United States Patent

[11] 3,614,280

[72] Inventor Yamaguchi, Tamio
Chigasaki, Japan
[21] Appl. No. 886,821
[22] Filed Dec. 22, 1969
[45] Patented Oct. 19, 1971
[73] Assignee Tokyo Gas Company Limited
Tokyo, Japan
[32] Priority Dec. 27, 1968, Jan. 13, 1969
[33] Japan
[31] 43/366 and 44/46562

[54] **IGNITION AND FLAME DETECTION SYSTEM UTILIZING A SINGLE ELECTRODE**
2 Claims, 2 Drawing Figs.

[52] U.S. Cl. 431/25, 431/78, 431/266, 328/6
[51] Int. Cl. F23n
[50] Field of Search 431/25, 78, 266; 328/6

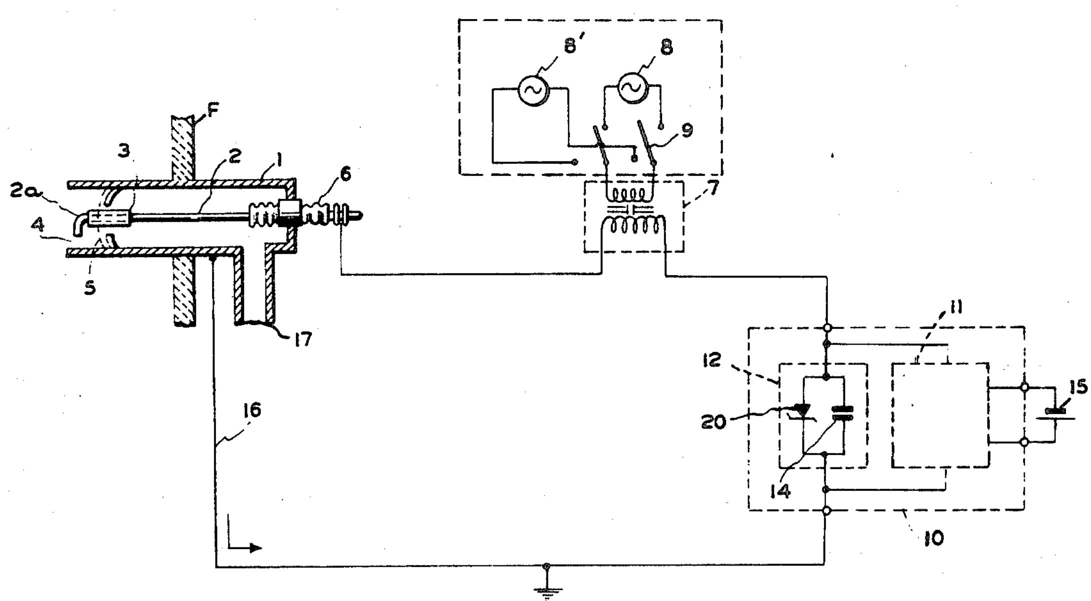
[56] **References Cited**

UNITED STATES PATENTS

2,360,532	10/1944	Yates	328/6
2,996,113	8/1961	Williams	431/266 X
3,002,550	10/1961	Schreter	431/25 X
3,270,799	9/1966	Pinckaers	431/25
3,291,183	12/1966	Fairley	431/78 X

Primary Examiner—Carroll B. Dority, Jr.
Attorney—Wenderoth, Lind & Ponack

ABSTRACT: A single electrode is positioned adjacent a burner in a furnace. A single circuit supplies current to create an arc across the electrode to the burner to ignite the furnace. The same circuit detects a DC current from the electrode to the burner due to the electric conductivity of the flame. The circuit includes means to shunt any AC current from the detector. An insulation material covers the electrode adjacent the arc-creating end to stabilize the DC current.



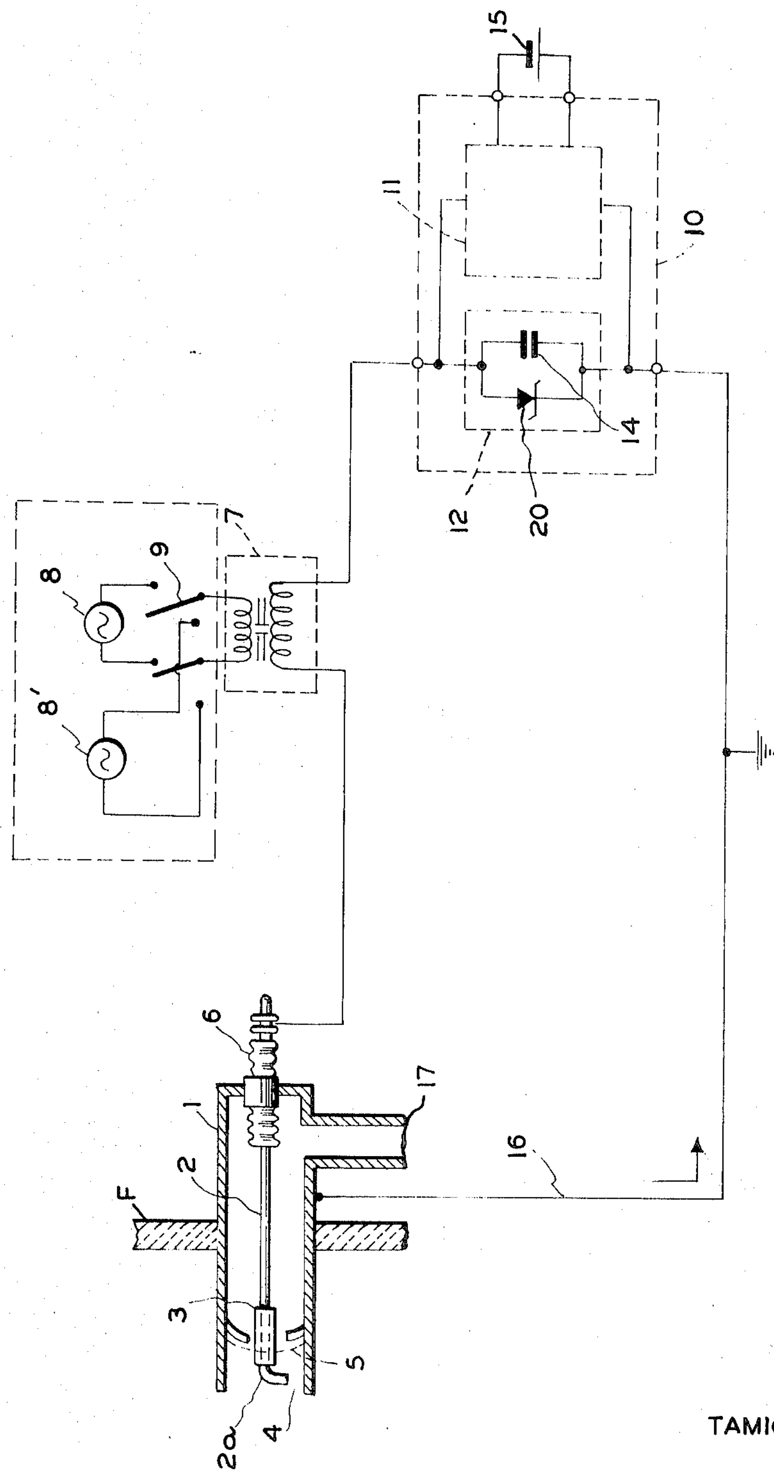


FIG. 1

INVENTOR
TAMIO YAMAGUCHI

BY Wenderoth, Lind & Ponack
ATTORNEYS

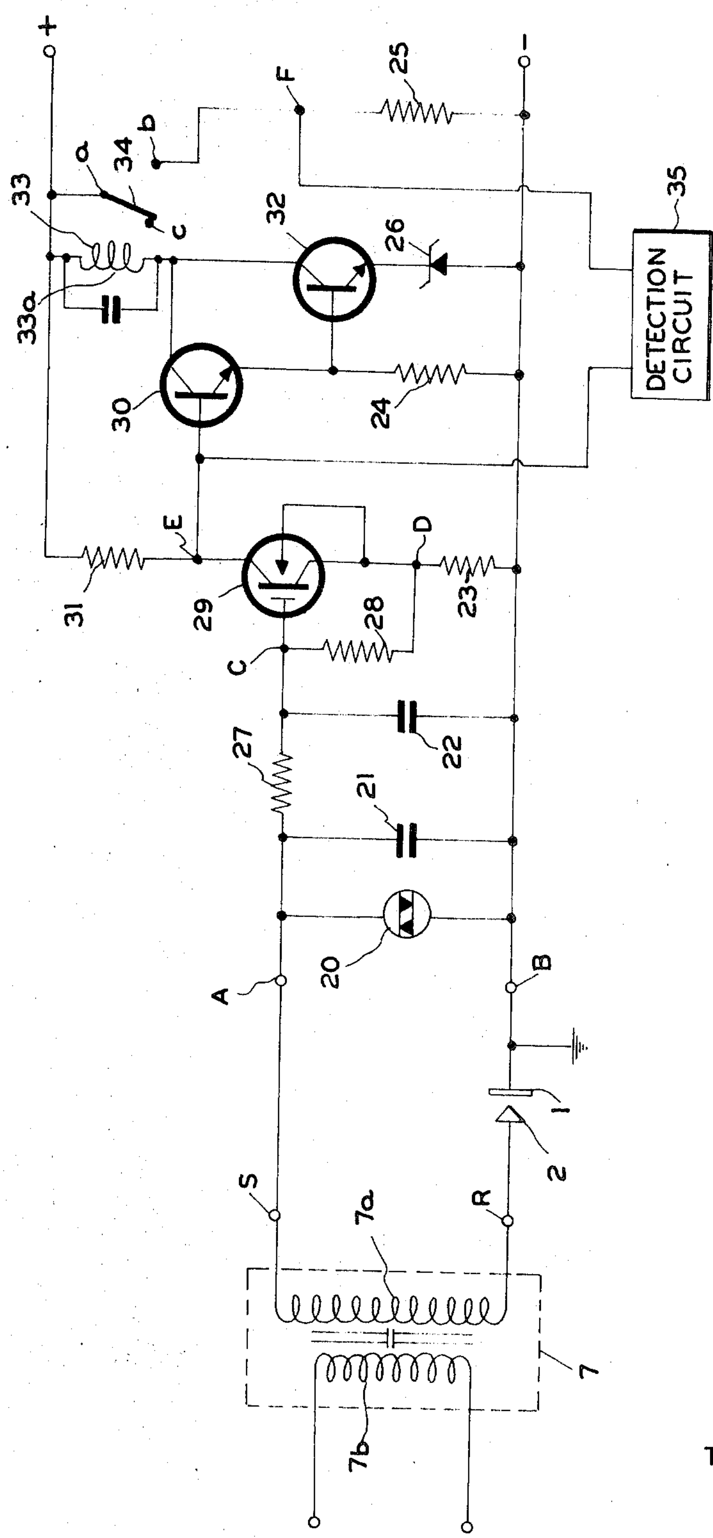


FIG.2

INVENTOR
TAMIO YAMAGUCHI

BY Wenderoth, Lind & Ponack
ATTORNEYS.

IGNITION AND FLAME DETECTION SYSTEM UTILIZING A SINGLE ELECTRODE

BACKGROUND OF THE INVENTION

The present invention relates to a system for igniting the flame in an industrial gas burner, and for detecting whether or not the flame is burning.

More specifically, the present invention relates to a system wherein a single electrode and a single circuit is used both for ignition and for detection.

In industrial furnaces, combustion is created by causing an electrode or a series of electrodes within the furnace to ignite a gaseous fuel. However, for efficient operation, it is necessary in some way to determine whether or not the flame is burning; that is, whether or not the electrode has ignited. To accomplish this result, a number of systems have been used in the past. A typical prior art system employs a detection electrode for each ignition electrode. In addition, each detection electrode requires a separate detection circuit. However, such prior art systems suffer from certain inherent disadvantages. They are expensive to install and expensive to maintain. In addition, they are complex and require a great deal of equipment around and in the furnace wall.

An additional prior art device employs an optical detector to detect whether or not the flame within the furnace exists. However, these optical detectors also require multiple circuits and are extremely expensive and difficult to maintain.

With these disadvantages in mind, it is an object of the present invention to provide a single electrode system wherein both ignition and detection of the flame can be accomplished. Furthermore, the system of the invention contemplates the use of a single circuit for both ignition and detection.

According to the present invention, a single electrode and burner are provided in a furnace. A circuit is provided to supply a high voltage to the electrode to create an arc to ignite the fuel. The circuit also provides means for reducing the current after the ignition has occurred. At this time, the flame, due to its electric conductivity, acts as a current rectifier between the electrode and the burner whereby a small pulsating DC current is provided to the circuit. This DC current is used as the detecting medium. When the DC current ceases, that is when the flame is extinguished, the detection circuit will so indicate. The combined detection and ignition circuit also provides means for insuring that AC current does not reach the detecting unit. A shunting circuit is provided which insures that AC current never reaches the detecting circuit. Also, an insulation material may be provided around the electrode to control the influence of the rectifying function of the flame, to thereby insure a stabilized DC current.

Other features of the invention will be made clear by the following description taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial sectional and partial schematic view of an ignition and detection system in accordance with the present invention; and

FIG. 2 is a schematic view of a modified detection circuit in accordance with the present invention.

Referring now to FIG. 1, a burner 1 fits through a furnace wall F. An electrode 2 is positioned within burner 1. The exterior end of electrode 2 extends through burner 1 and is insulated therefrom by insulator 6. The other end 2*a* of electrode 2 is positioned to form an arc across gap 4 with burner 1 to ignite the furnace.

Insulation material 3 may cover the electrode 2 in the area of end 2*a*, namely in the vicinity indicated by the dotted line 5. This insulation material completely surrounds the electrode 2 and provides a desirable feature in the present invention in which both the ignition and detection of the flame is accomplished by the use of a single electrode. The ionization of the fuel at the start of combustion in the burner gap in the region near the ear shown by the dotted line 5, i.e. wherein the gas/air fuel mixture starts combustion, is extremely complicated. An electrical charge distribution may exert an unstable potential influence upon the electrode 2 and burner 1. If this occurs, the insulation material 3 may be provided to tend to alleviate this undesirable influence and stabilize the passage of a small DC current through the flame due to the electrical conductivity of the flame (i.e. its rectifying ability).

The creation of this small DC current when a flame exists is the basis of the flame detection of the present invention.

An ignition transformer 7 includes a switch 9. Through switch 9, a normal power source 8 for ignition can be switched to a detecting low-voltage source 8′, by means of a solid-state timer mechanism (not shown). 8, 8′ and 9 may comprise a solid-state circuit for controlling voltage. The reference 10 indicates an ignition detection circuit consisting of a transistorized detector circuit 11 and a discharge current bypass circuit 12. 20 and 14 are respectively a zener diode and a capacitor incorporated into the discharge current bypass circuit 12, and 15 is a DC power source for the detector circuit 11.

In the circuit as described above during the ignition operation, the primary winding of the ignition transformer 7 is connected to the normal AC power source 8, for example 100 or 200 v. whereby a high voltage is induced in the secondary winding to effect a spark discharge. This spark discharge is formed in the gap 4 between the burner 1 and end 2*a* of electrode 2. At the same time, the gas/air fuel mixture is introduced into burner 1 from a fuel inlet 17, whereby the fuel is ignited.

In this operation, the AC discharge current is much greater than the small DC current produced during the detection operation. If this AC current flows directly to the transistorized detector circuit 11 of the ignition detector circuit 10, the circuit elements may be damaged. To avoid this, the AC current is caused to pass through discharge current bypass circuit 12 consisting of a limitor 20 (alternative silicone diode varistor limitor) and a capacitor 14. In practice, most of the AC current passes through the capacitor 14. If, for some reason, an excessively high voltage is applied to the detector circuit 11, the circuit is protected from such high voltage by the limitor 20. Thus by means of the bypass circuit 12, the discharge current is allowed to flow therein to effect ignition without damaging the transistorized detector circuit 11.

The detection operation will now be explained. The primary winding of the ignition transformer 7 is switched from the normal ignition power source 8 to the low-voltage detection source 8′. After this switching, the voltage in the secondary winding of the ignition transformer 7 is approximately one-thirtieth to one-fiftieth of the voltage produced at start of discharge. When flame is present, a small DC current flows through gap 4 from the electrode 2 to the burner 1 due to the electrical conductivity of the flame (i.e. the rectifying ability of the flame). This small DC current flows through line 16 as shown by the arrow to the transistorized detector circuit 11. Virtually none of this DC current flows through bypass circuit 12. This small current is then amplified to operate a built-in detection contact (not shown). If the flame is extinguished for some reason, the detection contact is opened to actuate a safety device or an alarm device which has an electrical connection with the detection contact.

According to the invention as above described, ignition is effected by the use of a single electrode inserted into the burner and the existence of the flame is detected by the same electrode. Also, according to this invention, the construction of the burner and of the furnace wall around the burner is simplified, and thus maintenance is simplified. In addition, the ignition detection system can be of a very compact construction. Thus, it is possible to facilitate control of combustion and to secure safety and low cost of operation.

Referring now to FIG. 2, a modified form of the detection system of the present invention will be described. Ignition transformer 7 has the high-voltage terminal R of the secondary winding 7*a* connected to electrode 2. Burner 1 is disposed in a furnace and faces electrode 2 as explained above with reference to FIG. 1. Burner 1 is grounded by way of the burner body and then connected to limitor 20 and capacitors 21 and 22 at their one ends via a connection terminal B. The burner is further connected to one end of resistors 23, 24, 25 and of a zener diode 26, and thence to the negative side of a DC power source. The other terminal of secondary winding 7*a* of ignition transformer 7 is connected to the other ends of the limitor 20 and capacitor 21 and to one end of a resistor 27. The other end of resistor 27 is connected to capacitor 22, a resistor 28 and the gate terminal of a field effect transistor 29 (hereinafter referred to as FET). The other end of resistor 28 is connected to the other end of resistor 23 and to the source terminal of the FET. The drain terminal of the FET is connected to the base terminal E of a middle stage transistor 30 and then to the positive side of the DC power source by way of a resistor 31. The collector terminal of the transistor 30 is connected to the positive side of the power source by way of the collector terminal of a last-stage transistor 32 and through a coil 33*a* of a small electromagnetic relay 33 which serves as a load. The emitter terminal of middle-stage transistor 30 is connected to the other end of the resistor 24 and to the base terminal of the last-stage transistor 32. The emitter terminal of the last-stage transistor 32 is connected to the other end of the zener diode 26. The middle- and last-stage transistors constitute a Darlington Circuit for increasing the current gain. The terminal a of an armature 34 of the electromagnetic relay 33 is connected to the positive side of the DC power source. The terminal *b* of the armature 34 is connected to the resistor 25 and also to one of the input terminals of misoperation detecting logic circuit 35. The other input terminal of the logic circuit 35 is connected to terminal E.

The ignition detector circuit thus described consists chiefly of three parts: a bypass and smoothing circuit, an amplifier circuit composed of the three transistors, and a misoperation detecting logic circuit. The major parts of the circuit of this invention will be more specifically explained below. The limitor 20 is a voltage limiter for maintaining the voltage across the input terminals A and B below a certain value. Thus, the main circuit is protected against excessive voltage. The capacitors 21 and 22 and the resistors 27 perform two functions: first, to operate as an AC bypass circuit during spark discharge at ignition and in the event of an abnormal short circuit which may occur across electrode 2 and burner 1; and second, to smooth the pulsating DC current flowing between terminals A and B as the result of a normal flame. The resistor 28 has a high resistance and is used in the gate circuit of the FET 29 for the purpose of ignition detection. The limitor 20 and zener diode 26 operate as a temperature compensator to maintain the ignition detector circuit normal even when the circuit is exposed to high temperatures. Resistor 25 supplies the point F with a potential when the armature 34 is in the detection position, i.e. when the armature 34 moves from the terminal *c* to the terminal *b*. The potentials at points F and E are applied to logic circuit 35, whereby misoperation of the detector circuit is self-detected.

The operation of the ignition detector circuit of this embodiment of the invention will now be explained. During the ignition operation, the proper voltage for generating a discharge is applied to the primary winding 7*b* of the ignition transformer 7 to thereby produce a high voltage in the secondary winding 7*a*. This high voltage is applied to the gap between electrode 2 and burner 1 by way of high-voltage terminal R and ground terminal B through the terminal S and the elements of the bypass circuit. Thus, a spark occurs across the gap. The resultant discharge serves to ignite the gaseous fuel. The current flowing during this discharge is AC. Resistor 28 has a much higher resistance than resistor 27, and a greater impedance than capacitors 21 and 22 against an AC component of current. Accordingly the above-mentioned AC current does not flow in the detector circuit but is shunted to the series circuit consisting of the capacitor 21 and resistor 27 of the bypass circuit, and to the parallel circuit consisting of the capacitor 21 and limitor 20. As a result, the detector circuit is not operable and the voltage across the terminals A and B is maintained below a certain value by limitor 20.

The ignition operation will continue for several seconds. Then, the voltage applied to the primary winding 7*b* of the ignition transformer 7 is switched to a low-power source of several volts. Then the detection operation starts. During this operation, the ignition transformer 7 serves as a detecting power transformer. The secondary voltage of the transformer is reduced to approximately one-thirtieth to one-fiftieth of the voltage produced during ignition. When the fuel is perfectly fired and normal flame has been formed, the flame acts to rectify the AC voltage existing in the plane between the electrode 2 and the burner 1. Thus, a small amount of current flows from the electrode to the burner but only during the half cycle in which the electrode 2 possesses a higher potential than the burner 1. Thus, a pulsating DC current is formed. The pulsating DC voltage produced across the terminals A and B by the pulsating DC current is stabilized by the smoothing circuit consisting of the capacitors 21 and 22 and resistor 27 and is then applied across the detecting terminals C and B. Specifically, the DC current flows not through the capacitors but through the resistors 23 and 28 of the detector circuit. Whenever the voltage across the terminals A and B exceeds a certain value the excess current will flow in the voltage limiter circuit. By the foregoing smoothing function, the detecting operation is stabilized.

During the ignition, the large AC ignition current, for example 20 m. is shunted to the bypass circuit. Likewise, assuming a short circuit occurs across electrode 2 and burner 1 during ignition or during detection, the resultant AC current would be shunted by the bypass circuit. Thus, the only current component which is detected is the DC current which results from the rectifying ability of the flame. As a result, the system is operable to detect only the existence of a normal flame.

These results are obtainable due to the limitor 20 which operates as a limiter and by the multifunctional circuit including the capacitors 21 and 22 and resistor 27 and the terminals B and C. This circuit operates to smooth the pulsating DC component and to bypass the AC component to the current. A certain voltage which is determined by the rating of the limitor 20 is produced between the input terminals A and B during both normal detection and abnormal short circuiting at the electrode. This voltage takes the form of pulsating DC during normal detection, and of AC during spark discharge of electrode short circuit. Without taking the varistor 20 into consideration, AC current flows through the parallel circuit consisting of a capacitor 21, resistor 27 and capacitor 22, serially connected and DC current flows through the series circuit consisting of resistors 23, 28 and 27. When an AC voltage appears across the terminals A and B, this voltage is divided and applied to resistor 27 and capacitor 22. If the impedance of resistor 27 is larger than that of capacitor 22, most of the voltage is across resistor 27, and only a very limited amount is across detecting terminals C and B. As a result, there is no significant potential difference produced between the terminals C and D even during the half period in which the FET 29 would be operative. Thus, the FET is made inoperative, and the circuit is not in operation for detection. However, when DC current flows through the circuit a voltage is applied across the detecting gate circuit resistor 28, and a sufficient potential difference is produced to operate the FET 29. Thus the detecting circuit is operable. Therefore, the resistor 27, in combination with the capacitors 21 and 22, has the function of smoothing the pulsating DC component, and also the function of bypassing the AC component, as described previously. A further important function of the resistor 27 is to discriminate between DC and AC components to maintain the circuit inoperative for the detection of all current components except the pulsating DC component produced by normal flame.

In addition to the above-described important advantages of this system, other advantages are obtainable. For instance, it is possible that certain of the elements, such as limitor 20 transistors 29, 30, 32 and diode 26, may fail and become entirely conducting. However, as will be evident, any such failure will not endanger the detecting circuit. For example, assume that limitor 20 should fail. In such event, the potential at the terminal A becomes equal to that at the terminal B and, as a result, no input voltage is applied across the detecting terminals C and D and the FET 29 is kept inoperative.

Although preferred embodiments of the invention have been described in detail, such description is intended to be illustrative only, and not restrictive, since many details of the construction of the invention may be altered or modified without departing from the spirit or scope of the invention.

What is claimed is:

1. A furnace ignition and flame detection system comprising a burner mounted in the wall of the furnace; means for supplying fuel to said burner; an electrode positioned adjacent said burner; transformer means connected in series with said electrode for supplying AC current at a high voltage to said electrode to create an arc between said electrode and said burner and thus ignite said fuel, said transformer means adapted to reduce said voltage to a level below that sufficient to create said arc after the ignition of said fuel; said electrode and said burner adapted to have a pulsating DC current flow therebetween due to the electric conductivity of said flame only when said fuel is ignited; a transistorized flame detection means connected in series with said burner and said transformer means for detecting the absence of said pulsating DC current when said flame is not present; and bypass circuit means connected in parallel with said detection means for preventing said AC current from flowing to said detection means.

2. A system as claimed in claim 1, wherein said transistorized flame detection means comprises a plurality of transistors, and said bypass circuit means comprises a varistor and a plurality of capacitors connected in parallel and a resistor connected in series with said capacitors.