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Ikegami et al.

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[45] **Sept. 17, 1974**

[54] **FLAME DETECTOR**

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[52] **U.S. Cl.** **328/6,** 307/310, 307/311, 328/2, 340/228.1

[51] **Int. Cl.** **H03k 3/26,** G01n 27/00

[58] **Field of Search** 328/6, 5, 1; 340/228.1; 315/53; 451/15, 25; 307/310, 311

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Assistant Examiner—B. P. Davis
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

A flame detector wherein a pair of diodes are connected in series with opposite directions of conduction across the respective terminals of an AC power source, and a light emitting device, such as a discharge tube, is connected between the point of connection of the two diodes and a flame rod disposed in a flame to be detected. With this construction, a predetermined voltage is applied between a burner and the flame rod, whichever side of the AC power source is grounded.

6 Claims, 4 Drawing Figures

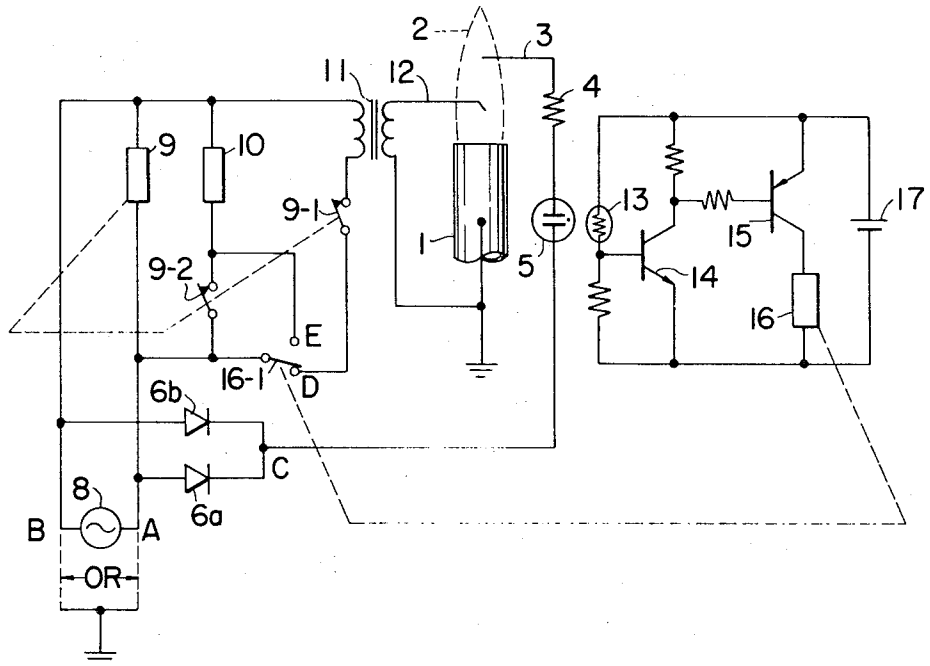


FIG. 1

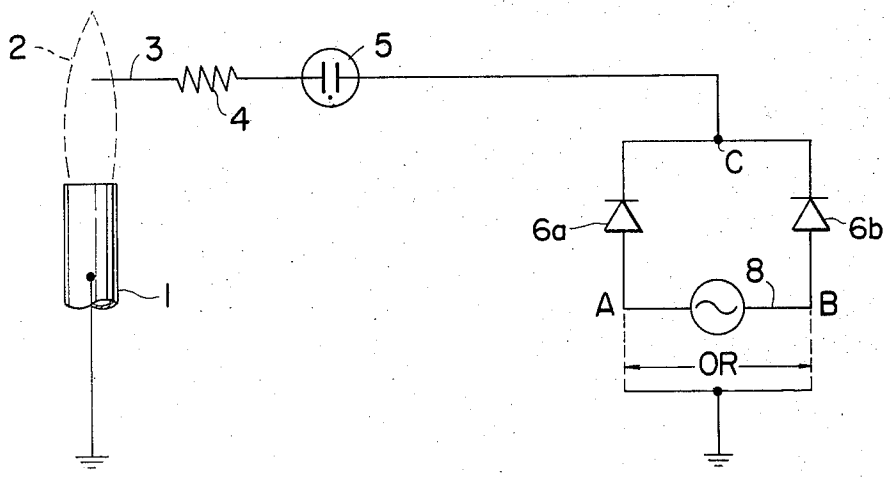

2
3
4
5
1
C
6a
6b
8
A
B
OR

FIG. 2

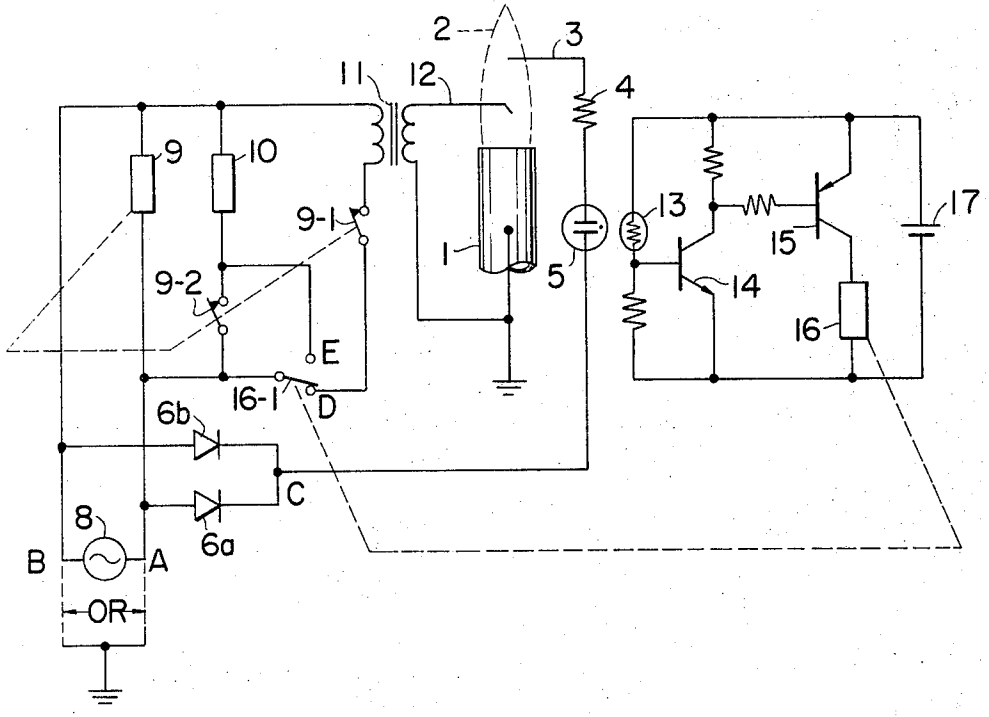

2
3
4
11
12
9
10
9-1
9-2
E
16-1
D
1
5
13
14
15
16
17
6b
6a
C
8
B
A
OR

FIG. 3

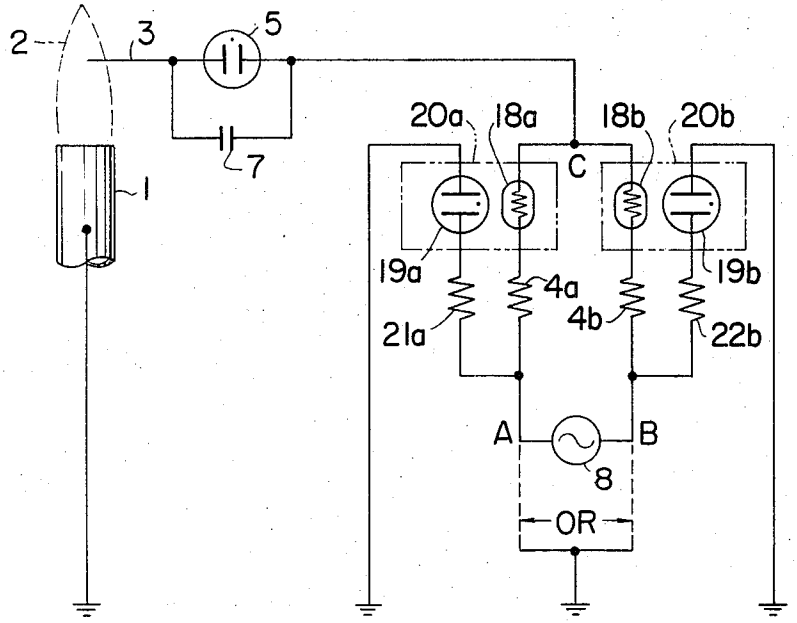
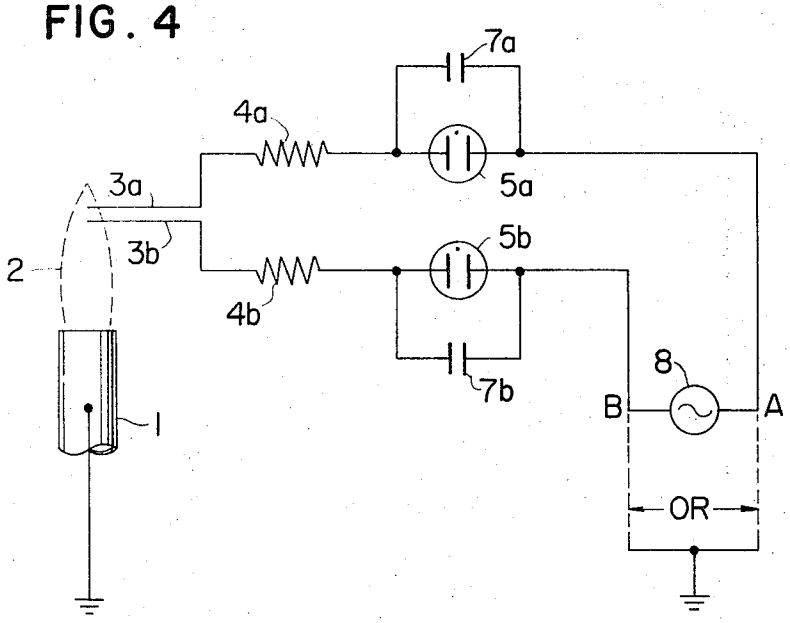

2
3
5
7
1
20a
18a
18b
20b
C
19a
19b
4a
4b
21a
22b
A
B
8
OR

FIG. 4


7a
4a
5a
3a
3b
2
5b
4b
7b
8
B
A
1
OR

FLAME DETECTOR

BACKGROUND OF THE INVENTION

The present invention relates to a detector for flames, and more particularly to a flame detector in which a light emitting device, such as a discharge tube or a luminescent diode, is turned on and off in response to the presence and absence of a flame.

In general, a flame detector exploiting the electric conductibility or rectification action of a flame detects the presence of the flame in such way that a voltage of several hundreds volts is applied between a flame rod provided within the flame and a burner, a minute current caused to flow via the flame between the flame rod and the burner is amplified by an amplifier circuit of high input impedance which employs a field-effect transistor or the like, or a light emitting device, such as a neon tube, is caused to emit light by the use of the minute current, and a photoconductive device (such as a cadmium sulfide cell) is rendered operative by the emitted light. As a power source for such a detector, the usual commercial power supply can be directly used. Since, however, one terminal of the commercial power supply is generally grounded and a non-polarized type is often employed for a power plug socket, an inconvenience results in that no voltage is applied in one of the directions in which the plug socket is inserted in the power outlet (because the burner is generally grounded). For this reason, in the prior art, the voltage to be applied between the flame rod and the burner must be supplied through a transformer from the power source. The transformer isolates the primary and secondary sides in a DC sense, so that even when one of the primary side terminals is grounded, a voltage on the secondary side floats from ground. An appropriate voltage is accordingly applied between the flame rod and the burner irrespective of the direction in which the power plug socket is inserted in the power outlet.

The provision of the transformer as stated above, however, has the disadvantages of making the flame detector large in volume, as well as in weight, and high in cost.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide a novel flame detector which is free from the disadvantages of the prior art as mentioned above.

Another object of the present invention is to provide a flame detector which is constructed such that both terminals of a power source are connected to one terminal of a light emitting device through respective diodes, while the other terminal of the light emitting device is connected to a flame rod.

Another object of the present invention is to provide a flame detector which employs a composite element comprising a light emitting element and a photoconductive element integrally coupled, thereby to make the previously required power transformer unnecessary.

Still another object of the present invention is to provide a flame detector which is constructed such that two flame rods are disposed in a flame, and that one of the terminals of a power source is connected through the first light emitting device to one of the flame rods, while the other terminal of the power source is connected through the second light emitting device to the other flame rod.

The other objects, features, and advantages will be apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuit diagram showing an embodiment of a flame detector of the present invention;

FIG. 2 is a circuit diagram showing an example of a flame detecting and control apparatus to which the flame detector of the present invention is applied; and

FIGS. 3 and 4 are circuit diagrams each showing other embodiments of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 showing an embodiment of the present invention, numeral **8** designates an AC power source which is grounded at either of the terminals A or B ("OR" in the figure signifies that either terminal is grounded). Diodes **6***a* and **6***b* are connected in series with opposite directions of conduction across the respective terminals of the AC power source. A voltage is therefor provided at the juncture C between the diodes. Accordingly, whichever terminal A or B is grounded, the rectified voltage of the AC power source **8** is obtained at the point C through the diode connected to the terminal which is not grounded. Through a detecting device **5**, the voltage is applied between a flame rod or detecting electrode **3** and a burner **1**, which is grounded. A current flows between the burner **1** and the flame rod **3** via a flame **2**. The detecting device **5** is thereby rendered operative (in the embodiment in FIG. **1**, a discharge tube is lit). Thus, the presence of the flame **2** is detected. A protective resistance **4** is provided for the case where the burner **1** and the flame rod **3** erroneously come into contact.

FIG. **2** is a circuit diagram of flame detecting and control apparatus which makes use of the flame detector of the present invention. Referring to the figure, in case of ignition, a power switch (not shown) is first turned on to connect the power source **8**. Upon connection of the power source **8**, a timer **9** is actuated. Contacts **9 – 1** and **9 – 2** of the timer **9** are so set as to initially turn on and to turn off after a fixed time. Accordingly, the power source **8** is connected through the contact **9 – 2** to a coil **10** of a standard magnet valve (not shown), the magnet valve is opened, and a gas is ejected from the burner **1**. Since a transfer contact **16 – 1** of a relay **16** is connected on the side D at this time, the voltage of the power source **8** is applied onto the primary side of a high-tension transformer for ignition **11**. A high voltage is induced on the secondary side of the transformer **11**, to give rise to a spark discharge between a discharge electrode for ignition **12** and the burner **1**. The gas is thereby ignited. In the case where the ignition fails for any cause, the opening of the contacts **9 – 1** and **9 – 2** of the timer **9** after a fixed time will close the magnet valve to stop the gas and to arrest the spark discharge. Whichever terminal A or B of the power source **8** is grounded, the rectified voltage is produced at the point C through the diode **6a** or **6b**, connected to the other terminal which is not grounded. The voltage is applied through the discharge tube **5** be-

tween the flame rod 3 and the grounded burner 1. Therefore, in the case where the ignition is normally effected with no misfiring, the current flows via the flame 2 between the flame rod 3 and the burner 1, to light the discharge tube 5. The resistance of a cadmium sulfide cell 13 is thereby decreased, transistors 14 and 15 are brought from the "off" state into the "on" state, and the relay 16 is energized.

The changeover contact 16 – 1 of the relay 16 is so set as to be connected to the side D for the "off" state of the transistor 15 and to the side E for the "on" state. Accordingly, when the ignition is normally effected and the relay 16 is energized, the primary side of the igniting high-tension transformer 11 turns off to stop the discharge. If the burning is normally carried out, the current continually flows via the flame 2 between the burner 1 and the flame rod 3, to keep the relay 16 energized. On the other hand, the contacts 9 – 1 and 9 – 2 of the timer 9 are opened by the operation of the timer after a fixed time, as has been previously stated. In this case, the magnet valve coil 10 is connected to the power source 8 by the contact 16 – 1 of the relay 16, so that the burning is continued.

In the case where the flame is extinguished by any cause during the burning, the current between the flame rod 3 and the burner 1 vanishes. The illumination of the discharge tube 5 is therefore put out to turn off the transistor 15, with the result that the contact 16 – 1 of the relay 16 is reset onto the side D. Accordingly, since the timer 9 has already caused switch 9 – 2 to open, the magnet valve coil 10 is deenergized, the solenoid valve is closed, and the gas supply is stopped. Reference numeral 17 in FIG. 2 indicates a power source for operating the transistors 14 and 15 and the relay 16.

FIG. 3 is a circuit diagram showing another embodiment of the present invention, which permits elimination of the rectifiers 6a and 6b. Numeral 8 designates an AC power source which is grounded at either of the terminals A or B ("OR" in the figure signifies that either one is grounded). Composite elements 20*a* and 20*b*, the former comprising a light emitting element 19*a* and a photoconductive element 18*a* and the latter comprising a light emitting element 19*b* and a photoconductive element 18*b*, are connected across the respective terminals of the AC power source 8. Each of the light emitting elements 19*a* and 19*b* is grounded at one end, while the output ends of the photoconductive elements 18*a* and 18*b* are connected together at a point C. Accordingly, whichever terminal A or B is grounded, an AC voltage from the power source 8 is obtained at the point C in such a manner that the light emitting element in the composite element connected to the terminal which is not grounded emits light to thereby bring the photoconductive element in the identical composite element into the conductive state. In that case, the light emitting element in the composite element connected to the terminal on the ground side has no voltage applied thereto, and does not emit light. Accordingly, the photoconductive element in the identical composite element exhibits a very high resistance, and is in the nonconductive state.

When the voltage is applied through a detecting element 5 between a detecting electrode or flame rod 3 and a grounded burner 1, a current is permitted to flow via a flame 2 between the flame rod 3 and the burner 1. The detecting element 5 is thereby rendered operative (in FIG. 3, a discharge tube is lit). Thus, the presence of the flame 2 is detected.

A capacitor 7 connected in parallel with the detecting element 5 is effective in the case where the rectification action of the flame is utilized. When the impedance of the capacitor 7 is made sufficiently low as compared with the resistances of the protective resistors 4*a*, 4*b*, 21*a*, and 21*b*, the capacitor constitutes a bypass circuit for AC components. Therefore, in the case where an AC current flows through the detecting circuit (in such case where the flame rod is erroneously grounded), the detecting device 5 does not operate. The detecting device 5 is rendered operative only by the DC component which is produced by the rectifying action of the flame. It is accordingly possible to prevent the detecting device from erroneously operating at such undesirable conditions as grounding of the flame rod.

FIG. 4 shows a further embodiment of the present invention wherein rectifiers are not required. Referring to the figure, numeral 8 represents an AC power source which is grounded at either of the terminals A or B ("OR" in the figure means that either one is grounded). A first circuit in which a detecting electrode or flame rod 3*a*, protective resistance 4*a*, and a detecting device 5a are connected in series, and a second circuit in which a detecting electrode or flame rod 3*b*, protective resistance 4*b*, and a detecting device 5*b* are connected in series, are connected across the respective terminals of the power source 8.

Accordingly, depending on which terminal A or B is grounded, the voltage of the power source 8 is applied between the flame rod 3*a* or 3*b* connected to the terminal not grounded and the grounded burner 1. A current is accordingly caused to flow via the flame 2 between the flame rod 3*a* or 3*b* and the burner 1, so that the corresponding detecting device 5*a* or 5*b* is made operative (in FIG. 4, a discharge tube is lit). In this way, the presence of the flame 2 is detected. A capacitor 7*a* or 7*b* connected in parallel with the detecting device 5*a* or 5*b* serves as bypass components for AC components, as described in connection with the embodiment of FIG. 3. Owing to the bypass circuit, in the case where an AC current flows through the detecting circuit (in such case where the flame rod is erroneously grounded), the detecting device is not operated. The detecting device is operated only by the DC component which is created by the rectifying action of the flame. It is accordingly possible to prevent the detecting device from damage which might result from grounding of the flame rod.

While the embodiments of FIGS. 3 and 4 are described in the absence of control circuitry to control the starting and continuing operation of the burner, it should be understood that these embodiments may be used with the control apparatus formed by elements 9 through 17 in FIG. 2 or any other suitable control apparatus.

As described above, the present invention makes it possible to use the usual commercial power supply as the power source of the detecting circuit without employing a power transformer for the detector circuit. The flame detector of the present invention accordingly has the advantages of being light in weight, low in cost and capable of reliably detecting a flame by exploiting the electric conductibility or the rectifying property induced between the flame rod and the burner by the presence of the flame. It can be utilized in a vari-

ety of equipment, such as an oil burner, heavy oil combustion equipment, an instantaneous water boiler and a gas bath, for example.

What is claimed is:

1. A flame detector comprising a grounded burner, a flame rod disposed at a place at which a flame from the burner is to exist, first and second non-linear impedance means each presenting a low impedance when a voltage is applied thereto and exhibiting a high impedance when no voltage is applied thereo, an AC power source having one of its terminals grounded, one of said terminals of said power source being connected to one terminal of said first non-linear impedance means and the other terminal thereof being connected to one terminal of said second non-linear impedance means, and a light emitting device for emitting light in response to the presence to the flame, one of the electrodes of said light emitting device being connected to said flame rod and the other electrode being connected in common to the other terminal of each of said first and second non-linear impedance means.

2. The flame detector according to claim **1**, wherein each of said first and second non-linear impedance means comprises a diode.

3. The flame detector according to claim **1**, wherein each of said first and second non-linear impedance means comprises a non-linear photoconductive element having a high resistance when not irradiated by light and presenting a low resistance when irradiated by light, and a light emitting element formed integrally therewith, said light emitting element being connected between one terminal of said AC power source and ground, said photoconductive element being connected between said one terminal of said AC power source and said light emitting device.

4. The flame detector according to claim **3**, wherein a capacitor for bypassing AC signal components is connected across the terminals of said light emitting device.

5. A flame detector comprising a grounded burner, first and second flame rods disposed at a place at which a flame from the burner is to exist, an AC power source one of its terminals grounded, and first and second light emitting devices for emitting light in response to the presence of the flame, said first light emitting device being connected between said first flame rod and one of the terminals of said AC power source, said second light emitting device being connected between said second flame rod and the other terminal of said AC power source.

6. The flame detector according to claim **5**, wherein an individual capacitor for bypassing AC signal components is connected across both terminals of, and in parallel with, each light emitting device.

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