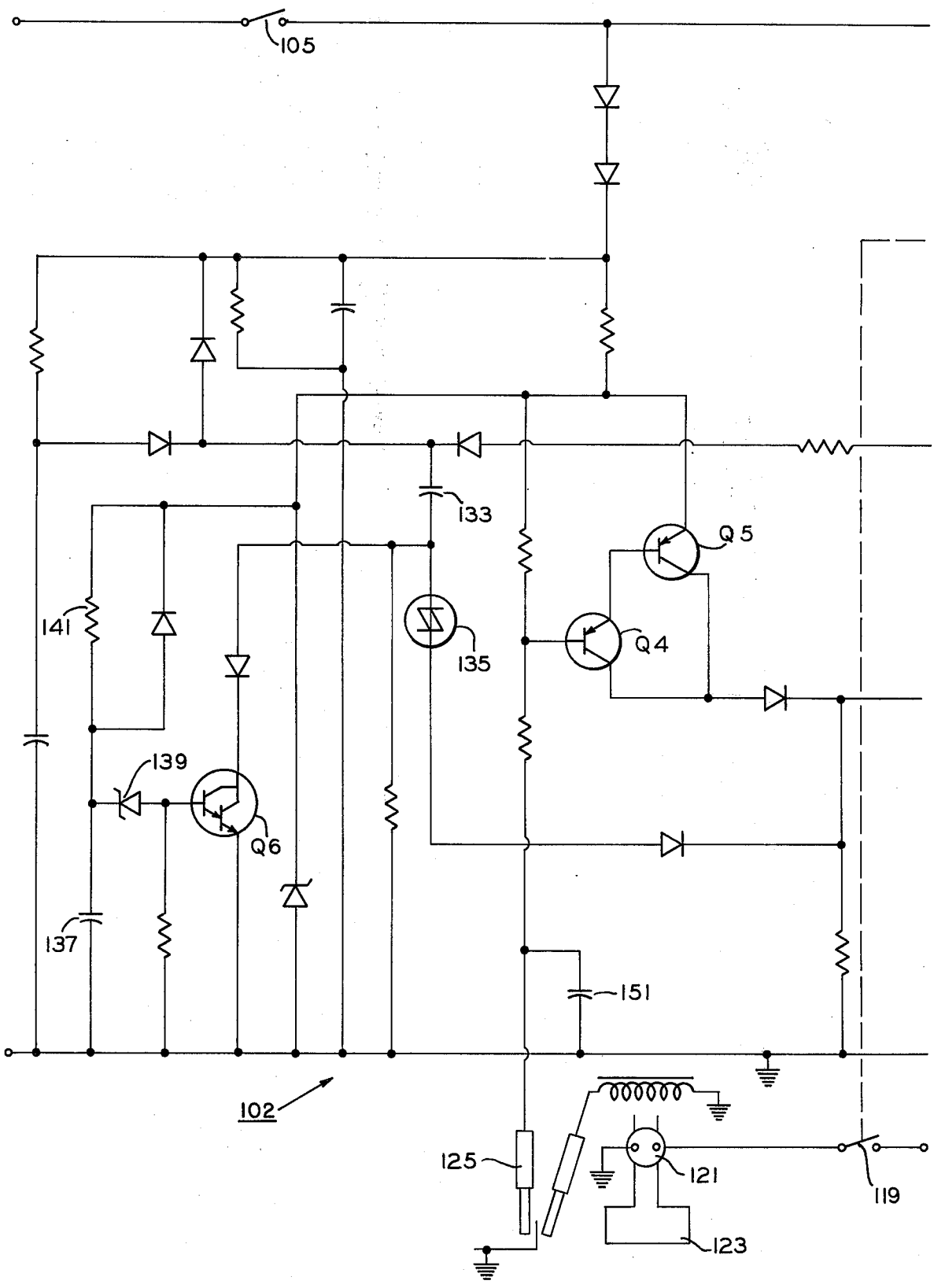


FIG. 2a

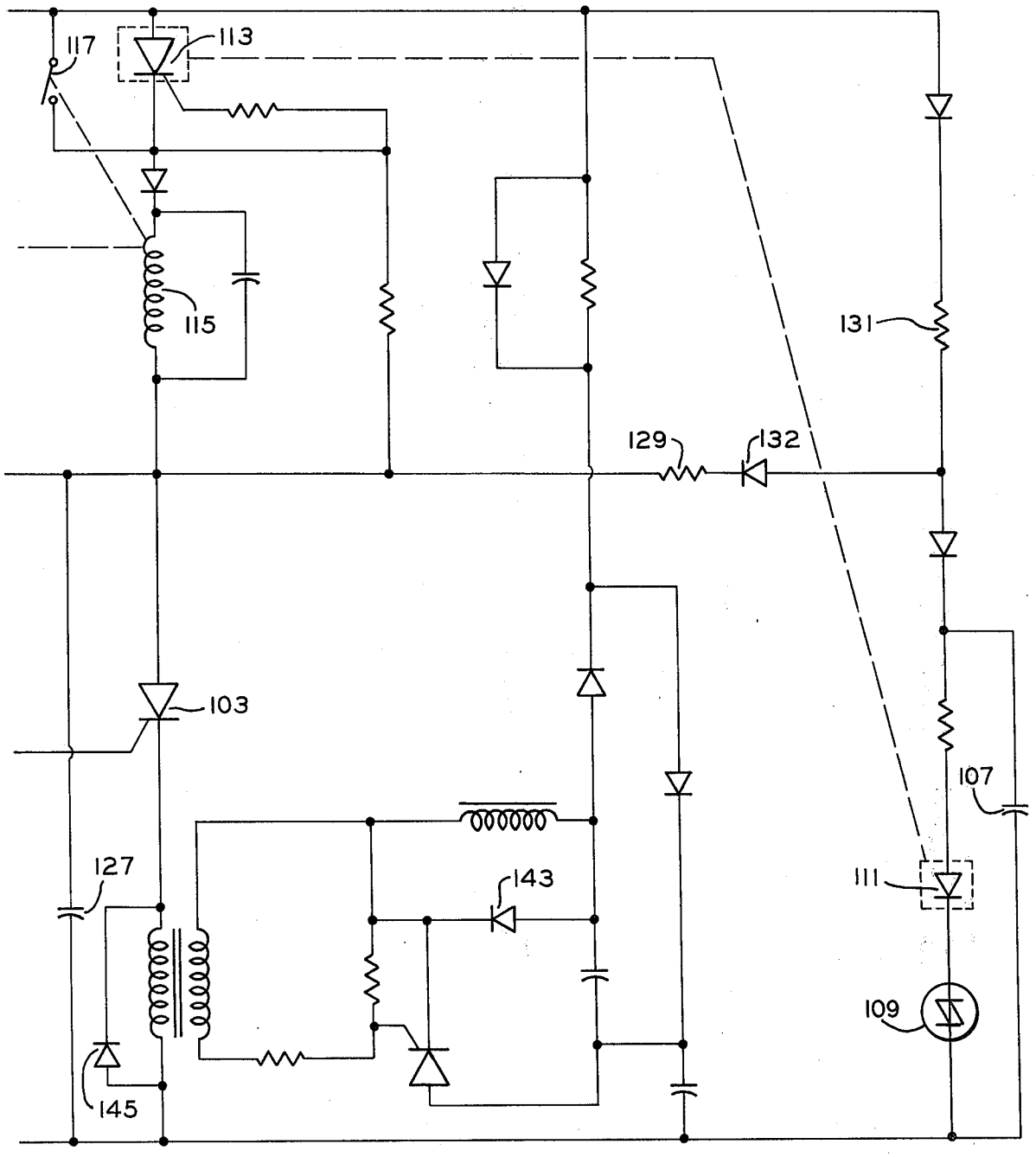


FIG. 2b

CONTROL SYSTEM FOR A FUEL BURNER

BACKGROUND OF THE INVENTION

The present invention relates generally to a control system for a fuel burner and in particular to a low voltage control system of the direct ignition type.

As is well known in the prior art, fuel burners, such as gas furnaces for instance, typically provide a thermostat to open a fuel valve when that thermostat demands heat and some means for igniting the fuel emitted from the burner. Ignition may be achieved by a small pilot flame which burns continuously or by using a spark or arc igniter which provides a spark in the vicinity of the burner soon after the fuel valve is opened.

An improvement in burner control units of the above-mentioned type is illustrated in my U.S. Pat. No. **3,734,676** which discloses a control system for a fuel burner. In this patented control system, an igniter and a controlled switching device are effective, when gated, to connect the igniter to a source of electrical energy for providing pulses of electrical energy to the igniter. My prior patented control system has a gate circuit including a capacitance for providing gate signals to the controlled switching device. These gate signals are provided so long as the capacitance has a charge below a predetermined level and the capacitance is initially provided with a charge of at least the predetermined level. This initial charge is reduced below the predetermined level after the expiration of a predetermined period of time. In this manner, the controlled switching device is gated to operatively connect the igniter to a source of electrical energy only after a predetermined period of energization of the control system thereby to effect pre-ignition purging of the burner area to insure there is not an overabundance of fuel when ignition occurs.

Control systems according to my prior patent function well but operate on a **120** volt alternating current supply or employ a step-up transformer from the commonly encountered low voltage thermostat systems which typically operate around **24** volts A.C.

SUMMARY OF THE INVENTION

Among the several objects of the present invention may be noted the provision of an improved solid state ignition and flame monitoring system for a fuel burner; the provision of a low voltage operating electrically energizable control system for a fuel burner; the provision of a fuel burner system having a plurality of safety features incorporated therein; the provision of an improved spark igniter circuit which may be utilized with a control system for a fuel burner; the provision of an improved flame detector circuit which may also be utilized with a control system for a fuel burner; and the provision of a fuel burner control system, a flame detector circuit, and a spark igniter circuit which are respectively simplistic in design, economical to manufacture, and easily assembled and maintained. Other objects and features will be in part apparent and in part pointed out hereinafter.

In general and in one form of the invention, a control system for a fuel burner has a fuel valve which is opened on thermostatic demand and closed a predetermined time thereafter if ignition fails. The control system includes a flame detector circuit having a Darlington amplifier and means in circuit relation with the

Darlington amplifier input for enabling it when impedance between the enabling means and a reference potential is below a predetermined impedance. The enabling means is operable generally to disable the Darlington amplifier when impedance between the enabling means and the reference potential is above the predetermined impedance. A spark ignitor supply circuit is also provided including means operable generally for providing a spark to effect ignition of the fuel supplied to the fuel burner and means for controlling the spark providing means to effect its operation in the event the enabling means disables the Darlington amplifier.

Also in general, an electrically energizable control system in one form of the invention is provided for a fuel burner. The system has means for actuating a fuel valve to enable flow of combustible fuel from the fuel burner, and means is provided for igniting fuel emitted from the fuel burner. A first controlled switching device is provided in the system, and means is provided for connecting the actuating means and first controlled switching device to a source of electrical energy to effect energization of the actuating means when the first controlled switching device becomes conductive. A gate controlled switch is coupled to the first controlled switching device for rendering it nonconducting when the gate controlled switch has been nonconducting for a predetermined length of time, and a third controlled switching device is responsive to the combustion of fuel emitted from the burner for gating the gate controlled switch to a conducting state.

Further in general and in one form of the invention, an electrically energizable control system is provided for a fuel burner having a fuel valve opened on thermostatic demand and closed a predetermined time thereafter if ignition fails. An improved spark igniter supply circuit is provided in the system and includes first and second gate controlled switches, and first and second transformer means. One winding of the first transformer means is connected in series with the first gate controlled switch, and another winding of the first transformer means is coupled to the gate of the second gate controlled switch. Also, one winding of the second transformer means is connected in series with the second gate controlled switch, and another winding of the second transformer means provides a spark source for igniting fuel emitted from the burner.

Still further and in general, an electrically energizable control system for a fuel burner is provided having a fuel valve opened on thermostatic demand and closed a predetermined time thereafter if ignition fails. An improved flame detector circuit is provided in the system having a Darlington amplifier. Means is in circuit relation with the Darlington amplifier input for enabling it when impedance between the enabling means and a reference is below a predetermined impedance, and the enabling means is also operable generally to disable the Darlington amplifier when the impedance between the enabling means and the reference potential is above the predetermined impedance. A spark ignitor circuit has first and second gate controlled switches and first and second transformer means. One winding of the first transformer means is connected in series with the first gate controlled switch, and another winding of the first transformer means is coupled to the gate of the second gate controlled switch. One winding of the second transformer means is connected in series with the sec-

ond gate controlled switch, and another winding of the second transformer means provides a spark source for igniting the fuel. The Darlington amplifier output is coupled to the gate of the first gate controlled switch to maintain it in a conducting state so long as the thermostat demands and a flame is present.

In general, an electrically energizable control system in one form of the invention is provided for a fuel burner. The system has means for actuating a fuel valve to enable flow of a combustible fuel to the burner and also means for igniting the fuel emitted from the burner. A first controlled switching device is provided in the system, and means aare provided for connecting the first controlled switching device to a source of electrical energy to effect energization of the actuating means when the first controlled switching device becomes conductive. A second controlled switching device is coupled to the first controlled switching device for rendering it nonconducting when the second controlled switching device has been nonconducting for a predetermined length of time. A third controlled switching device is responsive to combustion of the fuel emitted from the burner for maintaining the second controlled switching device in its conducting state. The first controlled switching device includes a relay having normally open contacts in series with the actuating means and the source of electrical energy and also an actuating coil in series with the second controlled switching device.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. **1***a* and **1***b* when joined together form a schematic diagram of a low voltage control system according to the present invention; and

FIGS. **2***a* and **2***b* when jointed together form a schematic diagram of a low voltage control according to the present invention incorporating additional lock-out features.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawing.

The following examples illustrate the invention and are not to be construed as limiting in any manner.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawing in greater detail, there is indicated generally at **10** in FIGS. **1***a* and **1***b* a control system which receives low voltage, such as **24** volts alternating current for instance, between a pair of terminals **11** and **13.** Upon a demand for heat, a thermostatic switch **15,** of a type well known in the art such as a bimetal thermostat or the like, closes thereby to supply this low voltage to the remainder of the circuit. A rectified charging current flows into a capacitor voltage divider circuit **17, 19,** and when sufficient charge accumulates on capacitor **19,** a relay actuating coil **21** is energized sufficiently to close its normally open contacts **23.** If a gate controlled switch **25,** which may, for example, be a silicon controlled rectifier or the like, is in its conducting state, a relay actuating coil **27** conducts sufficient current by way of contacts **23,** a diode **29,** a resistor **31,** silicon controlled rectifier **25** and a transformer primary winding **33** to close its normally open contacts **35, 37.** When closed, contacts **37** supply electrical energy (which may or may not be from the same source as the energy source coupled to terminals **11,** 13) to a valve actuating device **39** which opens thereby to allow flow of fuel to a burner **41.** Gate current for enabling controlled switching device **25** is provided by way of contacts **23** or **35,** a resistor **43,** a resistor **45,** a diode **47,** a capacitor **49,** a switching device **51** (which may be a diac or, as disclosed in my aforementioned patent, a neon tube or other device having a minimum voltage conduction trait), and a diode **53.** Parallel paths also exist by way of a diode **55,** a resistor **57,** and a diode **59** as well as diode **29,** relay coil **27,** and resistor **31.** In one preferred implementation with the assumed **24** volt alternating current energization of terminals **11, 13,** the voltage across gate controlled switch **25** must attain a selected voltage, generally about **8–16** volts, before diac **151** conducts to trigger switch **25.** Under these circumstances, there is also a similar voltage charge on a capacitor **61,** and when switch **25** conducts, this capacitor is discharged through primary winding **33** of a transformer **T1** which, in turn, induces a voltage in a secondary winding **63** of the transformer to trigger another controlled switching device, such as a silicon controlled rectifier **65.** Conduction by switch **65** discharges the previously accumulated charge on a capacitor **67** through a primary winding **69** of another transformer **T2** which functions as a step-up transformer having a secondary winding **71** connected between ground and a spark probe **73** to provide an igniting spark in the burner **41.**

In this manner, each time the silicon controlled rectifier **25** conducts, it draws a certain amount of gate current thus incrementing the charge on capacitor **49** and decreasing the portion of the line voltage available to break down diac **51.** When the charge on capacitor **49** increments sufficiently to prevent the breakdown of diac **51,** silicon controlled rectifier **25** no longer receives gating signals and ceases to provide ignition pulses. This ignition trial time may be of the order of **10** seconds. After the ignition trial, if no flame has been established, the lack of conduction of silicon controlled rectifier **25** interrupts the energizing current for relay coil **27,** and as soon as the charge on a capacitor **75** discharges through the relay coil that relay will open its contacts **35, 37** thus shutting off the fuel flow to burner **41.**

As well known in the art, a flame has an impedance substantially lower than the impedance of a corresponding air gap, and the flame impedance is a function of the direction of current flow, as discussed hereinafter. In FIG. **1***a*, a detector probe **75** and a grounded conductor **77** are placed near burner **41** so that when a flame is established at the burner, the impedance between detector probe **75** and grounded conductor **77** is, for example, about **10** megohms. If a flame has been established in burner **41,** the flame current flow causes a corresponding base current in a transistor **Q1,** which in turn induces a substantial base current in a transistor **Q2** so that the gate of silicon controlled rectifier **25** may now be held constantly on due to the supply of substantially constant direct current from a filtered half-wave supply formed by a diode **79,** a capacitor **81,** and a resistor **83.** Transistors **Q1** and **Q2** are coupled together as a Darlington amplifier and will function much like a switch. Therefore, when no flame is present, transistor **Q2** is substantially non-conducting, and when the flame impedance appears causing transistor **Q1** to conduct, transistor **Q2** becomes substantially sat-

urated thus holding silicon controlled rectifier **25** in its conducting state.

Since silicon controlled rectifier **25** is receiving a gating signal when the alternating current passes through zero voltage, capacitor **61** will not charge, and there will be no pulse applied to primary winding **33** of transformer T1 sufficient to trigger silicon controlled rectifier **65.** Thus the ignitor circuit is disabled. Capacitor **49** will discharge by way of a diode **85,** a resistor **87,** and a diode **89** under this "flame present" condition.

If for some reason the flame should become extinguished, transistors Q1, Q2 immediately cease conducting, and the anode to cathode voltage across silicon controlled rectifier **25** will again build up to the exemplary **8–16** volt level. Further, transformer primary winding **33** will again receive pulses when switch **25** conducts to again trigger the igniting circuit. These above discussed ignition trials will continue until the flame is re-established or the charge on capacitor **49** builds up sufficiently to lock-out.

The ignition spark is generated by discharging capacitor **67** through primary winding **69** of transformer T2. While transformer T1 could, for example, be a one-to-one isolation transformer, transformer T2 has a high turns ratio to generate a high voltage pulse in secondary winding **71** sufficient to jump the desired spark gap. Capacitor **67** is a portion of a voltage doubler which also includes a capacitor **91,** a pair of diodes **93, 95,** and a resistor **97.** When terminal **13** is positive relative to terminal **11,** current flows generally downwardly through resistor **97** and diode **93** to charge capacitor **91** up to substantially peak line voltage. When terminal **13** is negative relative to terminal **11,** current flows through the series combination, as at **91, 67** generally upwardly through a diode **95** and resistor **97.** With respect to the voltage doubler circuits, this effectively places a voltage on capacitor **67,** with the lower plate thereof positive, which is close to but slightly less than twice the peak value of the line voltage. When silicon controlled rectifier **65** is triggered by a pulse transmitted through transformer T1, a charge on capacitor **67** discharges through primary winding **69** of step-up transformer T2 providing on secondary winding **71** a desired spark voltage.

In view of the foregoing discussion, the function of several other circuit elements in the schematic diagram of FIGS. **1***a* and **1***b* should be clear. Briefly, resistors **31,** 45, 83, 97 function as current limiting resistors while resistors **57, 87, 99** provide capacitor discharge paths during the periods when thermostat **15** is not supplying power to the circuit. Capacitors **19, 75, 81, 101** function as filter capacitors, and it may be noted that capacitor **75** maintains relay coil **27** energized during short intervals when silicon controlled rectifier **25** is not conducting.

If silicon controlled rectifier **25** is shorted or gated into its conducting state, for example, by the detector probe **75** being grounded or transistor Q2 shorted out when the voltage is initially applied to the circuit by the closing of thermostat **15,** coil **21** will not be energized, and contact **23** will not close thus insuring relay coil **27** is not energized and that the fuel valve will remain in its closed position.

The safety feature discussed in the previous paragraph along with the advantages of the circuit of FIGS. **1***a* and **1***b* which include less costly components due to the lower operating voltage as well as other advantages earlier discussed may also be found in another system in one form of the invention, as indicated generally at **102** in FIGS. **2***a* and **2***b*. System **102** may function generally in the manner as system **1** discussed hereinabove with respect to FIGS. **1***a* and **1***b*, but it may be noted that system **102** has additional safety features as well as additional advantageous features of its own.

Referring now with particularity to FIGS. **2***a* and **2***b*, the circuit of system **102** provides a pre-start safety check of a principal control element, such as a silicon controlled rectifier **103,** as well as the lock-out functions with relative certainty that an opened or short circuited component will not create an unsafe condition.

When the low voltage alternating current is applied to the circuit of system **102** due to a thermostat **105** calling for heat, a capacitor **107** charges until its voltage reaches the breakdown voltage for a diac **109,** which is one preferred implementation was about **8** volts. When diac **109** conducts, a light emitting diode **111** is energized, and the light thereof is coupled to a light activated silicon controlled rectifier or switch **113** to enable it. In this manner, rectified line voltage is applied to a relay actuating coil **115** which functions in a latching mode to close its contacts **117** as well as contacts **119** thereby to energize a fuel valve **121** to supply fuel to a burner **123.** Light emitting diode **111** and light activated silicon controlled rectifier **113** may be of a type available on a single small integrated circuit chip (not shown). If for some reason capacitor **107** cannot charge up to the breakdown voltage for diac **109,** no coil current will flow in relay actuating coil **115** thereby to prevent fuel flow to burner **123.** Capacitor **107** will be unable to charge if silicon controlled rectifier **103** is shorted, a flame detector probe **125** is grounded, one of a pair of transistor Q4, Q5 is shorted, or a capacitor **127** is shorted. In practice, the ratio of the resistances of a resistor **129** to a resistor **131** are about **60** to **1,** and if a diode **132** is for any reason shorted, the current through relay actuating coil **115** is limited to less than the hold-in value for that relay thus prohibiting fuel flow.

A Darlington pair Q6, which, like the other Darlington configured transistor pairs in this application, may be a physical separated pair of transistors or an integral amplifier. Darlington pair Q6 is in the circuit to provide an additional lock-out function, and capacitor **133** incrementally increases its charge just as the previously discussed capacitor **49** of FIG. **1***a*. When this charge is sufficient that a diac **135** no longer conducts to provide ignition pulses to the ignition probe, a lock-out occurs disabling relay actuating coil **115** and shutting off the fuel flow. If, for some reason, capacitor **133** has substantial leakage or otherwise fails to perform this lock-out function, transistor Q6 will do so at a later time. Transistor Q6 is nonconducting until the voltage on a capacitor **137** reaches the zener diode voltage of a zener diode **139,** at which time Darlington pair Q6 switches to its conducting state and essentially grounds the gate of silicon controlled rectifier **103** thus shutting down the system. The lock-out time for transistor Q6 is greater than that associated with the timing circuitry including capacitor **133** and is essentially a function of the value of capacitor **137** and of a resistor **141.**

In other respects, the circuit of system **102** functions generally in the same manner as system **1** previously discussed with respect to FIGS. **1***a* and **1***b*. A pair of diodes, such as indicated at **143, 145,** (**147** and **149** in

FIGS. 1*a* and 1*b*) are present to conduct when the fields in their respective transformers collapse. A capacitor **151** provides an alternating current filtering function for the flame detector probe.

While no specific mention has been made of the manner in which the circuits are reset once a lock-out condition occurs, it should be clear that such lock-out is caused by an accumulated charge on one or more capacitors and that reset may be achieved by, for example, manually opening thermostat **105** and either relying on the inherent leakage in those capacitors or providing bleeder resistances to bleed off the charge prior to re-energizing the circuit.

It may be noted that many of the features of my aforementioned patent, as well as other prior art devices, may be incorporated into the control system of the present invention. For instance, a preignition time delay for purging the fuel burner area of excess fuel has not been discussed herein, but such is clearly within the scope of the present invention.

From the foregoing, it is now apparent that novel control systems **10, 102** as well as a novel spark igniter circuit and a novel flame detector circuit for use therein are presented meeting the objects and advantageous features set out hereinbefore, as well as others. Further, it is also contemplated that changes as to the arrangements, details and connections of the component parts of the novel control systems, flame detector circuit, and spark igniter circuit, which are presented to illustrate the invention, may be made by those skilled in the art without departing from the spirit or scope of the invention as set out in the claims which follow.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electrically energizable control system for a fuel burner comprising:

means for actuating a fuel valve to enable flow of a combustible fuel to the burner;

means for igniting the fuel emitted from the burner;

a first controlled switching device;

means for connecting the actuating means and the first controlled switching device to a source of electrical energy to effect energization of the actuating means when the first controlled switching device becomes conductive;

a second controlled switching device coupled to the first controlled switching device for rendering the first controlled switching device nonconducting when the second controlled switching device has been nonconducting for a predetermined length of time;

a third controlled switching device responsive to combustion of the fuel emitted from the burner for maintaining the second controlled switching device in its conducting state; and

the first controlled switching device including a relay having normally open contacts in series with the actuating means and the source of electrical energy, and an actuating coil in series with the second controlled switching device.

2. A control system as set forth in claim **1,** further comprising means responsive to an initial conducting state of the second switch and nonconducting state of the actuating coil for preventing the actuation of the relay.

3. In an electrically energizable control system for a fuel burner having a fuel valve opened on thermostatic demand and closed a predetermined time thereafter if fuel ignition fails; a spark igniter supply circuit comprising first and second gate controlled switches, first and second transformers, one winding of the first transformer being connected in series with the first gate controlled switch and another winding of the first transformer being coupled to the gate of the second gate controlled switch, and one winding of the second transformer being connected in series with the second gate controlled switch and another winding of the second transformer providing a spark source for igniting the fuel.

4. The circuit as set forth in claim **3,** further comprising means for providing a series of enabling signals to the gate of the first gate controlled switch, means for stopping the enabling signals a predetermined time after the enabling signals begin.

5. The circuit as set forth in claim **4,** further comprising a timing circuit coupled to the gate of the first gate controlled switch to render it nonconducting at a time subsequent to the predetermined time after the enabling signals begin.

6. The circuit as set forth in claim **3,** further comprising a relay having normally open contacts closable to open the fuel valve and having an actuating coil in series with the first gate controlled switch.

7. The circuit as set forth in claim **6,** further comprising means responsive to an initial conducting state of the gate controlled switch and nonconducting state of the actuating coil for preventing actuation of the relay.

8. In an electrically energizable control system for a fuel burner where a fuel valve is opened on thermostatic demand and closed a predetermined time thereafter if fuel ignition fails; a flame detector circuit comprising a Darlington amplifier, means in circuit relation with the Darlington amplifier input for enabling it when impedance between the enabling means and a reference potential is below a predetermined impedance, the enabling means also being operable generally to disable the Darlington amplifier when impedance between the enabling means and the reference potential is above the predetermined impedance, a spark igniter supply circuit including first and second gate controlled switches, and first and second transformer means, one winding of the first transformer means being connected in series with the first gate controlled switch and another winding of the first transformer means being coupled to the gate of the second gate controlled switch, and one winding of the second transformer means being connected in series witn the second gate controlled switch and another winding of the second transformer means providing a spark source for igniting the fuel, the output of the Darlington amplifier being coupled to the gate of the first gate controlled switch to maintain it in a conducting state so long as the thermostat demands and a flame is present.

9. The circuit as set forth in claim **8,** further comprising means for providing a series of enabling signals to the gate of the first gate controlled switch, means for stopping the enabling signals a predetermined time after the enabling signals begin, and a timing circuit coupled to the gate of the first gate controlled switch to render that switch nonconducting at a time subsequent to the predetermined time after the enabling signals begin.

10. The circuit as set forth in claim **8,** further comprising a relay having normally open contacts closable

to open the fuel valve and having an actuating coil in series with the first gate controlled switch, and means responsive to an initial conducting state of the gate controlled switch and nonconducting state of the actuating coil for preventing actuation of the relay.

11. An electrically energizable control system for a fuel burner comprising:

means for actuating a fuel valve to enable flow of a combustible fuel to the burner;

means for igniting the fuel emitted from the burner;

a first controlled switching device;

means for connecting the actuating means and the first controlled switching device to a source of electrical energy to effect energization of the actuating means when the controlled switching device becomes conductive;

a gate controlled switch coupled to the first controlled switching device for rendering it nonconducting when the gate controlled switch has been nonconducting for a predetermined length of time; and

a Darlington amplifier responsive to combustion of the fuel emitted from the burner for enabling the gate of the gate controlled switch to maintain it in a conducting state.

12. An electrically energizable control system for a fuel burner comprising:

means for actuating a fuel valve to enable flow of a combustible fuel to the burner;

means for igniting the fuel emitter from the burner;

a first controlled switching device;

means for connecting the actuating means and the first controlled switching device to a source of electrical energy to effect energization of the actuating means when the controlled switching device becomes conductive;

a gate controlled switch coupled to the first controlled switching device for rendering it nonconducting when the gate controlled switch has been nonconducting for a predetermined length of time; and

a third controlled switching device responsive to combustion of the fuel emitted from the burner for gating the gate controlled switch to a conducting state.

13. A control system as set forth in claim **12,** further comprising means coupled to the gate of the gate controlled switch for also supplying enabling signals to the gate.

14. A control system as set forth in claim **13,** further comprising means responsive to the enabling of the gate controlled switch by the supplying means for actuating the igniting means to ignite the fuel.

15. A control circuit as set forth in claim **13,** further comprising a first timing circuit for controlling the supplying means to stop the enabling signals thereof a predetermined time after the enabling signals begin.

16. A control system as set forth in claim **15,** further comprising a second timing circuit coupled to the gate of the gate controlled switch to render it nonconductive at a time subsequent to the predetermined time after the enabling signals begin.

17. A control system as set forth in claim **12,** wherein the actuating means comprises a first transformer, another gate controlled switch, and a second transformer, one winding of the first transformer being connected in series with the first named gate controlled switch and another winding of the first transformer being coupled to the gate of the other gate controlled switch, and one winding of the second transformer being connected in series with the other gate controlled switch and another winding of the second transformer being coupled to the igniting means.

18. In an electrically energizable control system for a fuel burner where a fuel valve is opened on thermostatic demand and closed a predetermined time thereafter if fuel ignition fails; the combination therewith comprising a flame detector circuit including a Darlington amplifier, and means in circuit relation with the Darlington amplifier input for enabling it when impedance between the enabling means and a reference potential is below a predetermined impedance, the enaabling means also being operable generally to disable the Darlington amplifier when impedance between the enabling means and the reference potential is above the predetermined impedance, and a spark ignitor supply circuit including means operable generally for providing a spark to effect ignition of the fuel supplied by the fuel burner, and a gate controlled switch for controlling the spark providing means to effect its operation in the event the enabling means disables the Darlington amplifier.

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