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FLAME DETECTOR

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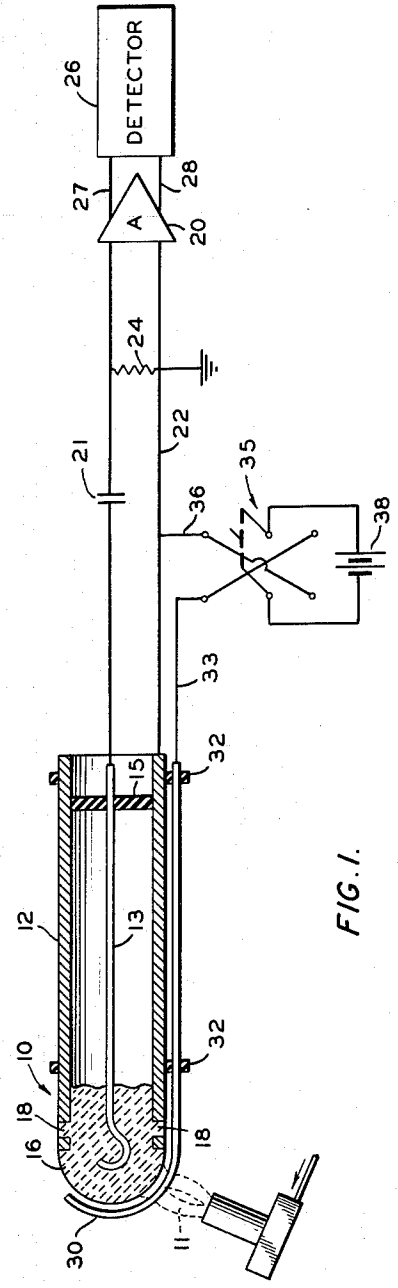


FIG. 1.

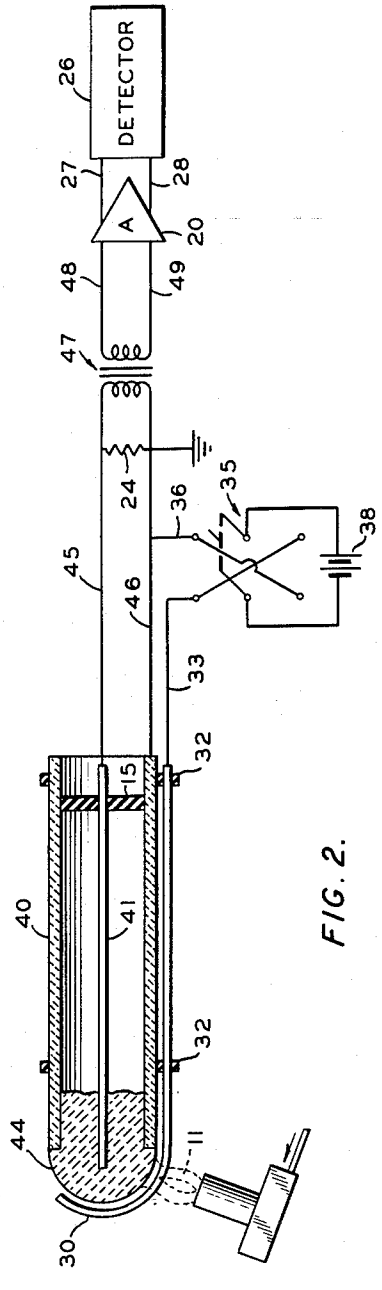


FIG. 2.

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FLAME DETECTOR

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12 Claims. (Cl. 324—71)

This invention relates to flame detection. In another aspect it relates to a method of and apparatus for detecting flame.

An improved flame detector recently has been developed which is based upon the well known fact that gases present in a flame and the atmosphere immediately surrounding a flame are ionized to a certain extent. It has been discovered that if an electrically conductive probe element is inserted in the region of a flame, alternating voltages are generated between the probe and a point of fixed reference potential. This is particularly true if the flame is turbulent. Through the use of a suitable amplifying circuit these generated voltages can be detected to provide an indication of flame in the region of the probe element. Appropriate apparatus for detecting flame in accordance with this principle is described and claimed in the copending application of D. R. de Boisblanc, Serial No. 220,113, filed April 9, 1951, entitled, "Detecting Device."

The alternating voltages generated by a flame in the above-described manner are, however, of small magnitude and must be amplified before being of sufficient strength to actuate commercially available indicating and control devices. As means for providing electrical signals of greater magnitude it has been discovered in accordance with the present invention that if a second probe maintained at a preselected potential is positioned in close proximity to the detecting probe, the voltages generated by the action of flame impinging on the detecting probe are considerably stronger than the voltages generated in the absence of this second probe. The use of a second potential probe in this manner, therefore, greatly extends the useful range of the previously developed flame detector to include small flames and those which produce relatively weak ionization.

Accordingly, it is an object of this invention to provide improved means for flame detection.

A further object is to provide flame detecting apparatus which is positive in action, of simplified durable construction, and which functions to give a rapid response to the presence of flame.

Various other objects, advantages, and features of this invention should become apparent from the following detailed description taken in conjunction with the accompanying drawing in which:

Figure 1 is a schematic representation of the improved flame detecting apparatus together with associated electrical circuitry; and

Figure 2 is a second embodiment of the apparatus shown in Figure 1.

Referring now to the drawing in detail and to Figure 1 in particular, there is illustrated a flame sensing element 10 which can be inserted in the region of a flame such as 11 which is to be detected. Element 10 comprises a cylindrical metallic casing 12 having a center electrode 13 mounted therein and electrically insulated from casing 12 by means of supports such as 15. A ceramic tip 16 is disposed across one end of casing 12, and a first hook-

shaped end of electrode 13 is anchored therein. Tip 16 preferably is constructed of a baked and hardened refractory material such as aluminum oxide which is capable of withstanding the effects of high temperature flames, and is secured to casing 12 by filling a plurality of holes 18 drilled near the end of casing 12. The second end of electrode 13 is connected to one input terminal of an alternating current amplifier 20 through a capacitor 21. Casing 12 is connected to the second input terminal of amplifier 20 by a grounded lead 22. A resistor 24 is connected across the input terminals of amplifier 20. The output terminals of amplifier 20 are connected to a suitable current detecting meter 26 by leads 27 and 28. Meter 26, for example, can comprise a thermocouple voltmeter or a rectifier and direct current indicating means. In place of or in addition to meter 26 the output signal from amplifier 20 can be employed to actuate a warning signal device or control mechanism responsive to the presence of flame in the region of ceramic tip 16.

The apparatus thus far described essentially comprises the detecting device disclosed in the aforementioned de Bloisblanc application. In accordance with the present invention a second electrode 30 is positioned adjacent tip 16 and secured in place by suitable insulating supports 32 attached to casing 12. A lead 33 serves to connect electrode 30 to one end terminal of a reversing switch 35, the adjacent end terminal thereof being connected to ground by a lead 36. A battery 38 is connected across the center terminals of reversing switch 35 such that either the positive or negative terminal of battery 38 can be connected to electrode 30 as desired with the other terminal of battery 38 being grounded.

It is believed that ions present in the region of flame 11 serve to generate an alternating voltage across resistor 24 by striking tip 16. While ceramic tip 16 normally is considered to be an electrical insulator, at the elevated temperatures encountered within a flame the electrical resistance of ceramic tip 16 is lowered considerably. That is, ceramic tip 16 exhibits a negative coefficient of thermal resistivity. The voltage fluctuations generated by ions striking tip 16 are of varying frequency, but are of such small amplitude as to require amplification before being of sufficient strength to actuate available detecting apparatus. In order to increase the amplitude of the generated voltages a second potential probe 30 is positioned adjacent tip 16. When switch 35 is positioned such that a positive potential appears on electrode 30 with respect to ground, the resulting voltages applied across the input terminals of amplifier 20 are of considerably larger amplitude than in the absence of such a potential probe 30. A similar effect is obtained if switch 35 is positioned such that electrode 30 is maintained at a negative potential with respect to ground, although it has been observed that the increased signal produced by such a negative potential is not as great as is produced by an equal positive potential. Increased voltages have been observed with values of applied potential varying from approximately 3 volts to approximately 120 volts. However, it should be emphasized that these values are given merely by way of description rather than by way of limitation.

Because of the well known property of flames to conduct electricity it should be apparent that a direct current circuit path is provided from electrode 30 through the flame and tip 16 to grounded casing 12. However, it should be emphasized that the flow of current through this direct current path does not produce the signal being detected on meter 29 in accordance with the present invention. This measured signal consists entirely of alternating voltages which are generated by the action of flame 11 impinging upon tip 16 of element 10. The presence of a second electrode in the region of the flame, which electrode preferably is maintained at a positive

potential, merely adds to the strength of the detected alternating signal. It is thought that the presence of such a positive potential in the region of the flame tends to attract negative ions from the flame thereby resulting in a relative increase of free positive ions which bombard the surface of tip 16. The converse appears true when a negative potential is applied to electrode 30, although the increased signal is not as large as when the positive potential is applied. However, any theory advanced herein as to the operation of this invention, while believed to be accurate, is not to be considered as a limitation. It rather is to be understood that the invention does operate in a satisfactory manner whether or not upon the theory set forth.

In Figure 2 there is illustrated a modified form of the apparatus of Figure 1 wherein corresponding parts are designated by like reference numerals. The detecting element comprises a casing 40 of ceramic material having an electrode 41 disposed axially therein. A ceramic tip 44 is disposed across one end of casing 40 corresponding to tip 16 of Figure 1. Leads 45 and 46 connect one end of electrode 41 and casing 40, respectively, to the end terminals of the primary winding of a transformer 47. Leads 48 and 49 connect the end terminals of the secondary winding of transformer 47 to the input terminals of amplifier 20, the output terminals of amplifier 20 again being connected by leads 27 and 28 to detector 26. Electrode 30 is attached to casing 40 by supports 32, and battery 38 is applied between electrode 30 and ground through reversing switch 35. The operation of this modified form of flame detector is the same as set forth above with reference to Figure 1. The advantage of such a structure is that ceramic casing 40 is capable of withstanding the effects of higher temperatures than is metallic casing 12. Also, amplifier 20 is coupled inductively to the flame sensing element rather than by capacitive coupling shown in Figure 1. Otherwise, the electrical circuits are identical.

Tips 16 and 44 can be formed by the addition of sufficient water to a powdered ceramic material to form a workable paste. This paste then is molded about the casing and center electrode and sintered to form a hardened tip. Materials which can be employed in this manner include the oxides of aluminum, calcium, magnesium, zirconium, columbium, tantalum and thorium, and the carbides of titanium, zirconium, columbium, tantalum, silicon, tungsten and hafnium. Mixtures of these oxides and/or carbides also can be employed. Casing 12 preferably is constructed of a metal, such as stainless steel, capable of withstanding the effects of high temperature flames. Electrodes 13 and 41 can be formed of a metal, such as Chromel, or can be formed of a conducting ceramic material. Electrode 30 likewise can be formed of either metal or a conducting ceramic. Because these ceramic materials have high resistance at normal room temperature it is not practical to employ such materials for those portions of the probes which do not become heated by the flame being detected. Amplifier 20 should be capable of amplifying frequencies from a few cycles to several kilocycles per second.

From the foregoing description it should be apparent that there is provided in accordance with this invention an improved form of flame detector wherein an electrode maintained at a preselected potential is disposed adjacent a flame detecting probe. The addition of the second potential electrode serves to increase the amplitude of the electrical signal obtained when a flame detecting probe is positioned in the region of flame. While this invention has been described in conjunction with present preferred embodiments thereof it should be apparent that the illustrated configurations are merely examples of possible probe construction. This invention contemplates the positioning of a probe maintained at a predetermined potential in close proximity to a flame detecting element of the type herein described. In addition to the probe element illustrated in Figures 1 and 2 various other configurations such as described in my copending application Serial No. 220,116, filed April 9, 1951, entitled "Electrical Noise Element," can be employed in conjunction with the present potential probe equally well. Accordingly, it is my intention not to be limited to the precise embodiments herein described.

Having described my invention, I claim:

1. A flame detector comprising, in combination, an electrical resistance element disposed in the region of flame being detected, an electrode disposed adjacent said resistance element, a source of direct voltage applied between said electrode and a point of reference potential, and means for detecting fluctuating voltages generated across said resistance element by flame impinging upon said resistance element.

2. A flame detector comprising, in combination, an electrical resistance element disposed in the region of flame being detected, an electrode disposed adjacent said resistance element, means for applying a potential to said electrode which is positive with respect to a point of reference potential, and means for detecting fluctuating voltages generated across said resistance element by flame impinging upon said resistance element, one terminal of said resistance element being maintained at said point of reference potential.

3. The combination in accordance with claim 2 wherein said resistance element is constructed of a material selected from the group consisting of the oxides of aluminum, calcium, magnesium, zirconium, columbium, tantalum and thorium, and the carbides of titanium, zirconium, columbium, tantalum, silicon, tungsten and hafnium.

4. A flame detector comprising, in combination, an elongated casing, an elongated first electrode positioned longitudinally within said casing, a ceramic tip disposed across one end of said casing in contact with said first electrode, a second electrode disposed adjacent said ceramic tip, a source of direct voltage applied between said second electrode and a point of reference potential, and means for detecting fluctuating voltages generated between said first electrode and said casing by flame impinging upon said ceramic tip, said casing being maintained at said point of reference potential.

5. A flame detector comprising, in combination, an elongated casing, an elongated first electrode positioned longitudinally within said casing, a ceramic tip disposed across one end of said casing in contact with said first electrode, a second electrode disposed adjacent said ceramic tip, means for applying a potential to said second electrode which is positive with respect to a point of reference potential, and means for detecting fluctuating voltages generated between said first electrode and said casing by flame impinging upon said ceramic tip, said casing being maintained at said point of reference potential.

6. The combination in accordance with claim 5 wherein said casing and said electrode are constructed of metal.

7. The combination in accordance with claim 5 wherein said casing and said electrode are constructed of an electrically conductive ceramic material.

8. The combination in accordance with claim 5 wherein said ceramic tip is selected from the group consisting of the oxides of aluminum, calcium, magnesium, zirconium, columbium, tantalum and thorium, and the carbides of titanium, zirconium, columbium, tantalum, silicon, tungsten and hafnium.

9. A flame detector comprising, in combination, a pair of spaced electrodes disposed in the region of a flame to be detected, a third electrode disposed adjacent said pair of electrodes, a source of direct voltage applied between said third electrode and a point of reference potential, and means for detecting fluctuating voltages generated between said pair of electrodes by the presence of flame in the region thereof.

10. The combination in accordance with claim 9 fur-

ther comprising a body of ceramic material extending between and making electrical contact with said pair of electrodes.

11. The combination in accordance with claim 10 wherein said ceramic material is selected from the group consisting of the oxides of aluminum, calcium, magnesium, zirconium, columbium, tantalum and thorium, and the carbides of titanium, zirconium, columbium, tantalum, silicon, tungsten and hafnium.

12. A flame detector comprising, in combination, a pair of spaced electrodes disposed in the region of a flame to be detected, a third electrode disposed adjacent said pair of electrodes, means for applying a potential to said third electrode which is positive with respect to a point of reference potential, means connecting one of said pair of electrodes to said point of reference potential, and means for detecting fluctuating voltages generated between said pair of electrodes by the presence of flame in the region thereof.

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