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GAS BURNER IGNITION SYSTEM

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FIG. 1

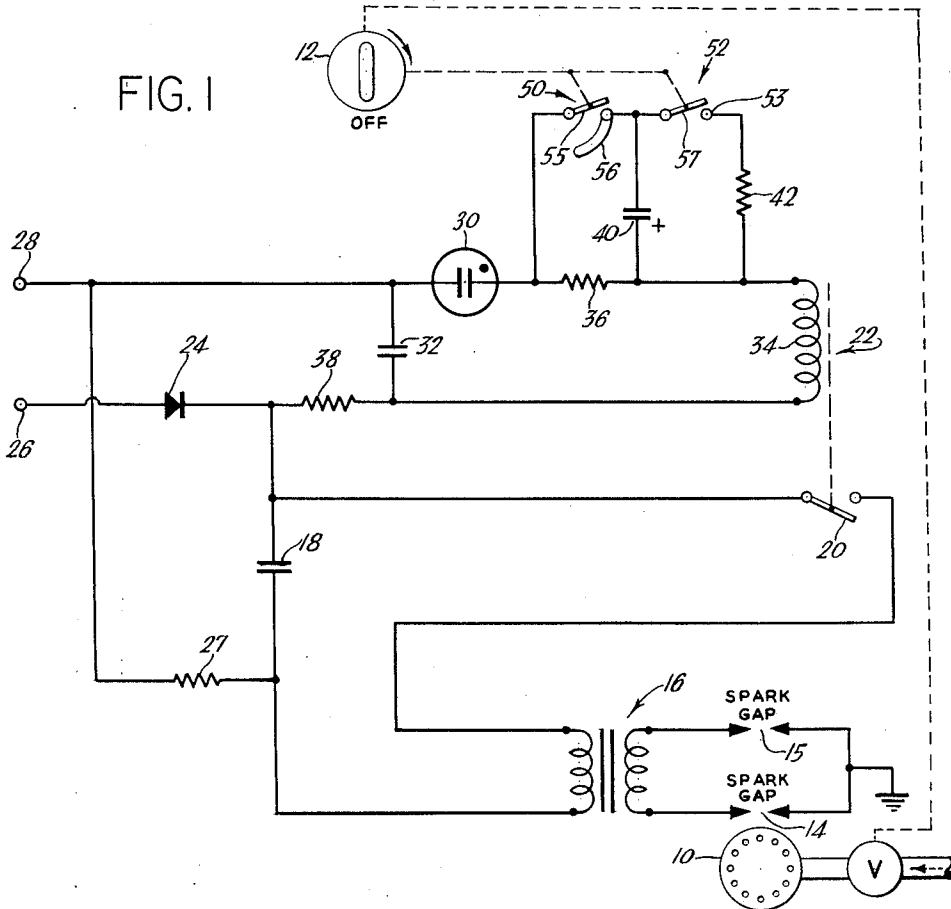


FIG. 2

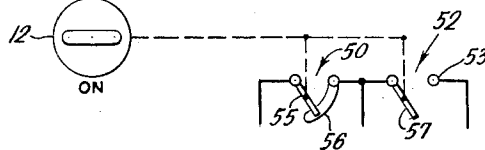
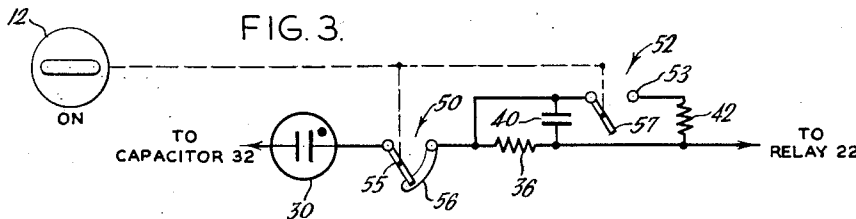


FIG. 3.



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GAS BURNER IGNITION SYSTEM

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This invention relates to electrical systems for the ignition of gas burners and the like.

In automatic electrical ignition systems for gas burners it is important to assure reliable, non-critical initial ignition when the burner is first turned on. Should the burner be extinguished after initial ignition while the gas remains on, as may occur for example due to a draft blowing out the flame, it is also desirable that reliable re-ignition of the burner be provided promptly by the automatic ignition system. It is also desirable that the ignition system perform its functions with minimal periods of operation and current flow, and that the system be simple and inexpensive.

These desirable features are provided in accordance with the invention by the provision of an automatic ignition system employing a high-voltage spark discharge for igniting the gas, in which system spark discharges for ignition purposes are produced repetitively at a relatively high rate immediately following turning on of the gas supply to the burner and at a substantially lower rate thereafter so long as the gas supply remains turned on. The initial rapidly-repetitive discharges assure that the burner will be ignited promptly when turned on without requiring critical synchronization between operation of the gas control and production of a spark discharge, and the less-frequently recurring spark discharges produced thereafter are adequate to re-ignite the burner in case of extinction while the burner is turned on while reducing the duration of periods of operation of the ignition system, thereby increasing the operating life of the system and decreasing the current drain from the electrical power source.

In a preferred embodiment of the invention the repetitive spark discharges used for ignition are produced in response to cyclically-recurrent intervals of conduction in a relaxation oscillator circuit; for example, the intermittent high current which flows in the relaxation oscillator may be used to close repetitively a relay switch to connect a charged capacitor intermittently across the primary of a spark coil, the secondary of which coil is connected across the spark electrodes of the spark-discharge device. The desired variation in the repetition rate of the relaxation oscillator is provided by a parallel resistance-capacitance (RC) circuit connected in series with the break-down device, such as a neon lamp, in the relaxation oscillator circuit. Switching means, responsive to motion of the gas control supplying the burner to be ignited, momentarily discharges the capacitor in this RC circuit when the gas control is first turned on. When the gas is first turned on and the capacitor in the RC circuit is therefore in its discharged condition, the relaxation oscillations occur at a relatively rapid rate to provide rapidly-recurrent ignition sparks, but with continued cycles of the relaxation oscillations the capacitor in the above-mentioned RC circuit charges incrementally to an equilibrium voltage which opposes the voltage applied to the breakdown-device in the relaxation oscillator, thereby requiring longer periods between successive firings of the breakdown device. In a particularly simple and effective form of the invention the voltage for operating the relaxation oscillator is derived from an A.C. line source by way of a rectifier and resistor in series with one side of the line followed by a capacitor connected across the line, and voltage for operating the primary

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of the spark coil is derived across another capacitor connected between the terminal of the rectifier at which rectified voltage appears and the opposite side of the A.C. line.

Other objects and features of the invention will be more readily appreciated from a consideration of the following detailed description taken in conjunction with the accompanying drawings, in which FIGURE 1 is a schematic circuit diagram of one preferred embodiment of the invention, FIGURE 2 is a schematic circuit diagram illustrating the operation of certain switches of FIGURE 1, and FIGURE 3 is a schematic circuit diagram of an alternative switch arrangement for use in the circuit of FIGURE 1.

Referring specifically to FIGURE 1, supply of gas to the conventional gas burner 10 is arranged to be turned on and off in the usual manner by rotation of a gas control handle 12 from the vertical position shown in FIGURE 1 toward the horizontal position shown in FIGURE 2. A pair of spark discharge electrodes 14 provide a spark gap so positioned with respect to the burner 10 that, upon the occurrence of sparks from electrodes 14 concurrently with issuance of gas from burner 10, the desired gas ignition is produced. Another pair of electrodes 15 may also be provided in series with electrodes 14 for igniting other burners (not shown). Electrode pairs 14 and 15 are connected in series across the secondary of a spark coil 16, the primary of which is connected across a capacitor 18 when the switch arm 20 of electrical relay 22 is closed. Charging of capacitor 18 to its operating voltage is provided by connecting one of its plates by way of a rectifier 24 to one terminal 26 of an A.C. power line source, typically of 110 volts, and its other plate by way of a current-limiting resistor 27 to the other terminal 28 of the line supply. Capacitor 18 is thereby continuously connected to a source of charging current. Closing of switch arm 20 discharges capacitor 18 through the primary of the spark coil 16, which in turn produces a high-voltage surge across electrodes 14 sufficient to provide the necessary sparks and ignition of the burner 10.

Closing of switch arm 20 is produced in response to current flowing in a relaxation oscillator circuit containing a neon lamp 30 of conventional type which "fires" and becomes highly conductive only when the voltage applied across its two terminals exceeds a predetermined critical value. Capacitor 32, relay winding 34 and resistor 36 are connected in series with each other between the discharge electrodes of neon lamp 30, while a charging resistor 38 is connected between the interconnection of winding 34 and capacitor 32 and the terminal of rectifier 24 more remote from the power-line terminal 26. Capacitor 40, resistor 42 and associated switching means are also connected in the circuit in a manner and for the purposes described in more detail hereinafter.

It will be recognized that if the terminals of resistor 36 were short-circuited the arrangement shown would operate as a conventional relaxation oscillator. Thus, rectified line current from rectifier 24 would flow through resistor 38 to charge capacitor 32 at a rate determined by the time constant of the resistance and capacitance of elements 38 and 32. The voltage across capacitor 32 would then be applied fully across the neon lamp 30 with the result that, when the capacitor 32 had charged to a sufficient voltage, the gas in neon lamp 30 would break down and effectively short-circuit capacitor 32. As a result strong conduction would occur at this time through the series circuit including the relay primary 34, resulting in a closing of switch 20 and the production of ignition sparks at electrodes 14 as described previously. During this process capacitor 32 would be substantially completely discharged, so that neon lamp 30 would be

come extinguished and capacitor 32 would then begin to recharge by way of resistor 38 until the firing voltage of lamp 30 was reached, at which point the cycle would repeat itself. In this way ignition sparks would be produced at electrodes 14 at a regular repetition rate determined by the time constant of elements 32 and 38.

However, with resistor 36 present in the circuit and with single-pole, single-throw switch 50 closed to connect capacitor 40 in shunt with resistor 36, the above-described operation of the relaxation oscillator is modified in the following manner. Assuming that the capacitor 40 has been initially completely discharged through a resistor 42 of small value by closing of momentary-contact switch 52, capacitor 40 initially presents a very low impedance for pulses and the repetition rate of current pulses produced by the relaxation oscillator initially has substantially the same high value as in the absence of resistor 36. However, each time that conduction occurs through lamp 30 by way of resistor 36, capacitor 40 connected across resistor 36 is charged incrementally in the direction to oppose the voltage across capacitor 32 and to reduce the portion of the voltage across capacitor 32 which is actually applied across the lamp 30. Accordingly, with each succeeding cycle of the relaxation oscillations the voltage across capacitor 32 must charge to a higher value in order to cause breakdown of neon lamp 30. Since such additional charging requires additional time, the period between successive firings of lamp 30 increases and the repetition rate at which current pulses are generated by the oscillator decreases. Without resistor 36 the repetition rate would decrease until pulses stopped altogether. However, resistor 36 limits this decrease in frequency and causes it to approach an equilibrium value. This is for the reason that the charge accumulated in the above-described manner on capacitor 40 tends to leak off by way of resistor 36 in the intervals between conduction through lamp 30, and an equilibrium voltage across capacitor 40 is thereby established corresponding to a minimum repetition rate for the oscillator. The repetition rate of the spark discharges at electrodes 14 varies in the same manner as the repetition rate of the relaxation oscillations.

Switches 50 and 52 are mechanically linked to the gas control 12 and are so constructed that when the gas control is in its off position, as shown in FIGURE 1, both switches 50 and 52 are open. Under these conditions no relaxation oscillations are generated, since resistor 36 is, in this example, chosen sufficiently large in value to prevent such oscillations from occurring. However as soon as the gas control is turned slightly in its ON direction, switch 52 is momentarily closed to short-circuit the terminals of capacitor 40 by way of the low-valued current-limiting resistor 42 and to remove any charge which may exist on the latter capacitor. For this purpose switch 52 may be of a momentary-contact or wiper type, so that the switch arm is closed to fixed contact 53 only briefly as the gas control is first turned on, while the value of resistor 42 is only large enough to protect the switch contacts from excessive current. Switch 50 is also closed as the gas control is turned on and remains closed so long as gas control 12 remains turned from its off position, so as to connect capacitor 40 across resistor 36. As an example, FIGURE 2 shows one possible position of switches 50 and 52 when the gas control handle 12 is turned to its fully-on position. As shown, in this condition switch arm 55 remains closed to an extended segmental, fixed contact 56, while switch arm 57 of switch 52 is now open, having passed its associated fixed contact 53 after momentarily contacting it.

In operation then, when it is desired to turn on a particular burner such as 10 the corresponding gas control handle 12 is rotated away from its off position, thereby momentarily closing switch 52 to short-circuit capacitor 40 and remove any charge therefrom, and thereby also closing switch 50 to connect capacitor 40 across resistor

36. Under these conditions relaxation oscillations are initiated at a relatively fast rate, the switch arm 20 of relay 22 being opened and closed at this same rate to produce corresponding repetitive current pulses through the primary of spark coil 16 and corresponding relatively rapidly-recurring spark discharges at electrodes 14 so as to ignite the burner 10 to which gas is being supplied. The rate of the relaxation oscillations then decreases gradually to a much lower, equilibrium value due to the incremental charging of capacitor 40 described previously, producing a corresponding slower repetition rate for the spark discharges at electrodes 14.

If the gas flame at burner 10 should then be extinguished, as by an air draft, the relatively slowly-recurrent spark discharges at electrodes 14 will produce prompt re-ignition of the burner. When the gas control 12 is later turned back to its OFF position, switch 50 opens and the large value of resistor 36 causes the relaxation oscillations and the spark discharges to terminate, the remaining charge on capacitor 40 being removed in the manner described above when the gas burner is turned on again for later use.

It is noted that in this arrangement there are a large number of rapidly-recurrent spark discharges occurring when the gas is first turned on, thereby assuring reliable ignition despite substantial variations in the time required for gas to reach the burner 10. In addition, should the burner be extinguished inadvertently while the gas is on, it will be re-ignited promptly. However, both the relaxation oscillator and the spark-gap electrodes and associated elements are operated less frequently than if the initial repetition rate were used continuously, thus increasing the life of the parts used and decreasing the amount of noise caused by the spark discharges. It is also noted that the particular arrangement shown is particularly simple in its circuitry and in the nature of the components used, and requires only three leads to the switches associated with the gas burner control.

Other forms and arrangements of switches 50 and 52 for providing the above-indicated sequence of operations may be used, and will occur to one skilled in the art. For example, as shown in FIGURE 3, switch 50 may be replaced by a short-circuit, and placed instead between resistor 36 and gas tube 30 so that relaxation oscillator is open-circuited by operation of this switch. In this latter case any undesirable leakage current through gas tube 30, which might tend to occur in the circuit of FIGURE 1 when switch 50 is open, is positively prevented.

In one specific form of the embodiment of the invention shown in FIGURE 1, the elements employed were as follows:

Capacitor 18----	4 microfarad, 200-volt capacitor.
Capacitor 32----	1 microfarad, 200-volt tubular capacitor.
Capacitor 40----	4 microfarad, 200-volt tubular capacitor.
Rectifier 24-----	200 milliampere rectifier.
Gas discharge device 30-----	Type NE-2H neon glow lamp.
Resistor 27-----	2,200 ohm, ½ watt, 10% tolerance.
Resistor 38-----	1 megohm, ½ watt, 10% tolerance.
Resistor 36-----	44 megohm, ½ watt, 10% tolerance.
Resistor 42-----	100 ohm, ½ watt, 10% tolerance.
Relay 22-----	1,000 ohm relay, single-pole, single-throw contacts.
Switch 50-----	Single-pole, single-throw switch on gas valve.
Switch 52-----	Single-pole, single-throw, momentary-contact switch on gas valve.
Spark coil 16----	Model-airplane type spark-coil, 140 primary turns, 10,000 secondary turns.

In this specific form of the invention the system provides ignition sparks at a rate of about one every half-second,

and this rate gradually decreases until, after about 15 seconds, it reaches an equilibrium rate of about one pulse every 30 seconds.

While the invention has been described with specific reference to particular embodiments thereof, it will be apparent to those skilled in the art that it may be embodied in many forms differing from that specifically described without departing from the scope of the invention as defined by the appended claims.

We claim:

1. Gas ignition apparatus comprising:
gas burner means;
control means for turning on and off the supply of gas to said burner means;
igniter means disposed adjacent said burner means and responsive to the application thereto of voltage to ignite gas emanating from said burner means;
pulse generating means responsive to each turning on of said supply of gas by said control means to initiate the generation of a series of voltage pulses continuing until the next turning-off of said supply of gas, said pulse generating means including apparatus responsive to each turning-on of said supply of gas automatically to reduce the rate of recurrence of said pulses from an initially relatively higher rate to a predetermined relatively lower rate following each said turning-on; and
means for applying said pulses to said igniter means to ignite gas emanating from said burner.
2. Apparatus in accordance with claim 1, in which said pulse-generating means comprises a relaxation oscillator including a voltage breakdown device having two electrodes, first capacitive means connected between said two electrodes, first resistive means and a source of voltage for charging said first capacitive means by way of said first resistive means, second resistive means in common series circuit with said first capacitive means and said two electrodes, and second capacitive means connected in parallel with said second resistive means when said control means is turned on.
3. Apparatus in accordance with claim 2, comprising means responsive to operation of said control means for discharging said second capacitive means following each turning-off of said supply of gas.
4. Gas burner ignition apparatus comprising:
gas burner means;
control means for turning on and off the supply of gas to said burner means;
igniter means responsive to pulses of voltage applied thereto to generate sparks for igniting gas from said burner;
a relaxation oscillator circuit including a gaseous discharge device having a pair of electrodes and having a low-conduction stable state for voltages of less than a critical value applied between said electrodes and a high-conduction state induced by voltages of greater than said critical value applied between said electrodes, first capacitive means connected between said electrodes, a first resistive element in common series circuit with said first capacitive means and said electrodes of said discharge device, second capacitive means in parallel with said first resistive element, and means for charging said first capacitive means at least to said critical voltage, thereby to produce a pulse of current through said discharge device whenever said first capacitive means attains a charge suf-

- ficient to apply said critical voltage to said electrodes of said discharge device;
- switch means responsive to turning-on of said control means substantially to short-circuit said second capacitive means momentarily and to connect said second capacitive means across said resistive element while said control means is turned on, whereby successive pulses of current through said discharge device produce a charging of said second capacitive means and a resultant decrease in the frequency of said pulses of current, said switch means also being responsive to turning off of said control means to render said relaxation oscillator circuit inoperable; and
- means responsive to the occurrence of successive pulses of current through said discharge device to apply successive pulses of voltage to said igniter means, thereby to generate sparks at a decreasing rate after turning-on of said control means.
5. Gas ignition apparatus comprising:
a gas burner to be ignited;
a gas control means for turning said burner on and off;
spark-electrode means adjacent said burner and responsive to high voltages applied thereto for generating sparks to ignite said burner;
a voltage-amplifying transformer having a primary winding, and having a secondary winding connected to said spark-electrode means;
a first capacitor and a current-operable, normally-open first switch connected in series with said primary winding and said first capacitor for discharging said first capacitor through said primary winding when said switch is closed;
a source of direct voltage and a first resistor in series between said source and said first capacitor for charging said first capacitor when said switch is open;
a relaxation oscillator comprising a voltage breakdown device and a circuit connected across said breakdown device for generating pulses of current through said breakdown device and through said circuit when said device breaks down;
circuit means for applying said current pulses to close said switch momentarily in response to each of said pulses;
a parallel combination including a first resistor and a second capacitor connected in series in said circuit when said burner is turned on; and
means responsive to operation of said gas control for momentarily discharging said second capacitor.
6. Apparatus in accordance with claim 5, in which said last-named means comprises a normally-open momentary-contact switch connected across said second capacitor and responsive to each cycle of turning on and off of said gas control effectively to short-circuit said second capacitor momentarily.

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