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[54] **SPARK IGNITION CIRCUIT FOR GAS BURNERS**

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[51] **Int. Cl.** **F23q 3/00**

[58] **Field of Search** 315/183, 206; 317/96, 97; 431/24, 66, 70, 264, 266

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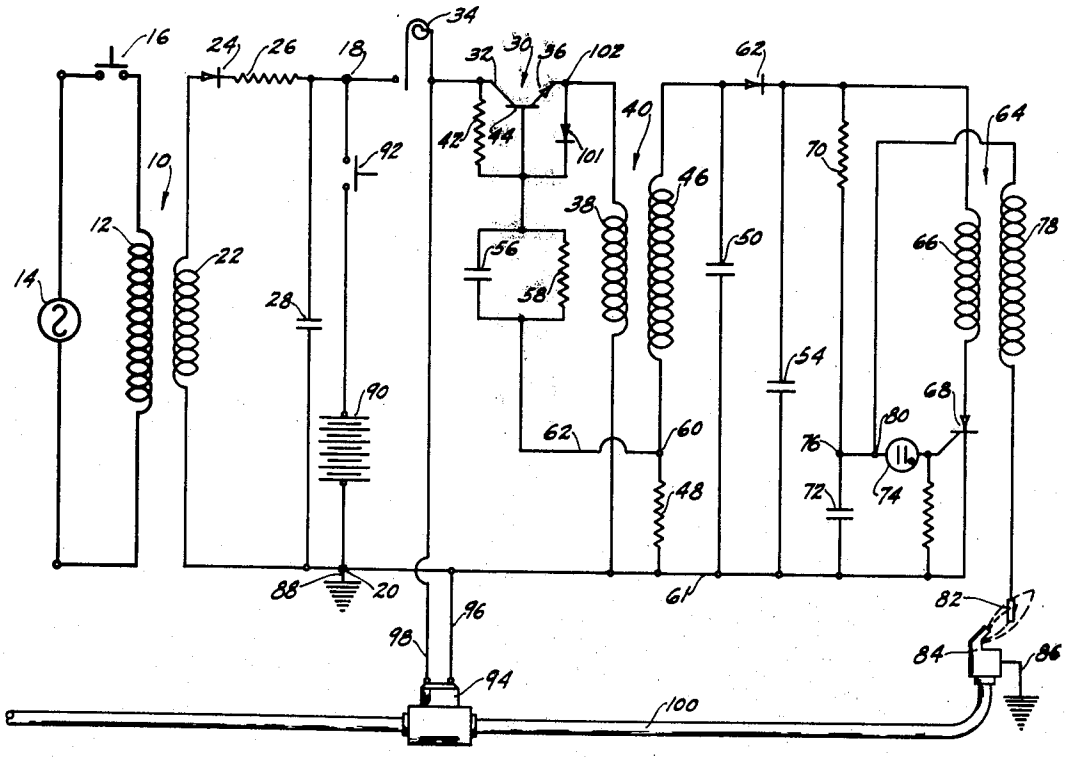
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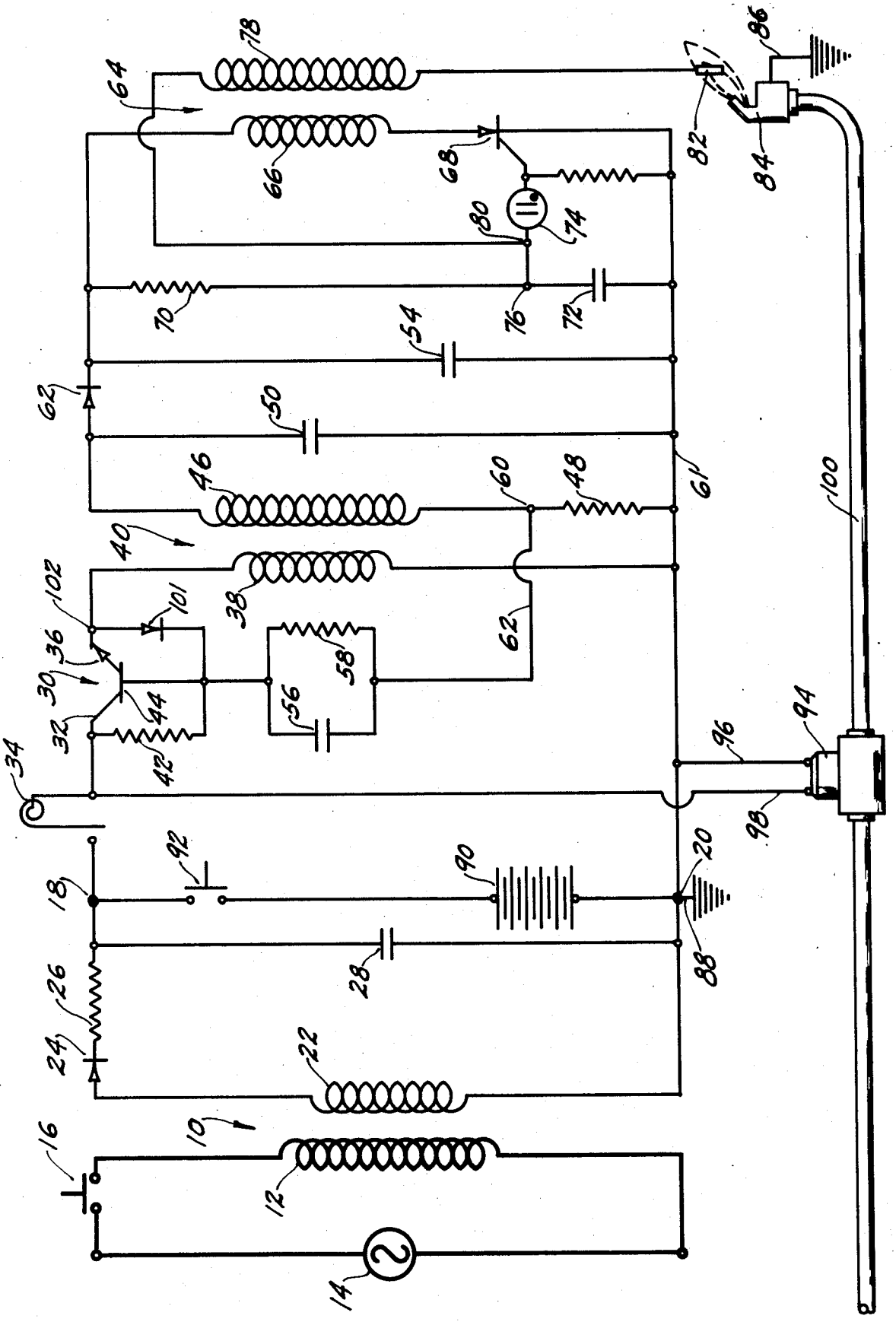
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[57] **ABSTRACT**

In a spark igniter circuit for gas burners operable on a low voltage direct current supply, a transistor is alternately driven to saturation and cut off abruptly so as to produce, through inductive coupling, high voltage pulses at relatively high frequency to incrementally charge a storage capacitor; a SCR is gated when the storage capacitor attains a predetermined charge and permits the discharge of the capacitor through the primary winding of an ignition transformer, thereby to produce strong sparking across spaced electrodes in a secondary circuit at relatively low frequency; and the spaced electrodes are arranged to be bridged by burner flame and the SCR gating signal is shunted across the spark electrodes to cut off discharge of the capacitor and sparking when burner flame bridges the spark gap.

8 Claims, 1 Drawing Figure




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SPARK IGNITION CIRCUIT FOR GAS BURNERS

This invention relates to electronic spark ignition circuits which operate on direct current supply and employ oscillating circuit means to producce energy pulses to effect sparking across spaced electrodes.

There is a need for a simple and inexpensive spark ignition circuit which will operate on a direct current supply as low as 12 volts to produce adequate sparking which will reliably ignite a gas burner. An igniter circuit of this kind, when provided with suitable rectifying means, may be directly incorporated in the room thermostat circuit of a space heating system operating on a commercial *a.c.* power supply. Conventionally, the thermostat circuits of space heating systems are, for reasons of safety, operated on a stepped down supply of 24 volts. Also, a spark ignition circuit of this kind could be operated on a 12-volt wet or dry cell storage battery when the commercial alternating current supply fails or is not available, as may occur in space heaters for recreational vehicles.

Accordingly, it is an object of this invention to provide a generally new and improved spark igniter circuit, operable on a low voltage direct current or rectified low voltage alternating current supply, having oscillator means operative to produce high voltage pulses at relatively high frequency, a storage capacitor which is incrementally charged by these pulses, and means to discharge the storage capacitor through an igniter transformer primary winding at a relatively low frequency to effect strong sparking across the spaced electrodes in the igniter transformer secondary circuit.

A further object is to provide a spark igniter, as characterized in the preceding paragraph, in which the high frequency, high voltage pulses are generated by alternately driving a transistor to saturation through the primary winding of a voltage step-up transformer and abruptly cutting off current flow through the transistor and primary winding at saturation to induce high voltage pulses in a second winding.

A further object is to provide a spark igniter circuit, as characterized in the penultimate paragraph, which further includes means to automatically cut off sparking when a burner is ignited and to re-institute sparking in event the burner flame fails while the burner control system is in heat demand condition.

Further objects and advantages will appear from the following description when read in connection with the accompanying drawing.

The single FIGURE of the drawing is a diagrammatic illustration of a spark igniter circuit constructed in accordance with the invention. a gaseous fuel burner and fuel flow control means therefor is also illustrated in operative association with the spark igniter circuit.

Referring to the drawing, a voltage step-down transformer indicated at **10** has a primary winding **12** connected across a commercial alternating current power supply **14** through a manual switch **16.** When manual switch **16** is closed, a rectified and filtered low voltage supply is provided across terminals **18** and **20** by a secondary winding **22** and the provision of a diode **24,** a resistor **26,** and a capacitor **28.**

A NPN transistor **30** has its collector **32** connected to terminal **18** through a room thermostat **34** and its emitter **36** connected to terminal **20** through the primary winding **38** of a coupling transformer **40.** A resistor **42** connected between terminal **18** and the base **44** of transistor **30** applies a limited forward bias which is just sufficient to initiate conduction through transistor **30** when thermostat **34** is closed.

A secondary winding **46** of transformer **40** is connected at its lower end at a point **60** to the base **44** of transistor **30** by a lead **62** and through a capacitor **56** and parallel connected resistor **58.** The lower end of secondary winding **46** is also connected to terminal **20** through a voltage dividing resistor **48** and a lead **61.** The upper end of secondary winding **46** is connected to terminal **20** through a small capacitor **50** and the lead **61.** The upper end of secondary winding **46** is also connected to terminal **20** through a diode **62,** a storage capacitor **54,** and the lead **61.** The diode **62** and storage capacitor **54** are connected in parallel with capacitor **50.**

An ignition transformer **64** has a primary winding **66** connected across the storage capacitor **54** through a SCR **68.** Gating means for SCR **68** comprises a resistor **70** and a capacitor **72** series connected across the storage capacitor **54,** and a triggering neon bulb **74** connected between the SCR control electrode and a point **76** between reistor **70** and capacitor **72.** The resistor **72** is connected between the SCR control electrode and the anode side thereof.

An ignition transformer secondary winding **78** is connected at one end to a point **80** in the SCR gate lead between neon bulb **74** and point **76.** The other end of secondary winding **78** is connected to a spark electrode **82** positioned adjacent a conductive metal gas burner indicated at **84.** The spacing of electrode **82** with respect to the metal burner **84** is such that a suitable spark gap is provided across which sparking will occur. Also, the electrode **82** is positioned so that the spark gap between it and the burner will be bridged by flame when the burner is ignited. The gas burner **84** and the igniter circuit are grounded at **86** and **88.** It is to be understood that the burner **84** may be either a main burner or a pilot burner arranged to ignite a main burner.

An alternate, direct current power source for operating the igniter circuit is provided by a storage battery indicated at **90.** Battery **90** is connected across terminals **18** and **20** through a manual switch **92.** Selection of a power source may be made by closing one or the other of switches **16** or **92.** Switches **16** and **92** may be interconnected so that only one may be closed at a time.

OPERATION

If the igniter circuit is to be operated on a commercial alternating current power supply, the switch **16** is closed and a low voltage rectified and filtered supply is available across terminals **18** and **20.** If the igniter is to be operated on battery-supplied direct current, the switch **16** is opened and switch **92** is closed.

When one or the other of switches **16** or **92** is closed and thermostat **34** closes in response to a temperature drop, a normally closed, solenoid operated valve **94** is energized through leads **96** and **98** and opens to admit gas to flow through a gas supply conduit **100** to the burner **84.** At the same time, a limited forward starting bias is supplied to transistor base **44** through resistor **42** to initiate conduction through transistor **30** and primary winding **38** of transformer **40.** This initial current flow through winding **38** induces a voltage in secondary winding **46.** This induced voltage is of such polarity that the lower end of secondary winding **46** is positive

and causes current to flow through capacitor **56,** causing it to charge, and through the parallel resistor **58** and the base-emitter circuit **44–36,** thereby to increase current flow through the collector-emitter circuit of transistor **30** and through primary winding **38.** Regenerative feedback therefore occurs, and the transistor **30** is rapidly driven to saturation.

During this period of increasing current flow through the transistor and winding **38,** capacitor **56** is charged by the induced voltage in winding **46.** Secondary winding **46** has a considerably greater number of turns than primary winding **38,** so that the voltage induced therein when transistor **30** approaches saturation is considerably greater than the supply voltage across terminals **18** and **20.** When saturation of transistor **30** occurs and current flow through primary winding **38** ceases to increase, the induced voltage in winding **46** drops to zero and its field collapses. As a result, capacitor **56** now discharges and a voltage of opposite polarity appears across winding **46.**

The collapse of the field around winding **46** and discharge of capacitor **56** reverse biases transistor **30** and abruptly cuts it off at maximum output. The cutoff transistor **30** at saturation causes the field around winding **38** to collapse and by mutual induction causes a high voltage pulse to appear across winding **46** of the same polarity as the pulse induced therein upon collapse of its own field.

The mutually induced high voltage pulse in winding **46** now charges capacitor **50** and charges capacitor **56** in an opposite direction through a diode **101.** This high voltage winding **46** is also simultaneously discharging through diode **52** to apaply an increment of charge on the storage capacitor **54.** As this high voltage pulse discharges into capacitor **54,** small capacitor **50** and capacitor **56** now discharge in a direction to again forward bias the base-emitter circuit to start another cycle. The diode **101** also functions to protect the transistor against reverse high voltage at the time the field around windidng **38** collapses.

The frequency at which the circuit oscillates is not critical except to the extent that it is desirable to stabilize the frequency at some point well below the frequencies assigned to commercial broadcasting channels. This is accomplished by predetermination of the R-C time constant of coupling capacitor **56** and resistor **58** and by small capacitor **50.**

When the storage capacitor **54** attains a predetermined charge, the capacitor **72** will become sufficiently charged through the relatively high resistor **70** to permit the application of a break-down voltage across neon bulb **74** through resistor **70.** When neon bulb **74** fires and conducts, the SCR **68** is fired and the storage capacitor discharges through primary winding **66** of igniter transformer **64.** This induces a high voltage pulse in secondary winding **78,** causing a spark to occur across the spark gap. The igniter transformer **64** is a voltage step-up transformer, the secondary winding having many more turns than the primary.

Upon discharge of storage capacitor **54,** neon bulb **74** again becomes non-conductive, and the swing of the storage capacitor **54** following its discharge cuts off conduction through the SCR **68.** The time constants of capacitor **72** and resistor **70,** as related to the charge developed on storage capacitor **54,** are such that the frequency of the storage capacitor discharge and, therefore, the occurrence of spark is in the order of two cycles per second.

It has been found that a strong spark occurring at relatively low frequency functions more reliably to ignite gas than a high frequency or continuous sparking. When gas is ignited at the burner **84,** flame bridges the spark gap between electrode **82** and burner **84,** thereby considerably reducing the gap impedance to the extent that lead-off from point **80** in the SCR gating circuit through secondary winding **78** and across the spark gap to ground is sufficient to preclude the charging of capacitor **72** through resistor **70** to the break-down voltage of neon bulb **74.** Sparking across the gap will therefore cease when flame is present. If, however, the flame is extinguished while thermostat **34** is closed, sparking will be immediately resumed.

When gating of the SCR **68** is shunted by conduction through burner flame, the circuit will continue to oscillate at a somewhat higher amplitude, but with less power consumption. Under these conditions, as the accumulated charge on the storage capacitors **54** approaches the voltage of the charging pulses, the inductive and capacitive reactance will increase. Some of the charge applied to capacitor **54** will, however, under these conditions, leak off through resistor **70,** igniter transformer secondary **78,** and across the spark gap through the flame to ground.

An igniter circuit constructed in accordance with the foregoing description, and comprising the following component values, oscillated at approximately 250 kilocycles when operated on a 12-volt storage battery and provided adequate sparking at approximately two cycles per second to reliably ignite a gas burner:

Transistor	30	Type 2N3642
Resistor	42	56 kilohms
Capacitor	56	.0047 microfarad
Resistor	58	1.8 kilohms
Resistor	48	220 kilohms
Capacitor	50	220 picofarad
Capacitor	54	1 microfarad
Resistor	70	22 megohms
Capacitor	72	.022 microfarad
Diode	101	Type IN 4004
Diode	62	Type IN 4004
Neon Bulb	74	Signalite A-322
SCR	68	G. E. Type C106B2
Winding	38	.132 millihenrys
Winding	46	2.93 millihenrys

It is to be understood that the circuit described will operate on direct current or rectified alternating current supply of considerably higher voltage than 24 volts with suitable changes in the values of circuit components. Also, the circuit described, having the above-listed component, values, has been successfully operated on both 12-volt direct current and 24-volt rectified and filtered alternating current supply.

Other modifications within the spirit of the invention will occur to those skilled in the art, such as substitution of a PNP transistor for the NPN transistor described.

The foregoing description and drawing is intended to be illustrative, and not limiting, the scope of the invention being defined in the appended claims.

We claim:

1. In a spark ignition circuit, a low voltage direct current power source, a storage capacitor, a pulsing oscillator circuit operating on said power source and operative to incrementally charge said storage capacitor to a considerably higher voltage than said power source,

said oscillator circuit comprising a transistor having its collector-emitter circuit connected across said power source, starting means, a transformer having a primary winding in the output of said transistor and a secondary winding of considerably greater inductance than said primary winding, parallel resistance-capacitance means connected between one end of said secondary winding and the base of said transistor and operative to drive said transistor to saturation and to abruptly cut off said transistor at saturation, thereby to effect an induced high voltage pulse in said secondary winding, circuit means including impedance means connecting the other end of said secondary winding to a point of fixed potential, and circuit means including a diode connecting said storage capacitor in parallel with said impedance means, an igniter transformer comprising a primary winding, a secondary winding, and a secondary circuit including spaced spark electrodes, circuit means including voltage responsive switching means connecting said igniter transformer primary winding across said storage capacitor, and said switching means being responsive to a predetermined charge on said storage capacitor to effect its discharge through said igniter transformer primary winding.

2. The spark ignition circuit claimed in claim **1** in which said impedance means connected between said other end of said secondary winding and said point of fixed potential is a small capacitor.

3. The spark ignition circuit claimed in claim **1** including a diode connected between the output side of said transistor and its base.

4. The spark ignition circuit claimed in claim **1** in which the time constants of the oscillator circuit are such that its oscillates at a frequency of between 100 and 400 kilocycles per second.

5. The spark ignition circuit claimed in claim **4** in which said storage capacitor is discharged one to three times per second.

6. The spark ignition circuit claimed in claim **1** in which said voltage responsive switching means is a controlled solid-state switch having gating circuit means therefor including resistance-capacitance means series connected across said storage capacitor and operative to permit the application of a firing signal to said switch through said resistance means only when said storage capacitor attains a predetermined charge.

7. The spark ignition circuit claimed in claim **6** in which said gating circuit means further includes a neon bulb between said resistance capacitance means and the control electrode of said controlled solid-state switch.

8. The spark ignition circuit claimed in claim **6** which further includes shunting circuit means connected between said gating circuit means and said point of fixed potential and including said spaced spark electrodes operative to shunt the application of a firing signal to said controlled solid-state switch when the impedance across said spaced spark electrodes is diminished by a bridging burner flame.

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