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NAOYA ONO ETAL

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DEVICE FOR DETECTING BURNER FLAME

Filed May 17, 1965

FIG. 1

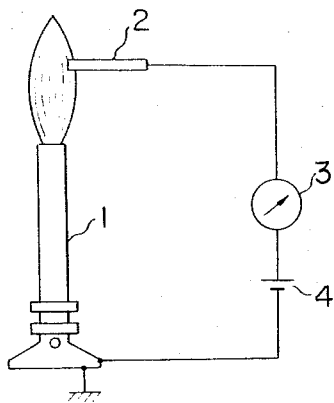


FIG. 2

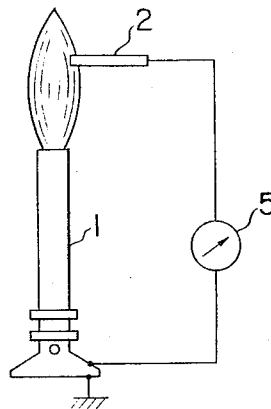


FIG. 3

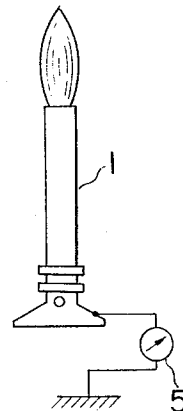
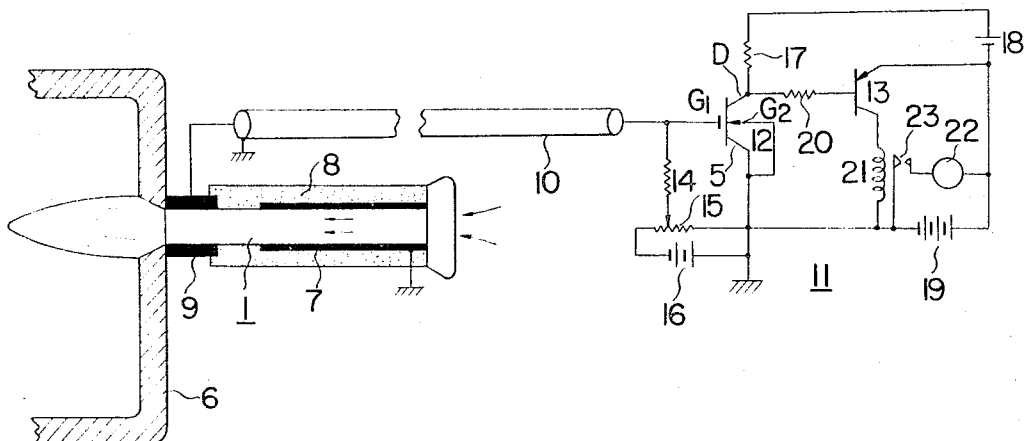


FIG. 4



INVENTOR
Naoya Ono
BY Junzo Haraguchi
Kazuo Takasugi
H. Edward Mestern

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DEVICE FOR DETECTING BURNER FLAME

Naoya Ono, Kodaira-shi, and Junzo Haraguchi and Jazuo Takasugi, Tokyo-to, Japan, assignors to Kabushiki Kaisha Hitachi Seisakusho, Tokyo-to, Japan, a joint-stock company of Japan

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1 Claim. (Cl. 158—28)

This invention relates to burners and control of their flames and to devices for detecting the states of burner flames. More specifically, the invention concerns a new burner flame detecting device capable of detecting and indicating the presence and absence of a burner flame without the use of a sensor inserted into the flame.

In general, in the control of combustion in apparatus such as an industrial furnace, it is necessary to determine from the outside whether or not each of the numerous burners installed at the furnace wall are lit. For this purpose, various devices have heretofore been proposed but have been accompanied by certain disadvantages as will be described more fully hereinafter.

It is a general object of the present invention to overcome these disadvantages of prior devices.

Briefly stated, the present invention provides a device for detecting the state of a burner flames, said device comprising at least one metal part of the burner, said metal part being electrically insulated from the ground and means to detect and indicate the potential difference between said metal part and the ground thereby to indicate the presence and absence of the burner flame in response to the magnitude of said potential difference.

The nature, principle, and details of the invention will be more clearly apparent from the following detailed description, taken in conjunction with the accompanying drawing in which like parts are designated by like reference characters, and in which:

FIGS. 1 and 2 are simplified schematic diagrams indicating the principles of examples of known devices;

FIG. 3 is a simplified schematic diagram indicating the principle of the device according to the invention; and

FIG. 4 is a schematic circuit diagram indicating the essential composition and arrangement of a preferred embodiment of the invention.

Referring to FIG. 1, the example of a known device shown therein comprises essentially a burner 1 made of an electrically conductive material, an electrode 2 disposed at a position where the flame of the burner 1 should exist, a direct-current power source 4 connected between the burner 1 and the electrode 2, and an ammeter 3 connected in series with the source 4 to measure the current flowing through between the burner 1 and the electrode 2. By this arrangement, the presence or absence of the flame can be detected from the reading of the ammeter 3.

That is, in the case where there is no flame, the electrical resistance between the burner 1 and the electrode 2 is of a value approaching infinity, and no current flows. In the case when a flame exists, the resistance between burner 1 and electrode 2 becomes considerably low since a part of the gases is ionized because of combustion, and current flows through the closed circuit of burner 1→electrode 2→power source 4. Thus, the presence or absence of the combustion flame can be detected from the indication of the ammeter 3.

In addition to this method of utilizing the combustion flame as an electrical resistance material, there has been proposed a method wherein the combustion flame itself is considered as an A-C. or a D-C. power source, and the potential produced within the flame is let out and meas-

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ured. This method is based on the discovery that a part of the gases related to the combustion are caused by the combustion to assume a molecularly activated state, and a potential difference of extremely low magnitude is produced between the electrode disposed within the combustion flame and burner. This phenomenon can be utilized by an even simpler device of an arrangement as indicated in FIG. 2, in which a voltmeter 5 is merely connected between an electrode 2 in the flame and the burner 1.

In both of the above described methods, since it is necessary to insert an electrode directly into a flame in a state of high temperature, the electrode is subject to damage, and numerous problems unavoidably arise in the case when the device is to be used over a long period. Furthermore, as a practical problem, the provision of electrodes within a furnace to correspond to every burner in the furnace wall gives rise to constructional complications, and the maintenance of the electrodes also becomes difficult.

The present invention contemplates overcoming the above described difficulties and providing a device whereby the presence or absence of such a combustion flame can be detected without an electrode or other sensor being inserted in the flame.

The method inserting an electrode into a flame to lead out voltage is based on the observation that the combustion flame itself has the property of being equivalent to a voltage source. According to this way of thinking, the device must always be so arranged that this combustion flames becomes a part of an electrical closed circuit.

According to the results of our experimental study, however, it has become apparent that, when the burner is electrically insulated from ground, and the flame is not permitted to contact any material object other than the burner nozzle, a voltage is produced between the burner in the state of combustion and the ground.

The exact reason for this phenomenon is not yet clear, but it may be surmised that ionic reaction accompanying ionization of the fuel progresses in space to establish a charge distribution such as to impart a certain potential to the burner. However, from the fact that an electrode is not inserted into the flame so as to cause the combustion flame to become a part of the electrical closed circuit for measurement as in the aforementioned known method, this phenomenon may be considered at least to be based on a principle which is completely different and apart from that of the conventional way of thinking.

The nature of the present invention, which is based on the above described phenomenon, will be apparent from the following results of experiments carried out with the use of a device as described hereinbelow. In principle, the device as shown in FIG. 3 comprises essentially a voltmeter 5 connected between a burner 1 electrically insulated from the ground and the ground to measure the voltage therebetween.

In the actual device used in the experiments, the extreme end, that is, the nozzle, of the burner was electrically insulated by means of Teflon from the other parts of the burner, and the voltage between the nozzle and the ground was measured. The bore of the burner was approximately 15 mm., and the nozzle length was 30 mm. The space surrounding the combustion flame was selected to measure 500 x 1200 x 1200 mm. in size and was enclosed by refractory bricks. The above-mentioned voltage was measured after amplification by means of a direct-current amplifier with an input impedance of the order of 10¹⁰ ohms and a gain of approximately 50 times.

The resulting measured voltage was approximately 1 volt, from which it is apparent that the voltage as converted to that on the input side of the amplifier, that is, the voltage which was actually generated directly between the nozzle and the ground, was of the order of

20 mv. This electromotive force promptly became zero when the combustion flame was extinguished. It was confirmed further that this electromotive force was maintained at a substantially constant value irrespective of the length of the flame.

Furthermore, it had been found that, while a voltage of the same order as mentioned above is produced also in the case when the space surrounding the flame is not enclosed by a refractory brick structure, this voltage is relatively unstable with respect to external conditions, having a tendency, for example, of becoming unstable when a human body approaches the flame. The reason for this is considered to be that the distribution of ions produced by the combustion is disturbed by the foreign body. In actual practice, however, this instability presents no problem since the combustion flame is ordinarily enclosed by some kind of thermally insulating structure. Furthermore, even in the case when such a preinstalled enclosure is not provided, the generated voltage can be stabilized very easily by shielding by means of an insulator.

The present invention has been reduced to practice on the basis of the above described experiments and considerations as described hereinbelow with respect to a preferred embodiment of the invention.

Referring to FIG. 4, reference numeral 1 generally designates a burner installed at one part of a side wall of a furnace 6 insulated from the ground and comprising a metal tube 7, an electrically insulating member 8 surrounding the metal tube 7, and a nozzle 9 fitted into the downstream end of the insulating member 8 and electrically insulated from the metal tube 7 by the insulating member 8, the metal tube 7 being grounded.

The nozzle 9 is connected by a shielded conductor 10 to an input terminal of an amplifier 11 installed in a control room. The amplifier 11 is formed with two transistors 12 and 13 as its principal components, a transistor with very high input impedance such as, for example, a field-effect transistor, type HS624 A made by Hitachi, Ltd., of Japan, being used in the input stage, and an ordinary junction type transistor being used in the following stage.

Between the first gate G_1 and source S of the field-effect transistor 12, there are connected a gate electrode leakage resistance 14 and a variable resistance 15 for bias adjustment, and the bias between the first gate G_1 and the source S is supplied by a D.-C. power source 16. The second gate electrode G_2 is connected directly to the source S and is maintained at the same potential as the source S. Between the source S and drain D of the transistor 12, there are connected in series a load resistance 17 and storage cells 18 and 19, the drain D being connected through a current limiting resistance 20 to the base of the latter stage transistor 13. The emitter of the transistor 13 is connected to the junction between the storage cells 18 and 19, and the collector of the transistor 13 is connected through a relay coil 21 to the negative terminal side of the storage cell 19. Between the terminals of the storage cell 19, there are inserted a buzzer 22 and a contactor 23 driven by a current flowing through the relay coil 21.

The flame detecting device according to the invention of the above described composition and arrangement operates in the following manner. First, the variable resistance 15 is so adjusted that, when a combustion flame exists at the nozzle 9, the transistor 12 is caused to be in a nonconductive state by the voltage produced between the nozzle 9 and the ground. Under this condition, a reverse bias is applied by the storage cell 18

to the base of the transistor 13, which, accordingly, is also placed in the nonconductive state.

When the combustion stops, or when a state of incomplete combustion exists, and the voltage produced between the nozzle 9 and the ground becomes zero or a very low value, the voltage applied to the first gate G_1 of the transistor 12 becomes small in the negative direction. Consequently, a drain current I_D flows. This current I_D is determined by the voltages of the storage cells 18 and 19 and by the resistance 17 and the resistance between source S and drain D of the transistor 12. When the voltage drop across the resistance 17 due to this current I_D becomes greater than the voltage of the storage cell 18, the transistor 13 assumes the conductive state. Consequently, the relay coil 21 is energized to close the contactor 23, whereupon the buzzer 22 sounds an alarm indicating the state of the combustion.

As described above, the flame detecting device according to the present invention is capable of detecting the state of the combustion flame of a burner without the use of an electrode or a sensor placed in the flame at a high temperature. Therefore, the device of the invention has a long serviceable life and high reliability and, moreover, is easily installed and maintained. Furthermore, the device costs much less than optical devices for the same purpose.

It should be observed that in the application of the present invention, various changes and modifications can be made to suit each circumstance. For example, the means to amplify the signal generated at the nozzle in accordance with the present or absence of the flame is not limited to the amplifier described above but may be any other suitable voltage amplifying means. Furthermore, since the input impedance of the signal source of this device is very high, shielding of the sensor parts exposed to the air for the purpose of eliminating externally induced noise is effective and, moreover, can be readily provided. In addition, in the case where an already installed burner is to be used without extensive alteration, the entire burner should be electrically insulated from ground, and the voltage produced between a selected part of the burner and the ground can be detected.

Accordingly, it should be understood that the foregoing disclosure relates to only a preferred embodiment of the invention and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention as set forth in the appended claim.

What we claim is:

A device for detecting the combustion flame of a burner comprising a nozzle part forming the end of said burner and made of an electrically conductive material; means for electrically insulating said nozzle part from the ground; and potential amplifying means for detecting and indicating the potential difference in the absence of current between said nozzle part and the ground, thereby indicating the presence or absence of a combustion flame in response to the magnitude of said potential difference; said nozzle part being arranged to deliver a flame in nonconducting relation to the ground.

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JAMES W. WESTHAVER, *Primary Examiner*.