BURNER IGNITER SYSTEM

Filed March 4, 1966 2 Sheets-Sheet 1

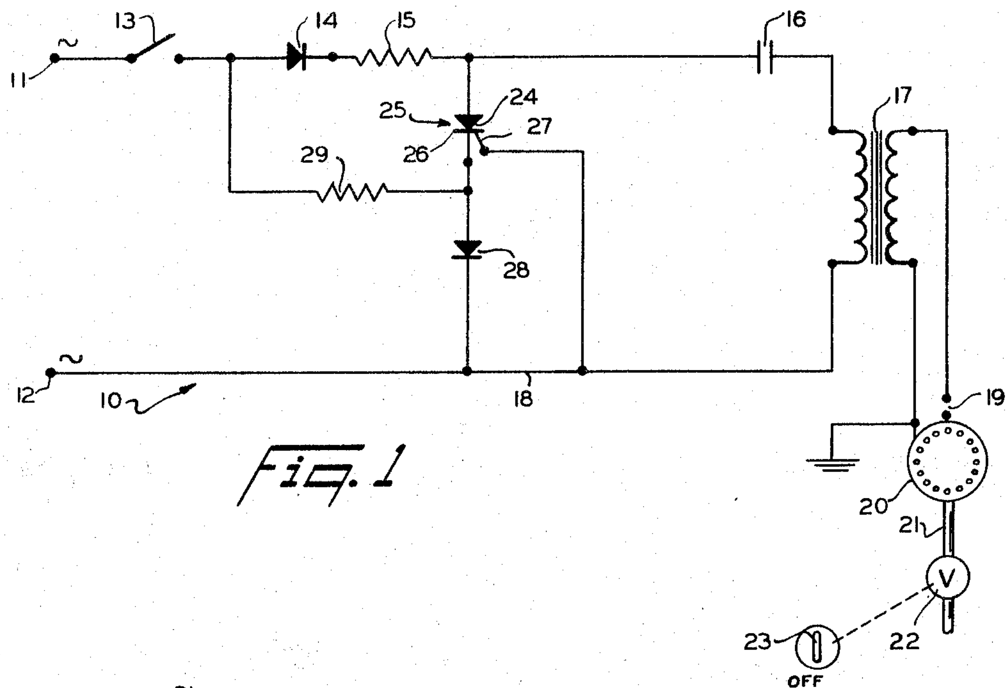

Fig. 1

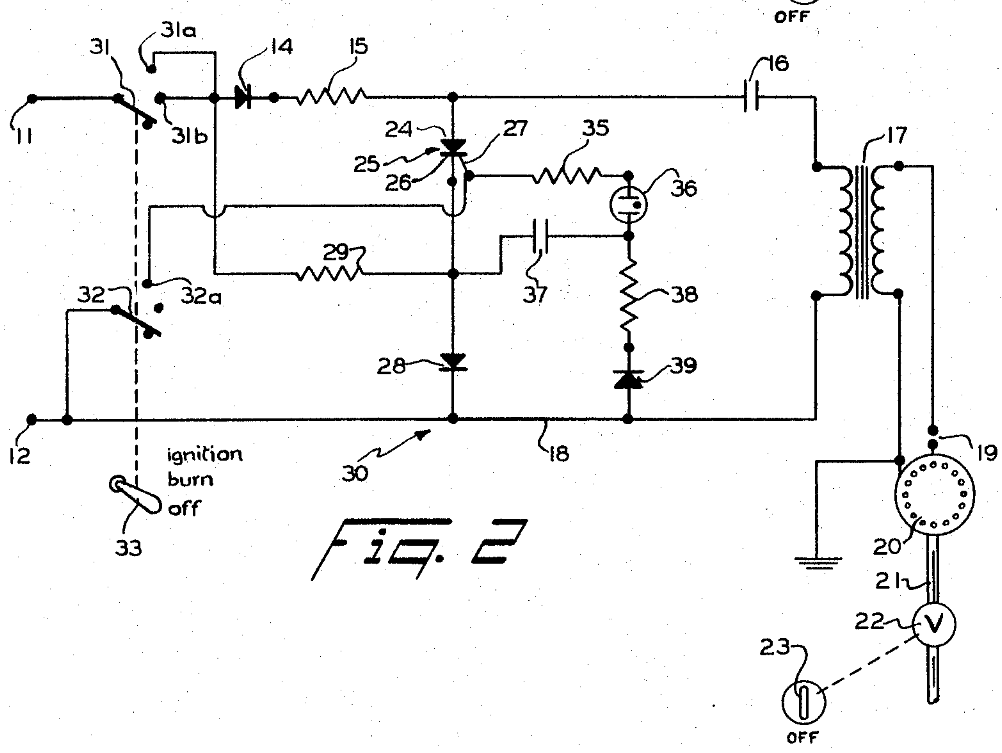

Fig. 2

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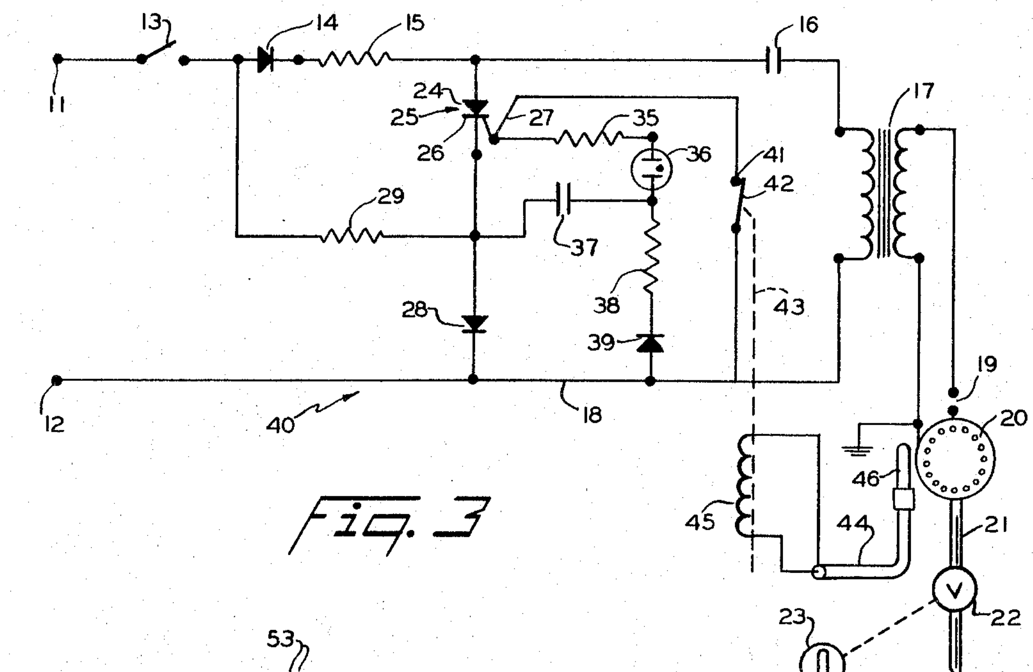

Fig. 3

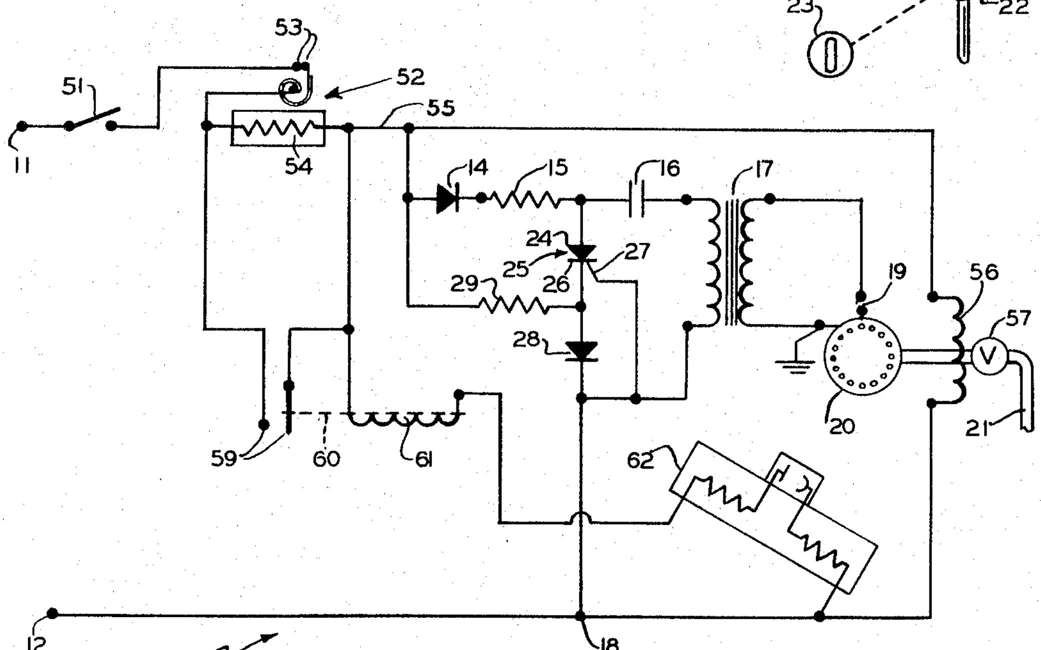

Fig. 4

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United States Patent Office

3,318,358

Patented May 9, 1967

3,318,358

BURNER IGNITER SYSTEM

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Filed Mar. 4, 1966, Ser. No. 531,906

7 Claims. (Cl. 158—28)

This invention relates to an electrical system for the ignition of a fluid fuel burner and more particularly to a system in which ignition is obtained by an electronically produced spark.

In electrical ignition systems for oil and gas burners it is important to assure reliable, non-critical ignition initially, when the burner is first turned on. In the event that the burner is inadvertently extinguished for whatever reason while the gas or other fuel remains on, it is important that dependable re-ignition be provided for. Furthermore, it is important that the ignition system operate with minimum periods of operation and current flow and that the system be simple and inexpensive. The present invention contemplates the use of high voltage spark discharges for igniting the fuel at the burner, the discharges being produced repetitively at the supply line frequency. Alternative system arrangements provide for various system parameters. In some arrangements, more slowly recurring spark discharges may be produced after the initial ignition, the reduced spark rate being adequate to re-ignite the burner in case of extinction of the flame while the burner is turned on, thus reducing the duration of periods of operation of the ignition system and thereby increasing the life of the system and decreasing the current drawn from the electrical power source. This reduction in rate may be produced manually or automatically. In another arrangement automatic means is provided for shutting off the ignition and the flow of fuel to the burner should the burner fail to ignite in a predetermined period and to again recycle the ignition arrangement after another predetermined period.

The primary object of the present invention is to provide electronic means for producing a rapidly repetitive high voltage spark discharge at the burner.

Another important object is to provide a less rapid repetitive spark discharge after initial ignition of the burner.

Still another object is to provide means for automatic cessation of the flow of fuel to the burner and the repetitive ignition spark should ignition not be obtained.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a schematic circuit diagram of the spark-producing circuit according to the invention in a simple manually controlled system;

FIGURE 2 is a diagram similar to FIGURE 1 and including a relaxation oscillator for triggering purposes which is controlled by a manually operated switch;

FIGURE 3 is a diagram similar to FIGURE 2 in which the relaxation oscillator is automatically controlled by heat sensing means; and

FIGURE 4 is a diagram similar to FIGURE 1 and including time delay shut-off means for the spark and fuel together with flame-sensing means for control thereof.

With reference to FIGURE 1, the spark producing circuit **10** includes terminals **11** and **12** which are connected to the wires of an alternating current line, typically 110 volts. Terminal **11** is connected through a manually operated switch **13** in a series combination to the anode of a rectifier **14** whose cathode is connected through a current limiting resistor **15** to one terminal of a capacitor **16** for purposes of charging the capacitor. The other

terminal of capacitor **16** is connected through the primary winding of a transformer **17** to a reference point **18** and thence to the other line terminal **12**.

Each terminal of the secondary winding of transformer **17** is connected to a respective electrode of a spaced pair of electrodes forming a spark gap at **19** in proximity to a gas burner **20**. One electrode at the spark gap is grounded and may be the burner itself for convenience sake, as shown. Burner **20** is supplied through the fuel line **21** which is provided with a manually operated shutoff valve **22** whose handle is shown at **23**.

Since the sparking device of the present invention may equally well be used for igniting an oil flame, burner **20** might be shown as an oil burner provided with a blower in its fuel supply, the motor for the blower being provided with a control switch. Additional spark gaps wired in series with the electrodes at **19** may be provided if there is more than one burner.

The junction of resistor **15** and capacitor **16** is connected to the anode **24** of a silicon controlled rectifier **25**. The cathode **26** and the gate terminal **27** thereof are each separately connected to the reference point **18** in the connection between line terminal **12** and the primary winding of transformer **17**, the cathode being connected through the anode-cathode combination of another rectifier **28** so that a discharge path for capacitor **16** is set up through rectifier **25**, rectifier **28** and the primary of transformer **17**.

Cathode **26** of rectifier **25** is also connected through another resistor **29**, for limiting current in the gate circuit, to the junction between switch **13** and the anode of rectifier **14** for connecting cathode **26** to line terminal **11**. A state of conduction of the silicon controlled rectifier **25** is produced in response to voltage being supplied between its gate **27** and its cathode **26**, the polarity of the voltage being such that the gate is positive with respect to the cathode. The magnitude of this voltage is sufficient to cause adequate current flow between gate **27** and cathode **26** necessary to allow the anode **24** and cathode **26** combination to become conductive.

In operation, the switch **13** is first closed and then gas supply valve **22** opened by turning handle **23**. Immediately upon closing the switch a path to charge capacitor **16** is set up as soon as the polarity of terminal **11** becomes positive with respect to terminal **12**, through the series combination of terminal **11**, the closed switch **13**, the anode and cathode of rectifier **14**, resistor **15**, capacitor **16**, the primary winding of transformer **17**, to terminal **12**.

Upon terminal **12** of the supply voltage becoming positive with respect to terminal **11** positive voltage is supplied to the gate terminal **27** of the silicon controlled rectifier by reason of its connection to terminal **12** through reference point **18**. Negative voltage is supplied at the same time from terminal **11**, through the closed switch **13**, and resistor **29** to the cathode of rectifier **25**. When the voltage differential between terminal **12** and terminal **11** reaches a sufficient magnitude it will cause adequate current flow between gate **27** and cathode **26** of the rectifier **25** and allow conduction between anode **24** and cathode **26** and a discharge path is set up for capacitor **16** from the positively charged terminal of the capacitor through anode **24**, cathode **26**, anode and cathode of rectifier **28**, reference point **18** and through the primary winding of transformer **17** through its connection to the other terminal of the capacitor.

Capacitor **16** having been charged to the peak value of the supply line voltage during the previous half-cycle period when terminal **11** was positive with respect to terminal **12**, it is now discharged through the primary winding of transformer **17** and a high voltage is induced in the transformer secondary winding which causes a high voltage spark to jump across the gap at **19**.

During the next cycle in the supply line voltage the same half-cycle charging of capacitor **16** and subsequent half-cycle discharge of the capacitor through the transformer **17** takes place. In this fashion a rapidly repetitive spark at the gap **13** is produced at the same rate as the supply line frequency, typically sixty per second. This high voltage sparking continues until switch **13** is opened.

In FIGURES 2 and 3 modifications of the circuit are shown with provision for an initial high sparking rate when the switch is first turned on and then a sparking rate less rapid for so long as the burner is burning after the flame is first lit.

FIGURE 2 shows the circuit **30** in which the elements shown in FIGURE 1 and identified by the same reference numbers are present except that a double pole triple throw switch **31–32–33** takes place of switch **13** and provision has been made in the connection of gate terminal **27** of silicon controlled rectifier **25** to the line terminals to provide for a reduced sparking rate.

The blades **31** and **32** and the manual control handle **33** of the switch **31–32–33** have three positions denoted "Ignite," "Burn" and "Off," respectively, in that order from top to bottom. The switch is arranged to be spring-biased in its "Ignite" position toward the "Burn" position. Blade **31** of the switch is connected to line terminal **11** and both the "Ignite" contact **31*a***, which is in contact with blade **31** when the switch is in "Ignite" position, and the "Burn" contact **31*b***, which is in contact with this blade when the switch is in its "Burn" position, are connected to the anode of rectifier **14** whose cathode is connected through resistor **15** to one terminal of the capacitor **16**. The other terminal of the capacitor is connected through the primary winding of transformer **17** to reference point **18** and thence to the line terminal **12** so that, during the first half-cycle while terminal **11** is positively charged, the capacitor **16** becomes charged.

Each terminal of the secondary winding of transformer **17** is connected to a respective spark electrode at gap **19** in close proximity to the burner **20**. The burner is supplied with fuel from the line **21** controlled by handle **23** of the valve **22**.

The junction of resistor **15** and capacitor **16** is connected to the anode **24** of rectifier **25** and the cathode **26** of this rectifier is connected through the anode-cathode combination of rectifier **28** to reference point **18**.

The gate terminal **27** of rectifier **25**, however, is connected through another resistor **35** to one terminal of a breakdown device comprising a neon tube **36**. The other terminal of tube **36** is connected to one terminal of another capacitor **37** and, through still another resistor **38**, to the cathode of a rectifier **39** whose anode is connected to reference point **18**.

The other terminal of capacitor **37** is connected to cathode **26** and is also connected through resistor **29** to both contacts **31*a*** and **31*b*** of the switch.

The gate terminal **27** of rectifier **25** is also connected to the contact **32*a*** with which blade **32** of the switch makes contact when it is in its "Ignite" position. Blade **32** of the switch is connected to line terminal **12**.

In operation, when switch **31–32–33** is turned manually to its "Ignite" position and valve **22** is turned on, a capacitor charging circuit is set up when a first half-cycle in the line renders terminal **11** positive, terminal **11** being connected through blade **31**, contact **31*a***, rectifier **14** and resistor **15** to one terminal of capacitor **16**. The other terminal of this capacitor is connected through the primary of transformer **17** to reference point **18** and the other line terminal **12**.

Upon terminal **12** becoming positive with respect to terminal **11**, positive voltage is applied from terminal **12**, through blade **32**, and switch contact **32*a***, to the gate terminal **27** of the rectifier **25**. Negative voltage is applied from terminal **11** through blade **31**, switch contact **31*a***, and resistor **29** to the cathode **26** of rectifier **25** and when the difference in potential is great enough rectifier **25** becomes conductive. A path for the discharge of capacitor **16** is thus set up through anode **24**, cathode **26**, rectifier **28**, reference point **18** and the primary winding of transformer **17** just as described in connection with FIGURE 1. A rapidly repetitive spark is produced at the gap **19** and, when valve **22** is turned on, a flame is initiated at the burner **20**.

When the burner is lit, handle **33** is released and, by reason of the spring bias on switch **31–32–33**, blade **31** moves into contact with contact **31*b*** and blade **32** moves from contact with contact **32*a*** to an open position.

Now the charging of capacitor **16** takes place as before, this time through blade **31** and contact **31*b***, but the discharge during the second half-cycle is initiated in a different manner because blade **32** has broken from contact **32*a***. As terminal **12** becomes positive its potential is connected through reference point **18**, rectifier **39** and resistor **38** to one terminal of the neon tube **36** and one terminal of the capacitor **37**. The other terminal of capacitor **37** is connected through resistor **29**, contact **31*b***, and blade **31** to line **11** so that capacitor **37** is charged incrementally during a plurality of second half-cycle until it reaches the firing voltage of the neon tube **36**.

When the tube **36** fires, positive voltage is applied to the gate terminal **27** from tube **36** through resistor **35**. Negative voltage is continually applied during the second half-cycle from terminal **11** through blade **31**, contact **31*b***, and resistor **29** to the cathode **26** of rectifier **25** and to the other terminal of capacitor **37**.

When the built-up positive voltage from the neon tube **36** is applied to gate terminal **27**, current flows between gate **27** and cathode **26** placing the silicon controlled rectifier in a conductive state. Capacitor **16** will then discharge through rectifier **25**, rectifier **28**, reference point **18** and the primary winding of transformer **17**, inducing a sparking voltage in the transformer secondary and across the gap at **19**.

When the capacitor **37** has been discharged so that its voltage falls below the minimum voltage required by the breakdown device **36** to remain ionized, the tube **36** will cease to conduct current and current will cease to flow between gate **27** and cathode **26** and rectifier **25** will no longer be conductive. The triggering of the silicon controlled rectifier **25** is thus dependent upon the time constant determined primarily by the value of resistor **38** and capacitor **37**. Resistor **35** serves as a current limiting resistor to limit current flow through tube **36** and the gate **27**-cathode **26** section of rectifier **25** to a safe value.

The next spark at gap **19** will occur when capacitor **37** has again been sufficiently charged so that its voltage causes breakdown device **36** to again conduct current. In practice, the reduced sparking rate may be arranged to provide spark rates varying from once each fraction of a second to as much as once every 30 seconds. This sparking at reduced rate will continue until handle **33** of the switch is turned to "Off" position.

Much the same result may be obtained automatically by the addition of a thermo-couple operated relay instead of the manual switch **31–32–33** as shown in the circuit **40** shown in FIGURE 3.

A capacitor charging series combination in FIGURE 3, like that shown in FIGURE 1, comprises the terminal **11** being connected through the normally open manual switch **13** to rectifier **14**, and resistor **15**, in that order, to one terminal of capacitor **16**, the other capacitor terminal being connected through the primary winding of transformer **17** to reference point **18** and thence to terminal **12**.

The junction between switch **13** and rectifier **14** is connected through a resistor **29** to one terminal of a capacitor **37** and to the cathode **26** of a silicon controlled rectifier **25**, just as in the circuit **30** of FIGURE 2. The junction of resistor **15** and capacitor **16** is connected to the anode **24** of rectifier **25** and the cathode **26** thereof is connected through a rectifier **28** to reference point **18**, as shown.

The gate terminal **27** of rectifier **25** is connected to one terminal of the neon tube breakdown device **36** through resistor **35** and the other terminal of tube **36** is connected to the other terminal of capacitor **37** and also, through resistor **38** and the cathode-anode of rectifier **39**, in that order, to reference point **18**, just as in FIGURE 2.

Gate **27**, instead of being connected to a line terminal through the manual switch of FIGURE 2, is connected to reference point **18**, and therefore to terminal **12**, through the normally closed contacts **41–42** of a relay **43**.

Relay **43** is operated by a thermocouple **44** connected to the coil **45** of relay **43** and having its heat sensing portion **46** located in proximity to the burner **20**. Thermocouple **44** is operated by heat at the burner to open the relay contacts **41** and **42**.

Burner **20** is supplied through line **21** having a control valve **22** just as in the other figures. Also in proximity to burner **20** is a gap **19** having its terminals connected respectively to the terminals of the secondary winding of transformer **17**.

In operation, when switch **13** is closed, during the first half-cycle capacitor **16** is charged as described above. During the second half-cycle, gate **27** of the rectifier **25** is supplied with positive voltage through the closed contacts **41** and **42** of the relay from reference point **18** and line terminal **12**.

Cathode **26** is connected through resistor **29** and the closed switch **13** to the other line terminal **11** so current flows between cathode **26** and gate **27** rendering the anode **24**-cathode **26** combination conductive and a peak voltage discharge of capacitor **16** takes place through transformer **17** and initially a rapidly recurring spark is induced at the gap **19**, as described above.

However, when a flame is ignited at burner **20**, the sensing portion **46** of thermocouple **44** is heated and operates the relay to break the circuit between contacts **41** and **42**. Now the only connection between gate **27** and terminal **12** is through the series combination of resistor **35**, tube **36**, resistor **38**, the cathode-anode combination of rectifier **39**, reference point **18**, and terminal **12**. Tube **36** requires the triggering circuit including capacitor **37** in order to operate, as described in connection with FIGURE 2, so that after burner **20** is ignited the recurring spark at gap **19** is induced at a slower rate.

The spark, even at the reduced rate, is sufficient to reignite the flame at burner **20** should it be accidentally exinguished. Should the flame go out because of a defect in the supply line, cooling of the thermocouple again closes contacts **41** and **42** producing sparking at the higher or "ignition" rate which may be clearly heard by a person standing near.

In one specific form of the invention the elements used in the circuit **40** were:

Capacitor 16	2 microfarads, 200 volts.
Capacitor 37	5 microfarads, 200 volts.
Rectifier 14	200 milliamperes, 200 volts.
Rectifier 28	200 milliamperes, 200 volts.
Rectifier 39	200 milliamperes, 200 volts.
Resistor 15	150 ohms, 5 watts, 10%.
Rectifier 29	10,000 ohms, 10 watts, 10%.
S.C. rectifier 25	200 volts, 7.2 ampere R.M.S.
Switch 13	Single pole, double throw.
Transformer 17	Miniature ignition coil.
Resistor 35	10,000 ohms, ½ watt, 10%.
Resistor 38	1 megohm, ½ watt, 10%.
Neon tube 36	Type NE–83.

In still another modification, shown in FIGURE 4, time delay safety means are provided for shut down of the system when the burner fails to ignite and flame sensing means are provided at the burner for preventing the shut down of the system when the burner is properly ignited.

In circuit **50**, the terminal **11**, of the pair of line terminals **11–12**, is connected through a switch **51**, which may be thermostat-operated, to a heater switch **52** having normally closed contacts **53**, **53** arranged, by the use of a bimetal contact arm, for instance, to open when subjected to heat. The series connection through contacts **53** to terminal **11** is then connected through the heater coil **54** of switch **52** to reference point **55**. Heater coil **54** is disposed near contacts **53** and arranged to open the contacts after current flows through the coil for a predetermined time.

Reference point **55** is connected, through the coil **56** of a solenoid operated control valve **57** in the fuel supply line **21** to burner **20**, to a reference point **18** and thence to line terminal **12**.

A by-pass connection is provided for heater coil **54** of switch **52** by connecting the junction between contacts **53** and coil **54** to reference point **55** through the normally open contacts **59** of a relay **60**.

For operating relay **60**, a series combination is made by connecting reference point **55** through the coil **61** of relay **60** to one terminal of a flame sensing device **62**, the other terminal of the device being connected to reference point **18**. Device **62** is a cadmium sulfide cell sensitive to yellow light and characterized by having its internal resistance reduced when subjected to light sufficiently to allow enough current to flow through coil **61** to operate the relay and close contacts **59**.

The remainder of circuit **50** is similar to circuit **10** shown in FIGURE 1, and has the same component elements indicated by the same reference numbers. Reference point **55** is connected to the anode of rectifier **14**, its cathode being connected through resistor **15** to one terminal of the capacitor **16**. The other terminal of capacitor **16** is connected through the primary winding of transformer **17** to reference point **18** which is connected to line terminal **12**.

The secondary winding of transformer **17** has each terminal connected to a respective electrode at gap **19** adjacent the burner **20**.

The junction of resistor **15** and capacitor **16** is connected to the anode **24** of the silicon controlled rectifier **25** whose cathode **26** is connected through the anode-cathode combination of rectifier **28** to reference point **18**. Cathode **26** is also connected through resistor **29** to reference point **55**.

The gate terminal of rectifier **25** is connected directly to reference point **18**.

In operation, when switch **51** is closed, either manually or thermostatically, line current is applied from terminal **11** through contacts **53** and coil **54** of the heater switch **52** and through the solenoid coil **56** of valve **57** which, in turn is connected through reference point **18** to terminal **12**. Upon operation of solenoid **56**, the valve **57** is opened and fuel is supplied to the burner **20**.

At the same time, during the first half-cycle, voltage is applied to one terminal of capacitor **16** from terminal **11**, through switch **51**, contacts **53**, coil **54**, reference point **55**, rectifier **14**, and resistor **15**. Voltage from the other terminal **12** is applied to the other terminal of capacitor **16**, through reference point **18**, and the primary winding of transformer **17**.

At the next half-cycle, voltage from terminal **11** is applied to cathode **26** of rectifier **25** through reference point **55** and resistor **29**. At the same time voltage from terminal **12** is applied to gate terminal **27** through reference point **18**. When the voltage differential is sufficient current passes through the gate **27**-cathode **26** combination and rectifier **25** becomes conductive. Capacitor **16** discharges through the primary of transformer **17**, reference point **18**, rectifier **28**, cathode **26**, anode **24** to capacitor **16**. As current passes through transformer **17** a high voltage spark is induced at the gap **19** from the secondary winding of the transformer, the spark rapidly recurring at line frequency, and burner **20** is ignited.

Should the burner not become ignited before coil **54** the switch **52** heats up, the contacts **53** of the switch separate and the circuits to both the solenoid of valve **57** and to the transformer **17** are interrupted until coil **54** cools.

Should the burner **20** be ignited, the device **62** becomes conductive and a circuit is completed from reference point **55** through relay coil **61**, device **62**, reference point **18**, and terminal **12** and relay **60** is operated. Operation of the relay closes the contacts **59** providing a by-pass around coil **54** from the contacts **53**, closed contacts **59** to reference point **55**, thus preventing the opening of contacts **53** once flame is sensed by the device **62**, unless the flame is extinguished and the circuit through the device **62** is thereby interrupted.

While the contacts **53** are closed the sparking at gap **19** continues and valve **57** remains open. Should the flame become extinguished for any reason it will be reignited unless reignition does not take place within the time delay period in which coil **54** is adapted to open contacts **53**, since the contacts **59** of relay **60** are now open.

It will be apparent that the rectifiers, resistors, capacitors, transformers and tubes of the above described circuits may conveniently be housed in a small space and connected in a variety of heating or other flame-control systems.

As will be apparent to those familiar with the art, the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The embodiments disclosed therefore are to be considered in all respects as illustrative, rather than restrictive, the scope of the invention being indicated by the appended claims.

What is claimed is:

1. An electrically operated igniter device for a burner having a fluid fuel supply, comprising: a source of alternating electric current; a transformer; a first series combination of one source terminal, a switch, the anode and cathode of a first rectifier, and a first resistor connected in that order to one terminal of a capacitor; a second series combination of the other terminal of the capacitor and the primary winding of the transformer connected in that order through a point of reference potential to the other source terminal; a silicon controlled rectifier having its anode connected to the junction of the first rectifier and the capacitor, having its gate terminal connected to the point of reference, and having its cathode connected through the anode and cathode, in that order, of a second rectifier to the point of reference, the cathode of the silicon controlled rectifier being also connected through a second resistor to the junction of the switch and the first rectifier; and spaced electrodes adapted to be fixed in proximity to the burner, said electrodes being in series circuit with the secondary winding of the transformer, one electrode being grounded, and the electrodes forming therebetween a gap for a rapidly recurring spark for igniting the burner whenever the switch is closed.

2. A flame ignition system, comprising: fluid fuel burner means; means for controlling the supply of fuel to the burner; spaced electrodes forming a spark gap disposed adjacent the burner, one electrode being grounded; a transformer having its high voltage secondary winding connecting the electrodes in series, one terminal of the primary winding of the transformer being connected in a first series combination of a capacitor, the anode of a silicon controlled rectifier, the cathode of said rectifier, the anode of a first diode rectifier, and the cathode of the first diode rectifier, in that order, the other terminal of the primary winding being connected to the cathode of the diode rectifier; the gate electrode of the silicon controlled rectifier being connected to the cathode of the

first diode rectifier; a second series combination of a first resistor, the cathode of a second diode rectifier, the anode of the second rectifier, and a second resistor connected in that order from the anode to the cathode of the silicon controlled rectifier; and a course of alternating current, the anode of the second diode rectifier being connected through a switch across the source to the cathode of the first diode rectifier.

3. The flame ignition system defined in claim **2** characterized by having the fuel control means operable by a solenoid operated valve; having a third series combination including the anode of the second diode rectifier, the solenoid coil and the cathode of the first diode rectifier connected in that order; having the heater coil and the normally closed heat responsive contacts of a timer switch included in series in that order in the connection between the anode of the second diode rectifier and the cathode of the first diode rectifier across the source and disposed between the second diode anode and the switch; having a fourth series combination including a pair of normally open relay contacts connecting the junction between the heat responsive contacts and the heater coil to the anode of the second diode rectifier; having a flame sensing device adjacent the burner, the device being normally nonconductive and being conductive when subjected to light; and a fifth series combination of the device and the coil of the relay connecting the cathode of the first diode rectifier to the anode of the second diode rectifier.

4. A flame ignition system, comprising: fluid fuel burner means; means for controlling the supply of fuel to the burner; spaced electrodes forming a spark gap disposed adjacent the burner; one electrode being grounded; a transformer having its high voltage secondary winding connecting the electrodes in series; one terminal of the transformer primary winding being connected in a series combination of a first capacitor, the anode of a silicon controlled rectifier, the cathode of the latter rectifier; the anode of a first diode rectifier, and the cathode of the diode rectifier, in that order, the other terminal of the primary winding being connected to the cathode of the diode rectifier; the gate electrode of the silicon controlled rectifier being connected to the cathode of the diode rectifier by a second series combination of first resistor, a breakdown device having a gas filled tube, a second resistor, the cathode of a second diode rectifier, and the anode of the second rectifier, in that order; the junction of the breakdown device and the second resistor being connected by a second capacitor to the cathode of the silicon controlled rectifier; a third series combination of a third resistor, the cathode of a third diode rectifier, the anode of the third rectifier, and a fourth resistor connected in that order from the anode to the cathode of the silicon controlled rectifier; and a source of alternating current, the anode of the third rectifier being connected across the source through first switch means to the cathode of the first diode rectifier; the gate electrode of the silicon controlled rectifier being connected through second switch means across the source then through the first switch means to the anode of the third diode rectifier.

5. The flame ignition system as defined in claim **4** in which said first and second switch means are connected and have at least two positions, the first switch means in either position connecting the anode of the third diode rectifier to one terminal of the source of current, and the second switch means connecting the gate electrode of the silicon controlled rectifier to the other terminal of the source in its one position and breaking said connection in its other position, the second switch means being spring biased from its one position to its other position.

6. The flame ignition system as defined in claim **4** having flame sensing means disposed adjacent the burner operable to automatically open said second switch means to break the connection between the gate electrode of the silicon controlled rectifier and the source of current.

7. A flame ignition system, comprising: fluid fuel burner means; a solenoid operated means for controlling supply of the fuel to the burner; spaced electrodes forming a spark gap disposed adjacent the burner, one electrode being grounded; a transformer having its high voltage secondary winding connecting the electrodes in series; one terminal of the transformer primary winding being connected in a first series combination of a capacitor, the anode of a silicon controlled rectifier, the cathode of said rectifier, the anode of a first diode rectifier, and the cathode of the diode rectifier, in that order, the other terminal of the primary winding being connected to the cathode of the diode rectifier; the gate electrode of the silicon controlled rectifier being connected to the cathode of the first diode rectifier; a second series combination of a first resistor, the cathode of a second diode rectifier, the anode of the second rectifier, and a second resistor connected in that order from the anode to the cathode of the silicon controlled rectifier; a source of alternating current; the anode of the second diode rectifier being connected by a third series combination of the heater coil and the heat responsive normally closed pair of contacts

of a heater switch and a second switch across the source to the cathode of the first diode rectifier; another series connection between the anode of the second diode rectifier and the cathode of the first diode rectifier including the coil of the solenoid of the fuel control means; and a light sensitive cadmium sulfide cell disposed adjacent to the burner for sensing when the burner is lit, the cell being in series with a relay coil and connected between the cathode of the first diode rectifier and the anode of the second diode rectifier, the normally open contacts of the relay being connected in a by-pass connection between the junction of the heat responsive pair of contacts and the heater coil to the anode of the second diode rectifier.

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