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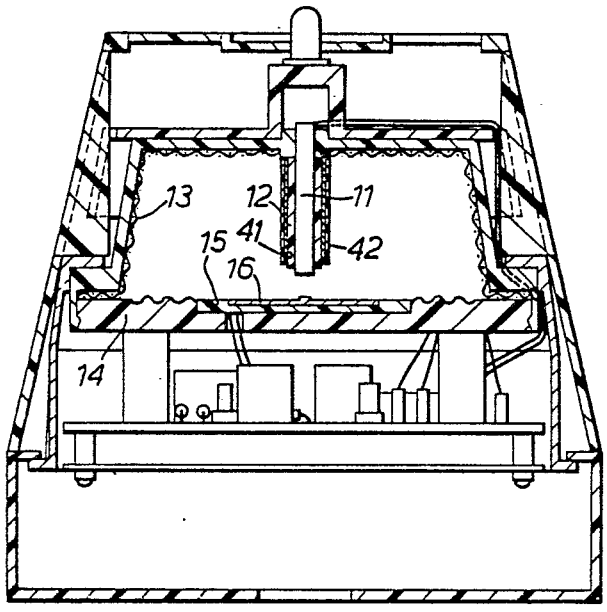
(54) Title: IONISATION DETECTOR CHAMBER

(57) Abstract

An ionisation chamber smoke detector in which a first electrode (11) is covered with an insulator (12) except at one end where it is opposed by a measuring electrode (15); the major part of the surface of the insulator (12) carries a conductor (41) not connected to the first electrode (11) to reduce the detrimental effect of condensation on the insulator (12).



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IONISATION DETECTOR CHAMBER

This invention relates to an ionisation detector chamber and is an improvement in the chamber, the subject of British Patent Specification NOs. 27668/76 and 38825/76 in which the statement of invention reads as follows;

According to the present invention a detector including an ionisation chamber has first and second electrodes, the exposed conducting area of the first of which is restricted, and a measuring electrode disposed adjacent the said exposed area, together with means for ionising gas in the chamber including the space between the three electrodes.

Restriction of the conducting area in a preferred embodiment was by means of an insulating sleeve surrounding all except the inner end of a rod extending into the chamber and constituting the first electrode, and the effect of restricting the exposed conducting area was to concentrate the electric field within the part of the chamber adjacent the one electrode, which enhanced the sensitivity of the detector.

According to the present invention, a detector includes an ionisation chamber having first and second electrodes, and a measuring electrode disposed adjacent to the exposed area of the first electrode, and means for ionising gas in the chamber including the space between the three electrodes, the conducting surface of the first electrode being covered by an insulator except at the part of the surface adjacent the measuring electrode, the major part of the surface of the insulator carrying a conductor not

connected to the first electrode.

It has been found that some of the benefit of the invention in the specification referred to above is lost if water from the atmosphere condenses on the surface of the insulator which tends to convert the insulator into a conductor. The conductor of the present invention carried on the major part of the surface of the insulator can be connected to a reference potential, for example being connected to the second electrode of the detector, and that tends to eliminate the detrimental effect of the condensation while having substantially no effect on the performance of the detector if there is no condensation.

The conductor is conveniently in the form of a sleeve surrounding all except the lower end of the insulator around the first electrode, and the conducting sleeve can itself be surrounded by an insulating sleeve.

The invention may be carried into practice in various ways, but one embodiment will be described by way of example with reference to the accompanying drawing, of which the single figure is a view corresponding to FIGURE 1 of the above identified specification showing the modification in accordance with the present invention.

The operation of the detector is described in detail in the above mentioned specification, and in the present specification it will suffice to say that thereis a first electrode 11 in the form of a conducting rod, a second perforated surrounding electrode

13 and a measuring electrode 15 in the centre of a base 14 carrying the second electrode 13, and the measuring electrode 15 being spaced closely adajcent to the exposed end of the first electrode 11. An insulating tube 12 surrounds all of the conducting surface of the electrode 11 which is within the detector chamber except for the part closely adjacent to the measuring electrode 15, which carries an Americium foil 16 for ionising the air.

In accordance with the present invention, most of the external surface of the insulating sleeve 12 is covered with a conducting tube 41 which is electrically connected to the perforated wall electrode 13. The conducting tube 41 is itself covered by an insulating sleeve 42 except for the end of the tube 41 facing the measuring electrode 15.

Under normal conditions the additional electrode 41 has little effect on the performance of the detector but if water condenses on the sleeve 42, and on the lower end of the sleeve 12, to make it act like a conductor, that will not greatly affect the sensitivity of the detector because the tube 41 is held at the potential of the second electrode 13. Thus the effective increase in the surface area of first electrode 11 will be limited.

In the interests of clarity the drawing is not quite to scale, but the tube 41 is in fact in contact with the surface of the sleeve 12, and the insulating sleeve 42 is in contact with the surface of the tube 41.

British Patent Specification Number 27668/76 and 38825/76, reads as follows

This invention relates to a detector including an ionisation chamber for example for detecting the presence of smoke so as to be capable of giving a signal for giving an alarm that a fire is imminent in a building.

An object of the invention is to provide a simply constructed small detector which is nevertheless very sensitive to the presence of smoke.

According to the present invention a detector including an ionisation chamber has first and second electrodes, the exposed conducting area of the first of which is restricted, and a measuring electrode disposed adjacent the said exposed area, together with means for ionising gas in the chamber including the space between the three electrodes.

The disposition of the measuring electrode in relation to the first electrode concentrates the electric field, within the part of the chamber adjacent to one electrode, and ensures that the presence of smoke has a much greater effect on the ionisation current flowing between the measuring electrode and the other electrode than on the ionisation current flowing between the first electrode and the measuring electrode.

The first electrode preferably comprises a rod extending into the chamber, and surrounded by an insulating sleeve except for the exposed are which is at its inner end. The insulating sleeve is

preferably around the sides of the first electrode, except for a short length of the sides of the inner end.

The first electrode can be positioned concentrically within the other electrode constituting the ionisation chamber wall, and that effectively divides the space within the chamber into two areas, a central area between the measuring electrode and the exposed area of the first electrode, and a larger surrounding area between the measuring electrode and the wall of the ionisation chamber.

The ionisation means is conveniently a piece of radio-active material for example, a foil of radium or Americium and that can be positioned anywhere in the ionisation chamber, although a convenient position is on the measuring electrode centrally opposite the exposed part of the first electrode.

In one preferred construction the chamber has an insulating base carrying the measuring electrode which in turn carries a foil of Americium; the ionisation chamber consists of an upstanding wall around the base and an end wall closing the chamber, all those walls being perforated while the first electrode extends through the end wall of the ionisation chamber in the form of a cylindrical conducting rod which is a tight fit within an insulating sleeve.

The sensitivity of the detector may not be accurately reproducable from sample to sample if the dielectric constant of the insulation material varies from sample to sample. The critical region of the

detector is the region of high electric field between the first electrode and the measuring electrode and by terminating the insulation short of the end of the elongate first electrode so that the last part of the length of its sides is not covered by insulation the insulation is removed from this region of high electric field and in consequence variations in the dielectric constant are not reflected in substantial variations in the sensitivity of the detector. The detector is also made more sensitive as the surface area of the exposed end of the elongate first electrode is larger. This modifies the electric field pattern in the region between the first electrode and the measuring electrode, so giving increased sensitivity.

The insulation must extend reasonably near to the end of the elongate electrode to prevent the lines of the electric field going directly from the positive electrode to a surrounding negative electrode rather than by way of the measuring electrode.

The invention may be carried into practice in various ways, and one embodiment will now be described by way of example with reference to the accompanying drawings of which;

FIGURE 1 is a sectional elevation of an ionisation type smoke detector;

FIGURE 2 is an exploded view of components of the detector; and

FIGURE 3 is a circuit diagram of the detector.

The detector includes an ionisation chamber consisting of the space between an insulating base 14 and a perforated wall 13 upstanding from the sides of the base 14 with an enclosed top. A measuring

electrode 15 is mounted in a central recess in the base 14 and centrally mounted on the exposed face of the measuring electrode 15 is an elongate foil 16 of Americium.

Closely spaced centrally from the foil 16, is the exposed end of a cylindrical electrode 11 which is a close fit within an insulating sleeve 12 which serves to mount the electrode 11 in, and insulate it from, the top wall of the chamber 13.

The insulation 12 extends down the larger part of the length of the sides of the elongate cylindrical rod electrode 11 but terminates a little short of the exposed end of that electrode. This means that the insulation is removed from the region of high intensity field between the electrodes 11 and 15 so that the sensitivity of the detector does not depend to any substantial degree on the dielectric constant of the material of the insulating sleeve 12. The sleeve terminates sufficiently near the end of the electrode 11 to prevent the lines of electric field passing directly from the first electrode to the second electrode rather than by way of the measuring electrode 15.

In order to prevent excessive leakage currents from measuring electrode 15 to the second electrode 13 over the surface of the insulating base 14, a conducting guard ring could be fitted in an annular groove in the upper surface of the base surrounding the disc 15 and within the perforated wall 13.

The surface of the base 14 between the measuring electrode 15 and the perforated wall 13 constituting the

negative electrode is corrugated at 21 to increase the length of the creep path over insulation between those electrodes.

The perforated wall 13 is part of a sub-assembly constituting the outer wall of the ionisation chamber, and comprising three components. The perforated wall 13 is a simple mesh cup with a top having a central aperture for the insulator 12, and a frusto-conical side wall, and that fits within an inner moulding 22 having four radially directed retaining ribs 23, extending from a rim 24 to a central disc 25, and then there is an outer moulding 26 fitting around the apertured part of the inner moulding 23 and having four equally circumferentially spaced slots in its frusto-conical side wall, as indicated at 27, which are opposite the ribs 23. The arrangement allows ambient air free access to the ionisation chamber within the wall 13, while yet there is no direct passage for air to enter without having to deviate around the ribs.

Electrical circuit components are contained in a chamber 29 below the base 14, and within a lower wall 31, and electrical connections 32 respectively from the electrodes 11 and 13 are led down around the sub-assembly 24, 26, into the chamber 29. A connection from the measuring electrode 15 extends directly into the chamber 29, as indicated at 33, and if there is a guard ring, as described above, the connection from that also would extend through the base 14.

There is a surrounding casing 34 having slots for entry of the air, and a lamp 35 can be seen from

a central hole in the top of the cover 34 for giving a visual indication of an alarm. That lamp is connected to the circuit components in the chamber 29.

The circuit diagram is shown in FIGURE 3, and it can be seen the electrodes 11 and 13 are connected respectively to the drain and source electrode of a field effect transistor 17, while the gate electrode of the F.E.T. is connected to the measuring electrode 15. The circuit is conventional, and operates so that as the voltage on the measuring electrode 15 arise, the drain to source current in the field effect transistor 17 increases, so that the voltage across a resistor R1 also increases and this voltage also appears on the base of transistor TR3 which converts the voltage to a low impedance signal capable of triggering a transistor TR4 which is a programmable unijunction transistor (PUT). TR4 will only trigger, firing the output thyristor CSR1, if the input at A on TR4 exceeds the threshold voltage determined by the setting of a potentiometer RV1. When CSR1 is fired, the current through the detector increases and is usually limited by the circuit in the fire alarm control panel. This constitutes the alarm signal and a local indication is given of the switching of the detector to the alarm condition by the illumination of the lamp 35 which is a light emitting diode D7.

Thus an alarm is given in dependence on the voltage of the measuring electrode 15, and the operation of the detector is such that ionisation current

flows between the electrodes under the influence of the electric field in the ionisation chamber, and the voltage of the measuring electrode 15 is an intermediate voltage determined by the relationship of the impedance between the electrodes 11 and 15, to that between the electrodes 15 and 13.

Under normal conditions, that is with no smoke present in the chamber, the ratio of the impedance between the electrodes 11 and 15 to the impedance between the electrodes 15 and 13 will be set by the electric field concentrations in the two parts of the chamber. These concentrations are in turn determined by the sizes, shapes and spacing of the electrodes. Thus, the chamber can be considered to constitute an inner part between the positive electrode 11 and the measuring electrode 15 and a surrounding outer part between the measuring electrode 15 and the negative electrode 13.

The relationship of the measuring electrode 15 to the positive electrode 11 serves to concentrate the electric field at that region because substantially all the lines of electric field flow to the restricted exposed end of the electrode 11 rather than through the insulation to the sides of that electrode. Thus when smoke appears within the ionisation chamber, ions attach themselves to smoke particles and lose their mobility. The effect is much more pronounced in the larger region between the measuring electrode 15 and the negative electrode 13, than between the positive electrode 11 and the measuring electrode 15, and the

effect is for the impedance of the outer part of the chamber to increase so that the voltage on the measuring electrode 15 increases to the threshold value if the smoke concentration is sufficiently great.

This gives good sensitivity for getting a response from the field effect transistor from quite a small ionisation chamber and the construction is simple becauses a single piece of radioactive material suffices for both parts of the chamber.

In addition there is only one high impedance leakage path that could affect the detector's sensitivity , i.e. over the insulator 14 between electrodes 15 and 13. If this is corrugated as at 21 or protected with a guard ring as described above, or both, the detector will be more immune to contamination by duct and dirt than are more conventional detectors employing two or more high impedance paths.

CLAIMS

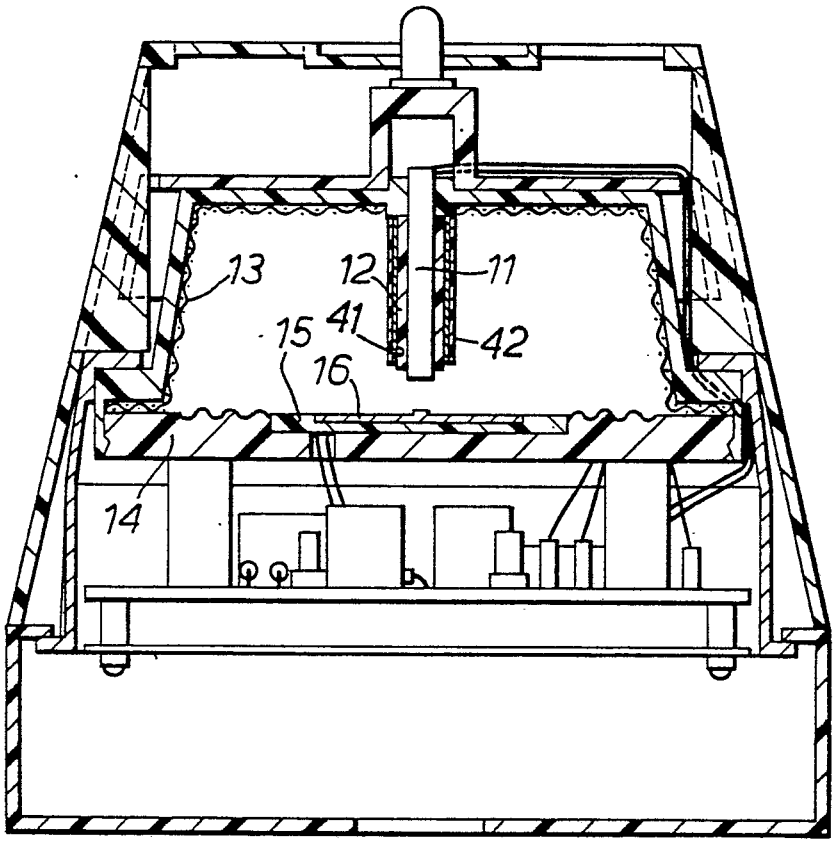
1. A detector including an ionisation chamber having first (11) and second (13) electrodes, and a measuring electrode (15) disposed adjacent the exposed area of the first electrode, and means (16) for ionising gas in the chamber including the space between the three electrodes, the conducting surface of the first electrode being covered by an insulation (12) except at the part of the surface adjacent the measuring electrode, characterised in that the major part of the surface of the insulator carries a conductor (41) not connected to the first electrode.

2. A detector as claimed in Claim 1 in which the said conductor (41) is electrically connected to the second electrode (13).

3. A detector as claimed in either of the preceding claims in which the said conductor is covered by an insulating layer (42).

4. A detector as claimed in Claim 2 and Claim 3 in which the said conductor (41) and the insulating layer (42) comprise sleeves extending for the same distance along the length of the insulator.

5. A detector as claimed in Claim 4 in which the sleeves terminate just short of the end of the insulator which faces the measuring electrode.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 79/00059

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 3

According to International Patent Classification (IPC) or to both National Classification and IPC

H 01 J 41/08; G 08 B 17/10

II. FIELDS SEARCHED

Minimum Documentation Searched 4

Classification System	Classification Symbols
Int.Cl.[2]	H 01 J 41/08; G 08 B 17/10; G 01 N 27/66

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 5

III. DOCUMENTS CONSIDERED TO BE RELEVANT 14

Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No. 18
	US, A, 3935492, published January 27, 1976, see abstract; column 2, lines 3-30; figure 1, Nittan Co.Ltd.	1, 2
A	FR, A, 1422350, published November 15, 1965, see page 2, left-hand column, line 38 to right-hand column, line 31; figures 1, 2, 4; Commissariat à l'Energie Atomique & Charbonnages de France	1, 2
A	DE, A, 2729599, published February 2, 1978, see page 7, line 8 to page 8, line 5; figure 1, Chloride Group Ltd. (this application corresponds to the British Patent Specifications Numbers 27668/76 and 38825/76, cited on page 4, lines 1 and 2 of the search copy).	1

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"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search 3	Date of Mailing of this International Search Report 3
18th June 1979	28th June 1979
International Searching Authority 1	**Signature of Authorized Officer 20**
European Patent Office	G.L.M.KRUYDENBERG