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[54] **IONIZATION SMOKE DETECTOR**

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[30] **Foreign Application Priority Data**

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Aug. 27, 1970 Japan 45/74532

[52] **U.S. Cl.** ..... **250/83.6 FT**, 340/237
[51] **Int. Cl.** **H01j 29/38**
[58] **Field of Search** ..... 250/83.6 R, 83.6 FT, 250/218; 340/237

[56] **References Cited**

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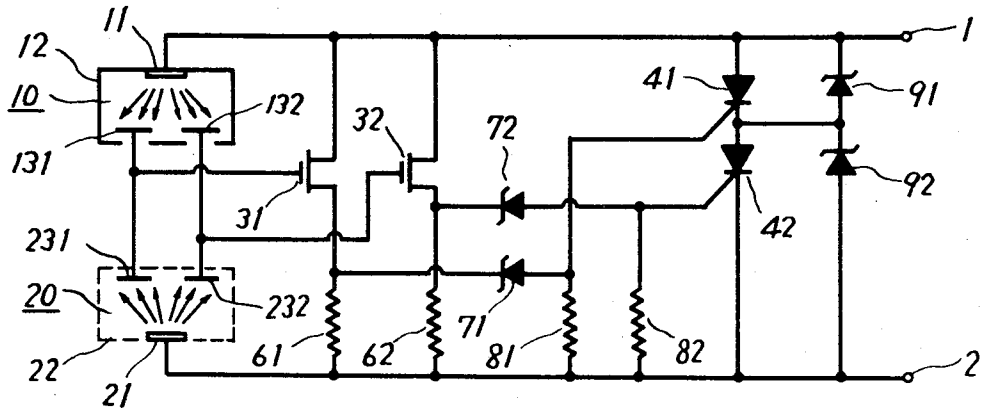
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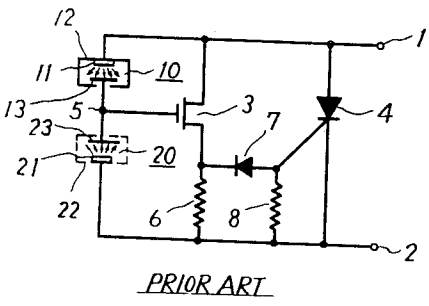
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[57] **ABSTRACT**

An ionization smoke detector having an open ionization chamber and a closed ionization chamber and each chamber includes a first electrode, at least two additional electrodes and a radioactive source. Corresponding additional electrodes of the chambers are interconnected while the first electrode of one chamber is connected to one terminal of a source of energy and the first electrode of the other chamber is connected to the other terminal of said source. A pair of field effect transistors have their bases individually connected to the junctions of each pair of connected additional electrodes and their source-drain paths including a load resistor connected between said source terminals. The voltage drop across each load resistor is then used to operate individual series connected switches.

4 Claims, 4 Drawing Figures





PRIOR ART

Fig. 1

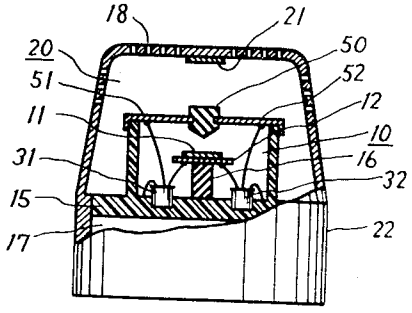


Fig. 4

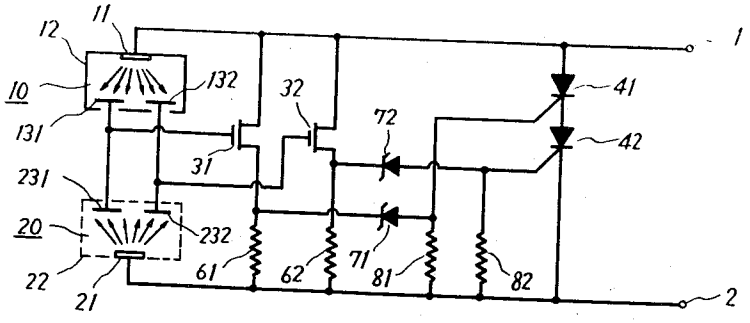


Fig. 2

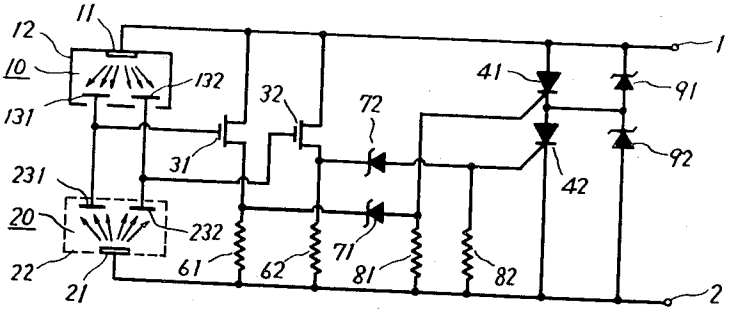


Fig. 3

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IONIZATION SMOKE DETECTOR

This invention relates to an ionization smoke detector and more particularly to an ionization smoke detector wherein erroneous operation is avoided.

An ionization smoke detector according to the prior art includes a pair of ionization chambers connected in series between a voltage source, each chamber having a pair of electrodes and a radioactive source for ionizing the atmosphere therein. One of these ionization chambers is closed to the external air and is referred to as a "closed ionization chamber," while the other is opened to the air to allow smoke to enter and is referred to as an "open ionization chamber." A field effect transistor (hereinafter referred to as FET) has a gate electrode connected to the junction between the both ionization chambers and a source-drain conduction path is connected through a load resistor between the both terminals of the voltage source detects a potential change at the junction of the both ionization chambers. When smoke enters the open ionization chamber, the ionization current in the open ionization chamber is reduced and this results in an increase of impedance of this chamber and a consequent increase in the potential at the junction between the both ionization chambers, that is, at the gate electrode of the FET. This results in an increase in the source-drain current of the FET, which in turn drives an alarm device to sound an alarm.

In most instances erroneous operation of prior ionization smoke detectors is caused by a difficulty in the FET, such as excessive gate leakage current or breakdown. Such erroneous operation of the detector is quite undesirable because it sounds a normal alarm signal and causes unnecessary confusion.

Therefore, one object of this invention is to provide novel and improved ionization smoke detector which minimizes the probability of such erroneous operation caused by a defective FET.

According to this invention, one of the electrodes of each ionization chamber is divided into two portions which are isolated from each other. Corresponding portions of the electrodes of each chamber are connected together and to the gate electrodes of two FET's. The outputs of the both FET's are applied to a logic "and" circuit operating as a relay device which drives an alarm device. Therefore, the "and" circuit produces its output to drive the alarm device only when the both FET's produce the outputs at the same time, but has no output when only one of the FET's produces the output as in the case of erroneous operation of one FET.

Other objects and features of this invention will be more clearly understood from the following description with reference to the accompanying drawings.

In the drawings:

FIG. 1 is a schematic circuit diagram representing a prior ionization smoke detector;

FIG. 2 is a schematic circuit diagram representing an embodiment of an ionization smoke detector according to this invention;

FIG. 3 is a schematic circuit diagram representing another embodiment of an ionization smoke detector according to this invention; and

FIG. 4 is a side view in partial section representing an ionization smoke detector according to this invention.

Throughout the drawings, like reference numerals are used to denote like structural components.

A prior ionization smoke detector, as shown in FIG. 1, is provided with a closed ionization chamber **10** having a radioactive source **11** and a pair of electrodes **12** and **13**, said electrode **12** being shown by a solid square as the wall of the chamber **10**, an open ionization chamber **20** having a radioactive source **21** and a pair of electrodes **22** and **23**, said electrode **22** being shown by a dotted square as the wall of the chamber **20** which is arranged to allow smoke to enter, an FET **3** having a gate electrode connected to the junction **5** of the both ionization chambers and a source-drain conduction path connected through a resistor **6** between the both terminals **1** and **2** of a voltage source in parallel with the series connection of the both ionization chambers **10** and **20**, and a silicon controlled rectifier (hereinafter referred to as (SCR) **4** having a control electrode connected through a zener diode **7** to the source electrode of the FET **3** and a conduction path connected between the both terminals **1** and **2** of the voltage source. The control electrode of the SCR **4** is also connected through a shunt resistor **8** to the terminal **2**.

In the normal state of the detector, the junction **5** of both ionization chambers **10** and **20**, that is, the gate electrode of the FET **3** is at a relatively low potential. When smoke enters the open ionization chamber **20**, however, its ionization current is reduced to increase its impedance, and therefore, the gate potential of the FET **3** is raised. This results in a reduction of impedance of the source-drain conduction path of the FET **3** and an increase in current flowing through the resistor **6** which in turn results in an increase of the source potential of the FET **3**. When the source potential exceeds the zener voltage of the zener diode **7**, it actuates the control electrode of the SCR **4** and drives the latter into conduction, thereby transmitting an alarm signal to the receiver (not shown).

In such prior ionization smoke detectors, even if the source potential of the FET **3** is erroneously raised by a malfunction of the FET **3** such as excessive gate leakage current or source-drain breakdown, the alarm signal is similarly sounded.

Referring now to FIG. 2 representing an embodiment of this invention, the closed ionization chamber **10** includes a radioactive source **11**, electrode **12**, which constitutes the wall of the chamber **10**, and two opposing electrodes **131** and **132**, and the open ionization chamber **20** includes a radioactive source **21**, an electrode **22** constituting the wall of the chamber **20** which is arranged to allow smoke to enter and two opposing electrodes **231** and **232**. The electrode **12** of the chamber **10** is connected to one terminal **1** of a voltage source (not shown) and the electrode **22** of the chamber **20** is connected to the other terminal **2** of the voltage source. The electrode **131** of the chamber **10** and the electrode **231** of the chamber **20** are connected together and to the gate electrode of a FET **31**, and the electrode **132** of the chamber **10** and the electrode **232** of the chamber **20** are connected together and to the gate electrode of another FET **32**. The source-drain conduction paths of both FET's **31** and **32** are respectively connected through zener diodes **71** and **72** to the control electrodes of two SCR's **41** and **42** the conduction paths of which are connected in series between the terminals **1** and **2** of the voltage source. The control electrodes of the respective SCR's **41** and **42** are con-

nected also through shunt resistors 81 and 82 to the second terminal 2 of the voltage source.

It is clear in this circuit that current cannot flow through the series conduction paths of the SCR's unless both SCR's are driven into conduction at the same time. Therefore, an alarm is not sounded when only one SCR is erroneously actuated, but an alarm is sounded when smoke enters the open ionization chamber 20 and both SCR's are actuated at the same time. It should be noted that the alarm can also be sounded in response to smoke even when one of the SCR's is erroneously actuated. Although the alarm would be sounded if both SCR's were to be driven erroneously at the same time, such condition would rarely occur.

FIG. 3 represents a modification of the circuit of FIG. 2 and this circuit is the same as that of FIG. 2 except that two zener diodes 91 and 92 are respectively connected in parallel with the SCR's 41 and 42. These zener diodes are provided for the purpose of detecting erroneous actuation of an SCR at the central receiving unit.

When the both SCR's 41 and 42 conduct at the same time, the potential difference between the terminals 1 and 2 will be substantially zero. However, when one of the SCR's for example the SCR 41 is erroneously actuated, conduction current flows through the SCR 41 and the zener diode 92 and the potential difference between the terminals 1 and 2 remains at the zener voltage of the zener diode 92. Therefore, no alarm will be sounded if the alarm device in the central unit is arranged so as to be actuated only when the potential difference between both terminals 1 and 2 drops down below the zener voltage, and the malfunction of the SCR can be detected if an indicator for indicating the potential difference between both terminals 1 and 2 is installed in the central unit. It should be noted that any smoke detector exhibiting a malfunction can be distinguished from a number of detectors connected on a line if the zener voltages of the zener diodes are previously selected to be peculiar to the respective detectors.

As described above, the potential difference between both terminals 1 and 2 drops to the zener voltage of the zener diode when one of the SCR's is actuated erroneously. Accordingly the voltage applied to the other detection circuit is also reduced to this zener voltage. Therefore, in order to maintain the other detectors in operable condition, the zener voltage should be selected so that is is higher than the operating voltage of the detection circuit.

FIG. 4 shows a preferred embodiment of a structure for the ionization smoke detector according to this invention. A metal housing 22 which serves the function of one electrode of the open ionization chamber 20 contains a pair of intermediate electrodes 51 and 52 which are mutually isolated by an insulating member 50 and supported on an insulating support member 15. The open ionization chamber 20 is surrounded by these members but the ambient gases can enter the chamber through holes 18 of the housing 22. Beneath the intermediate electrodes 51 and 52 as shown in FIG. 4, there is an inner electrode 12 carried by the insulating support 16 which serves a function of one electrode of the closed ionization chamber 10. The closed ionization chamber 10 is tightly closed by the intermediate electrodes 51 and 52 and the insulating support member 15. Thus the inner and outer surfaces of the intermediate electrodes 51 and 52 serve the functions of the pairs of electrodes 131, 132, and 231, 232 of the both ionization chambers in FIGS. 2 and 3. The housing 22 also contains radioactive material 21 attached to the inner face thereof and the inner electrode 12 supports radioactive material 11.

Two FET's 31 and 32 are partially embedded in the insulating member 15, and their gate electrodes are respectively connected to the intermediate electrodes 51 and 52 and their drain electrodes are connected to the inner electrode 12 as shown in the drawing. The space 17 under the support member 15 contains other circuit components (not shown) included in the present inventive circuit and a part of which may be arranged on a printed circuit board. However, it sould be noted that this invention is not limited to such a geometrical or mechanical arrangement of the smoke detector and various variations, modifications and changes can be made without departing from the scope of this invention as defined by the appended claims.

What is claimed is:

1. An ionization smoke detector, comprising a closed ionization chamber which is closed to the external air and includes a first electrode, a second electrode and a radioactive source, an open ionization chamber which is opened to the external air and includes a first electrode, a second electrode and a radioactive source, a pair of terminals connected respectively to both of said first electrodes of said ionization chambers, the second electrode of both said ionization chambers being connected in common, a first field effect transistor having a gate electrode connected to the junction of the second electrodes of said both ionization chambers and a source-to-drain conduction path connected through a load resistor between said both terminals, said ionization chambers further including third electrodes, said third electrodes of said ionization chambers being connected in common, a second field effect transistor having a gate electrode connected to the junction of the third electrodes of said both ionization chambers and a source-to-drain conduction path connected through a load resistor between both said terminals, and first and second relay elements connected in series between said terminals, said relay elements each including control means, and individual connections between said control means and the source-drain paths of said first and second field effect transistors respectively for control of said relay elements.

2. An ionization smoke detector according to claim 1 including first and second zener diodes connected in series between said terminals and a connection between the junction of the series connected first and second relay elements and the junction of the series connected first and second zener diodes.

3. An ionization smoke detector according to claim 1 wherein said second and third electrodes constitute opposite surfaces of single insulated electrodes, means including said single electrodes enclosing the first electrode of said closed chamber, one of said radioactive sources being disposed in said closed chamber, means including the first electrode of said open chamber enclosing the last said means to form said open chamber with the other radioactive source disposed therein, and individual connections between each of said single insulated electrodes and the gates of said field effect transistors.

4. An ionization smoke detector according to claim 3 including first and second zener diodes connected in series between said terminals and a connection between the junction of the series connected first and second relay elements and the junction of the series connected first and second zener diodes.

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