

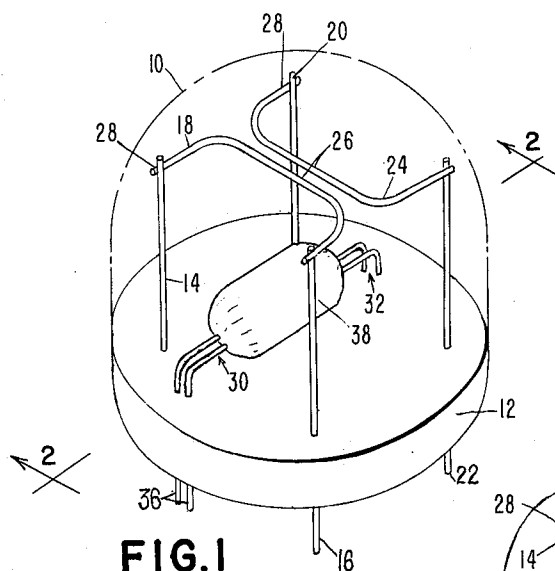
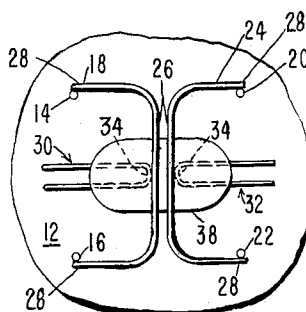
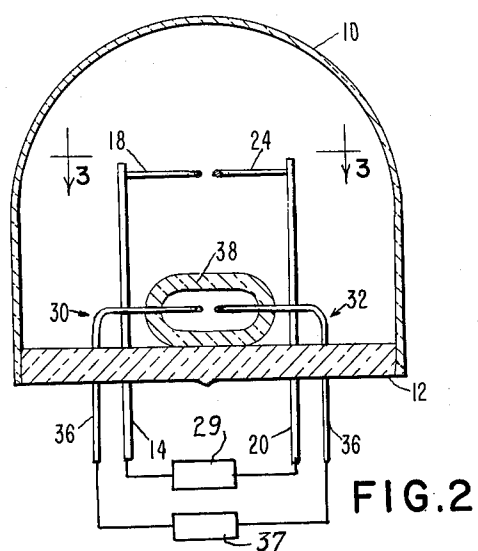
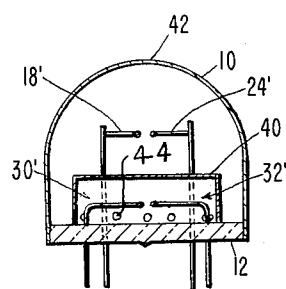
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ULTRAVIOLET RADIATION DETECTOR

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ULTRAVIOLET RADIATION DETECTOR

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5 Claims. (Cl. 250-83.6)

This invention relates to radiation detectors and more particularly to an improved radiation detector element arrangement which indicates failure of the detector element and which is particularly adapted for use in combustion control systems.

Combustion control systems employ a flame sensor and sensor responsive circuitry to indicate the presence or absence of flame. In industrial burner systems, for example, flame normally is continuously present for prolonged periods of time. Should the flame accidentally become extinguished, however, the sensor circuitry must promptly indicate that flame failure and terminate the flow of raw fuel into the combustion chamber. Unless such flow is promptly terminated, an explosive atmosphere is created in that chamber, an extremely hazardous condition. The possibility of sensor failure must be recognized and that failure may be either of two types—continuing to indicate the presence of flame when none is present, or the absence of flame when flame is actually present. The latter is a "safe" type of failure since a sensor indication of flame absence causes the burner to shut down in safe condition. However, should the sensor falsely indicate the presence of flame, the unsafe condition indicated above would result. A variety of arrangements have been devised for guarding against this unsafe failure. Among these arrangements is the use of a timer to simulate periodically the absence of flame and to check the circuitry at that time to ascertain whether the flame absence is indicated. Another fail-safe arrangement employs an electric charge storage circuit which must be periodically recharged and can be recharged only if the flame sensor is properly operating. These fail-safe arrangements require elaborate auxiliary circuitry which increases the cost and complexity of the installation, and which with the possibility of circuitry failure, albeit in a safe condition, results in unwanted and costly shutdowns and increased maintenance expense.

It is an object of this invention to provide a novel and improved fail-safe combustion supervision component.

Another object of the invention is to provide an improved radiation sensitive device suitable for use in combustion control systems which provides an indication of a sense of failure when the sensor fails in unsafe condition.

Other objects, features and advantages of the invention will be seen as the following description of a preferred embodiment thereof progresses, in conjunction with the drawing, in which:

FIG. 1 is a perspective view of the radiation sensor device constructed in accordance with principles of the invention;

FIG. 2 is a sectional view taken along the line 2-2 of FIG. 1;

FIG. 3 is a sectional view taken along the line 3-3 of FIG. 2; and

FIG. 4 is a sectional view similar to FIG. 3 illustrating a modified form of sensor device useful where the location of the radiation source is known.

The radiation detector sensor device shown in FIG. 1 includes a domed envelope portion 10 transparent to the flame radiation wavelengths of interest which in the preferred embodiment are wavelengths in the ultraviolet regions and less than 2800 Å. This envelope may be a borosilicate glass, for example. A press 12 completes

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the evacuable enclosure, it being fused to the walls of the transparent envelope portion 10. Secured in and extending through the press 12 are first electrode supports and terminals 14, 16 which support a first electrode 18, and second electrode supports and terminals 20, 22 which support a second electrode structure 24 identical in physical configuration to electrode 18. In the preferred embodiment the electrodes 18, 24 are tungsten wires formed to provide straight central portions 26 that are disposed parallel to one another and define a working region between those portions. The ends 28 of the electrodes are spaced a greater distance apart than the straight working region portions 26 and the ends are secured to the support elements in electrically conductive relation as by welding. Preferably, the electrode portions in the working region are of symmetrical configuration so that the device can be energized with an alternating current.

By suitable fabrication and purification techniques the working portions of electrodes have substantially uniform work functions and, as a result, a consistent response to impinging radiation. The envelope is filled with an avalanche discharge sustaining gas, preferably a reducing agent such as hydrogen, either pure or containing a minor fraction of inert gases. In operation of the sensor device a high voltage (in the order of 600 to 700 volts) is impressed across the working region of the electrodes by source 29, creating an electric field condition. When radiation of the appropriate wavelength impinges on an electrode, an electron is ejected which initiates an avalanche breakdown of the electric field by ionizing the gas. Where the tube is employed in a combustion supervision system, the presence of flame causes the tube to break down in avalanche discharge regularly.

However, this type of radiation sensor requires relatively uniform environmental conditions for proper operation. For example, if the electric field strength between the electrodes exceeds a predetermined value, the tube will break down and discharge in the absence of ionizing ultraviolet radiation, and if the field strength falls below a similar value, no discharge will result. However, field strength can be adequately controlled. A further cause of erroneous operation results from contamination of the gas in the tube, for example, from constituents released from the electrodes, their supports or the envelope. When the atmosphere becomes excessively contaminated avalanche discharge will occur between the electrodes in the absence of flame radiation and produce current pulses which may erroneously indicate the presence of flame, an unsafe failure.

Accordingly, there is provided in the envelope a pair of auxiliary electrodes 30, 32 which are spaced from one another at a distance corresponding to the distance that the working portions 26 of electrodes 18 and 24 are spaced. In the illustrated embodiment each electrode is formed as a loop to provide a smoothly curved end portion 34 and has two terminals 36 which extend through the press 12. According to the electrode end configuration employed, the voltage applied to the auxiliary electrodes by source 37 via terminals 36 produces an electric field comparable to that produced between the main electrodes 18, 24. The auxiliary electrode end portions are enclosed in a gas permeable casing 38 which is impervious to radiation, for example a fused glass frit or a metallic baffle structure, so that the space between the electrode end portions is filled with the same gas as that between the main electrodes but no radiation can impinge on those electrodes. Preferably, the auxiliary electrodes 30, 32 are manufactured of tungsten and each is connected between two external terminals so that they may be purified by the same resistance heating techniques as the main electrodes 18 and 24. When adequately treated,

neither set of electrodes introduces contaminants into the gaseous atmosphere in the tube.

A modified structure, useful where the only possible source of ultraviolet radiation is capable of precise location, in shown in FIG. 4. In this embodiment a metal baffle 40 having apertures 44 in its lower walls is positioned between the main electrodes 18', 24' and auxiliary electrodes 30', 32', and the tube is mounted so that radiation only enters through the top center of the envelope adjacent the area 42.

In operation the main electrodes 18, 24 are preferably energized with an alternating signal of a magnitude such that the potential generated at every half cycle will produce breakdown between the electrodes if an ultraviolet photon impinges on an electrode, and any resulting breakdown is automatically quenched during that half cycle. The auxiliary electrodes 30, 32 may be energized with a similar alternating potential or a D.C. potential, the magnitude of which is a function of the spacing of the adjacent electrode portions 34. The strengths of the two electric fields are proportioned so that breakdown of both will occur at substantially the same degree of contamination of the gaseous atmosphere in the tube in the absence of electron producing radiation. Should the gaseous atmosphere become excessively contaminated such that a breakdown will occur across the main electrodes 18, 24 in the absence of ultraviolet shielded radiation for example, a similar breakdown will also occur between the end portions 34 of the auxiliary electrodes, and hence promptly indicate the sensor defect, and may be used to shut down the combustion system in safe condition.

While a preferred embodiment of the invention has been shown and described, various modifications thereof will be obvious to those skilled in the art, and therefore it is not intended that the invention be limited to the disclosed embodiment or to details thereof and departures may be made therefrom within the spirit and scope of the invention as defined in the claims.

I claim:

1. A radiation sensitive tube comprising an envelope transparent to ultraviolet radiation,
 - a pair of main electrodes mounted within said envelope in spaced relation,
 - each said main electrode having a straight portion disposed parallel to the corresponding portion of the other main electrode,
 - means to connect said main electrodes to a source of electric potential to create a first electric field between said straight portions of said main electrodes,
 - a gas in said envelope, the principal constituent of which is hydrogen,
 - said gas being adapted to be ionized upon production of a photoelectron from one of said main electrodes in response to impinging ultraviolet radiation to produce an avalanche breakdown of said first electric field between said main electrodes,
 - a pair of auxiliary electrodes disposed in said envelope, the end portions of said auxiliary electrodes being spaced a predetermined distance apart to define a gap,
 - means to connect said auxiliary electrodes to a source of electric potential to create a second electric field across said gap,

said first and second electric fields being so proportioned relative to the configuration of said main and auxiliary electrodes respectively that both fields break down at substantially the same time as a function of the nature of the gas in said envelope in the absence of ultraviolet radiation impinging on said main electrodes,

and a gas permeable, ultraviolet radiation impermeable shield bridging the gap between said auxiliary electrodes and enclosing said end portions of said auxiliary electrodes.

2. A radiation sensitive device comprising an envelope transparent to ultraviolet radiation,
 - a pair of main electrodes mounted within said envelope in spaced relation,
 - each said main electrode having a photoelectric work function of such magnitude that photoelectrons are produced in response to radiation of wavelengths shorter than wavelengths in the visible spectrum and having a straight portion disposed parallel to the corresponding portion of the other main electrode,
 - means to connect said main electrodes to a source of electric potential to create a first electric field between said straight portions of said main electrodes,
 - a gas in said envelope adapted to be ionized upon production of a photoelectron from one of said main electrodes in response to impinging ultraviolet radiation to produce an avalanche breakdown of said electric field between said main electrodes,
 - a pair of auxiliary electrodes disposed in said envelope, the end portions of said auxiliary electrodes being spaced a predetermined distance apart to define a gap,
 - means to connect said auxiliary electrodes to a source of electric potential to create a second electric field across said gap,
 - said first and second electric fields being so proportioned relative to the configuration of said main and auxiliary electrodes respectively that both fields break down at substantially the same time as a function of the nature of the gas in said envelope in the absence of ultraviolet radiation impinging on said main electrodes,
 - and a gas permeable, ultraviolet radiation impermeable shield disposed between said main electrodes and said auxiliary electrodes.
3. The device as claimed in claim 2 wherein said shield is composed of glass frit.
4. The device as claimed in claim 2 wherein said shield is an ultraviolet radiation opaque baffle.
5. The device as claimed in claim 2 wherein said shield completely encloses the end portions of said auxiliary electrodes.

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