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Windscreen on radioactive ionization chamber

United States Patent [19]

Scheidweiler et al.

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[45] May 1, 1973

[54] IONIZATION FIRE ALARM WITH WIND SCREEN

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[73] Assignee: Cerberus AG, Mannedorf, Switzerland

[22] Filed: Apr. 5, 1971

[21] Appl. No.: 131,106

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 834,008, June 17, 1969, abandoned.

[30] **Foreign Application Priority Data**

June 18, 1968 Switzerland 9035/68

[52] U.S. Cl. ..... 250/44, 250/83.6 FT, 340/237

[51] Int. Cl. G01n 23/12

[58] Field of Search ..... 250/44, 43, 5 D, 250/83.6 FT; 340/237

[56] **References Cited**

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Assistant Examiner—C. E. Church
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[57] **ABSTRACT**

A low-voltage ionization fire alarm comprising at least one ionization chamber connected in series with a resistance element, preferably defining a reference chamber means, across a pair of conductors supplied by a direct-current voltage of less than 60 volts. The ionization chamber has a sheathing means serving as a wind screen for reducing the velocity of air flow within the chamber such that circulation of air within the chamber has substantially no effect upon the ionization current. The sheathing means preferably includes an outer and inner portion, with the inner surface of the outer portion having a geometric shape similar to that of the outer surface of the inner portion, the two surfaces being disposed substantially parallel to one another. At least one aperture is provided through the inner and the outer sheathing portions, respectively, the respective apertures being displaced such that the lateral separation between the margins of the aperture in the outer sheathing portion and the aperture in the inner sheathing portion is greater than the separation between the two sheathing portions themselves.

10 Claims, 6 Drawing Figures

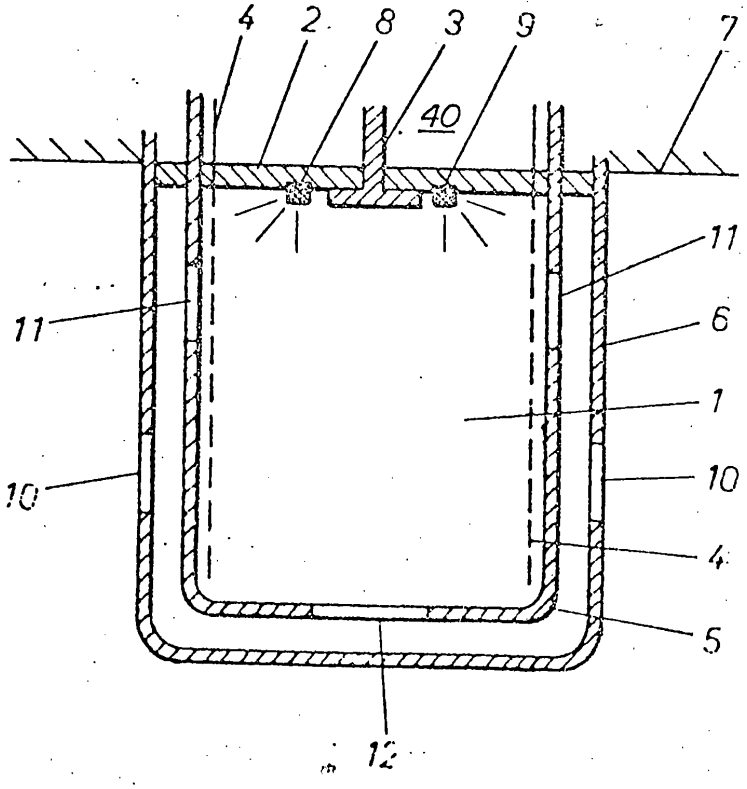

Fig. 1

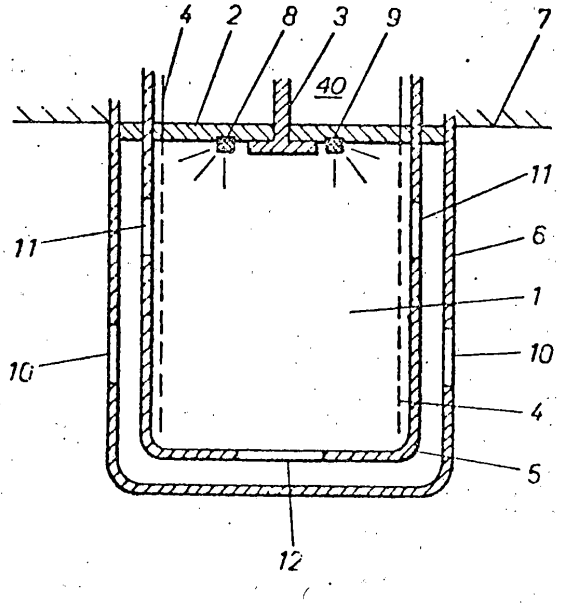

Fig. 2

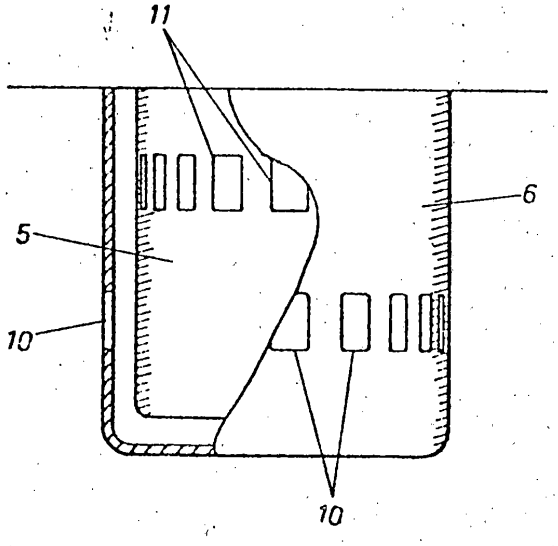

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Fig. 3

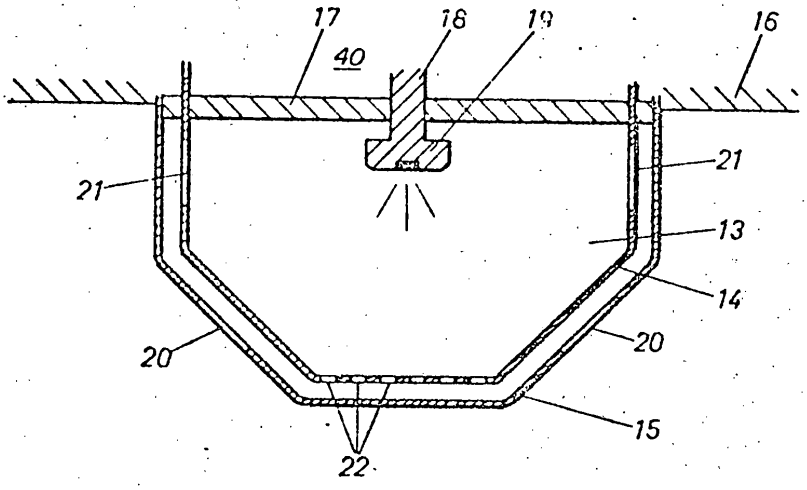

Fig. 4

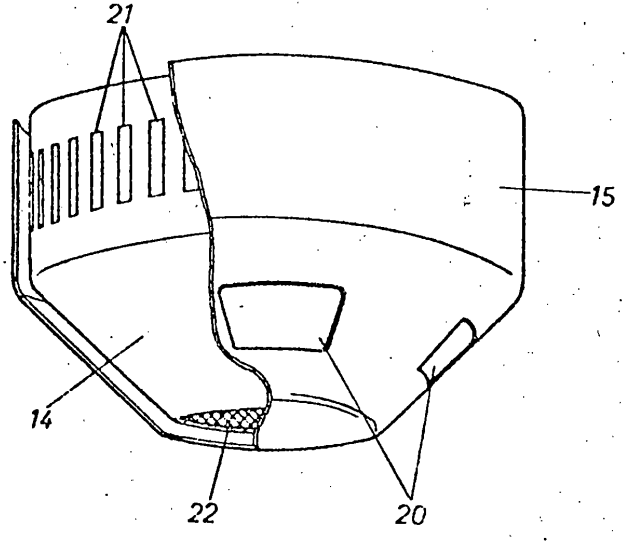

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Fig. 5

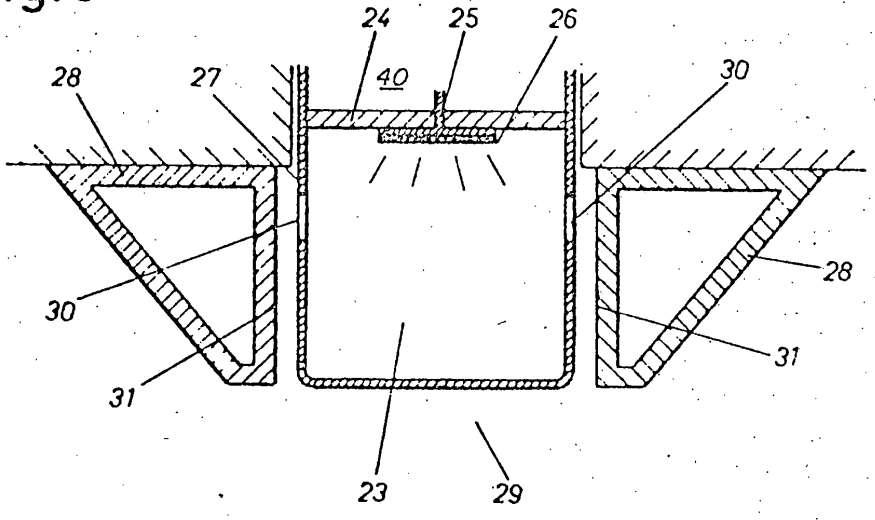
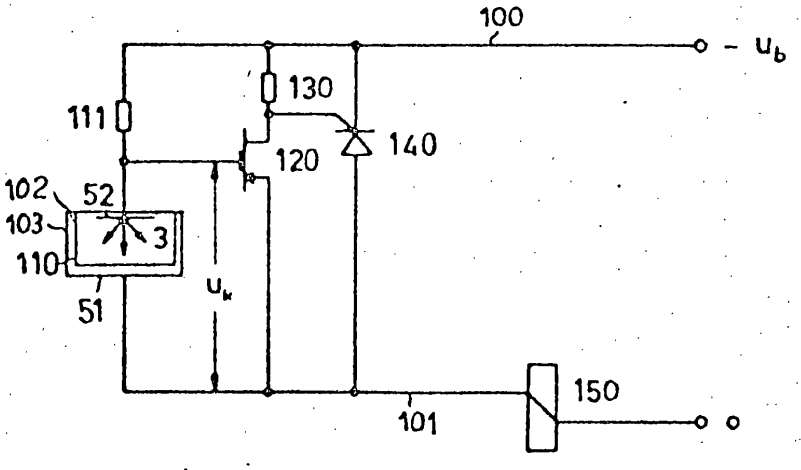


Fig. 6



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IONIZATION FIRE ALARM WITH WIND SCREEN

CROSS-REFERENCE TO RELATED CASE

The present application is a continuation-in-part application of our commonly assigned, copending U.S. application Ser. No. 834,008, filed June 17, 1969, now abandoned and entitled "Ionization Fire Alarm."

BACKGROUND OF THE INVENTION

This invention generally relates to fire alarms and particularly concerns low-voltage fire alarms of the ionization type which comprise at least one ionization chamber, the interior of which is in communication with the ambient air, at least a source of ionizing radiation and two electrodes, one of which electrodes may be constructed as a wall of the chamber, and a sheathing for reducing the speed of the ambient air flow into the interior of the chamber itself.

Ionization fire alarms serving to detect the presence of combustion aerosols in the ambient air generally comprise at least one ionization chamber which includes a radioactive substance for ionizing the air within the chamber. A voltage is applied between two electrodes within the chamber or between a single electrode and the chamber wall such that a flow of electric current arising from a flow of ions within the chamber occurs between the electrodes. Accordingly, upon the entrance of aerosols or other particles such as smoke or dust into the chamber, the ionization current will be altered.

Swiss patent specifications No. 297,463 and 355,380 describe an arrangement in which such an ionization chamber is connected in series with a resistor. The change of current in the ionization chamber occurring upon the appearance of aerosols or other particles within the chamber brings about a change in potential at an electrode, such potential change being appropriately amplified and subsequently employed so as to give an alarm.

Care must be taken in such apparatus so that the air has, so far as is possible, a free and unhindered access into the space between the electrodes in order to produce a sufficiently high apparatus sensitivity. As a rule, access of the air into the chamber is achieved by making the outer wall of the ionization chamber permeable to air in that such outer wall may, for example, be partially open or consist in part of a grid. Such general type of ionization fire alarm system has been disclosed in U.S. Pat. No. 3,353,170, granted Nov. 14, 1967, of Ernst Meili and Thomas Lampart, and assigned to the assignee of this application. There an ionization fire alarm system was disclosed which utilized a grid system of screen elements for the purpose of screening against the outflow of beta and electromagnetic radiation, whilst still allowing entry of combustion products or smoke particles into the ionization chamber. However, that particular patent was not concerned with measures to safeguard against the undesirable influence of wind effects upon the ionization current in ionization fire alarms operating at low voltages where wind speed within the ionization chamber can greatly affect the ionic current as will be explained hereinafter.

In more recent times, transistorized ionization fire alarms operating at low voltage have been developed, and in those cases wind effects are important factors to

be considered to ensure for the operational reliability of the alarm system. The commonly assigned U.S. Pat. No. 3,521,263, to be discussed again hereinafter, describes such an apparatus which typically operates at a chamber voltage of 20 volts or less, corresponding to a field strength of less than 5 V/cm. In ionization chambers of this type, however, the velocity of the ions that move between the electrodes is so greatly reduced that even a low wind speed or a slight circulation of the air within the chamber is sufficient to affect such ion current. If the integrity of the system is to be maintained safeguards against such wind effects must be provided.

Constructions have therefore been proposed in the art wherein it was sought to overcome the sensitivity of the ionization chamber to air currents by the provision of windshields of either plate or tube form. Yet, it has been found that even in such constructions, a certain flow of air still penetrates the ionization chamber and thus still affects the ionization current. Up to the present then, the prior art devices were unable of devising suitable measures to reliably mitigate or counteract these undesired wind effects.

SUMMARY OF THE INVENTION

Thus, a need still exists in the art for an ionization fire alarm which overcomes the above-mentioned drawbacks of prior-art constructions. It is a primary object of the instant invention to provide an ionization fire alarm which satisfies this need.

A further object of the instant invention is to provide a novel construction of an ionization fire alarm which is protected by screening devices specifically provided for he purpose of ensuring that the ionization current within the chamber is not appreciably affected by air flowing through the chamber.

Still a further extremely important object of the present invention is the provision of a novel construction of ionization fire alarm operating at low direct-current voltages, the supply voltage being less than 60 volts, resulting in reduced field strength conditions within the ionization chamber and thus reduced velocity of the ions, whereby to safeguard against undesirable affects upon ion mobility by wind currents entering the ionization chamber there is provided novel screening which minimizes the possible adverse affects which such wind current could otherwise have upon movement of the ions between the electrodes of the ionization chamber.

These objects as well as other objects which will become more readily apparent as the description proceeds, are implemented by the instant invention which is characterized by the provision of a low direct-current voltage ionization fire alarm comprising at least one ionization chamber to which chamber the external air has access and which includes at least a radioactive substance and two electrodes. This ionization chamber is connected in series with a resistance element, preferably defining a reference chamber, across two conductor lines supplied by a direct-current voltage of less than 60 volts. The terminal point of the ionization chamber and the resistance element is connected to the gate electrode of a field-effect transistor. The novel ionization fire alarm of the instant invention further has a sheathing provided at the ionization chamber for reducing the velocity of air flow within the chamber,

such sheathing comprising an outer and an inner portion which are separable from one another, the inner surface of the outer portion having a geometric form or shape similar to that of the outer surface of the inner portion, the two surfaces being disposed substantially parallel with one another. Both the inner and the outer sheathing portions are pierced by at least one aperture, the aperture or apertures in the outer portion being displaced with respect to the aperture or apertures in the inner portion such that the lateral separation between the margins or the edges of each aperture in the outer sheathing portion and each aperture in the inner sheathing portion is greater than the separation between the two sheathing portions themselves. It has been found that by maintaining these geometric conditions and the described structure of the sheathing as explained above and more fully hereinafter an extremely effective safeguard against the undesirable affects of wind currents within the ionization chamber is ensured for in cases of transistorized ionization fire alarm systems operating at low direct-current voltages, and thus, ion mobility predominantly unaffected by wind influences and necessary for achieving the required sensitivity of the alarm system during detection operations is adequately maintained.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself will be better understood and additional features and advantages thereof will be apparent from the following detailed description of preferred inventive embodiments, such description to be taken in conjunction with the accompanying drawings, wherein:

FIG. 1 depicts an axial cross-section through an ionization chamber of cylindrical form in accordance with the instant invention;

FIG. 2 depicts a partially sectional side elevational view of a novel ionization of the type depicted in FIG. 1;

FIG. 3 depicts a cross-section taken through an ionization chamber of more complex form forming a rough approximation to the hemispherical in accordance with the instant invention;

FIG. 4 is a partially cut-away perspective view of the ionization chamber of FIG. 3;

FIG. 5 depicts an ionization chamber built into a surrounding structure; and

FIG. 6 is a circuit diagram of typical circuitry of a low direct-current voltage transistorized ionization fire alarm system employing the inventive wind screening structure and serving to explain the general environment in which the concepts of the invention are particularly useful.

DETAILED DESCRIPTION OF PREFERRED INVENTIVE EMBODIMENTS

Referring now to the drawings and particularly to FIGS. 1 and 2 thereof, an ionization chamber is illustrated having a cylindrical sensitive space or measuring volume 1. An insulating base plate 2 carries an inner electrode 3 and an outer electrode 4, the outer electrode 4 preferably being of mesh form. The sensitive space or measuring volume 1 is surrounded by a sheathing consisting of two portions; an inner sheathing portion 5 which, in turn, is surrounded by an outer sheathing portion 6. The two sheathing portions surround the measuring chamber up to the fixing or supporting plane 7 thereof. Portions 8, 9 of radioactive material are provided in the interior of the chamber. The ionizing radiation emitted by such radioactive material serves to ionize the air in the space between the two electrodes 3 and 4 and gives rise to an electric current between such electrodes.

The outer sheathing portion 6 has a geometrical form or shape similar to that of the inner sheathing portion 5 such that the separation between the two sheathing portions is approximately the same at all places. The air to be investigated or monitored may enter through apertures 10 into the interspace between the two sheathing portions and thence through further apertures 11 and 12 provided in the inner sheathing portion 5 into the interior of the chamber. The separation between the two sheathing portions 5 and 6 is small as compared with the dimensions of the chamber. Furthermore, the apertures in the outer sheathing portion are displaced with respect to the apertures in the inner sheathing portion such that the separation of the margins or edges of the access apertures is greater than the separation between the two sheathing portions. Accordingly, by adhering to these measures the flow of air into the ionization fire alarm is so greatly retarded that it only has a low velocity as it enters into the measuring space or volume.

By virtue of the arrangement of access apertures as above described, it is ensured that the additional mobility of the ions resulting from the speed of flow of the air within the chamber is small in comparison with the mobility due to the electric field itself. In other words, the ionization current is effectively independent of the speed of flow of the air.

FIGS. 3 and 4 depict an ionization fire alarm of a somewhat more complex form than that depicted in FIGS. 1 and 2, such form being a rough approximation to the hemispherical. The measuring volume 13 is again surrounded by an inner sheathing portion 14 which, in turn, is surrounded at least as far as the fixing or supporting plane 16 by an outer sheathing portion 15 of similar geometrical form or shape such that the separation between the internal and external sheathing portions is approximately constant.

An inner electrode 18 passes through an insulating base plate 17, inner electrode 18 carrying a radioactive substance 19. The wall of the inner sheathing portion 14 acts as the second electrode in this embodiment.

The air to be supervised or monitored can enter into the measurement space or volume through access apertures 20 provided in the outer sheathing portion and through access apertures 21 and 22 provided in the inner sheathing portion. The arrangement or disposition of the access apertures in relation to one another is again importantly such that even with high flow velocity of the ambient air, the velocity of air flow within the chamber itself is small.

In this embodiment, the access apertures are displaced in relation to one another such that it is not possible to draw a straight line through an aperture n the outer sheathing portion and through any aperture in the inner sheathing portion. This is ensured by placing the apertures in the inner sheathing portion and in the outer sheathing portion on different surfaces which

are not parallel with one another, but which rather includes an angle between them. In this inventive embodiment, apertures 22 are preferably constructed as wire grids.

The access apertures 20 provided in the outer sheathing portion are inclined to the axis of the alarm itself, here a vertical axis, by an angle which lies between 30° and 60°, such angle in the illustrated embodiment being 45°. It is thus ensured that the ionization chamber has sufficient sensitivity and that such sensitivity remains as uniform as possible for both vertical and horizontal air flows.

Many variations are naturally possible with respect to the arrangement of the access apertures in the two sheathing portions. An adequately low speed of airflow in the interior of the chamber can always be attained if the inner and outer access apertures are displaced so far from one another that no direct air flow can take place through the measurement chamber and if, on the other hand, a uniform and so far as possible turbulence-free air flow occurs in the interspace between the two sheathing portions to the inner access chambers due to an approximately constant separation, without obstructions, between the two sheathing portions. Additionally, the sheathing may consist of a plurality of appropriately assembled parts. Advantageously, the inner and outer sheathing portions are mechanically separate from one another and the outer portion is preferably separable or removable. The apertures in the inner sheathing portion preferably and advantageously consist either wholly or in part of grids.

The illustrated embodiments depict fire alarms which are intended for building into a surrounding surface. In this instance, and as will be explained further hereinafter a further ionization chamber operating as a reference chamber closed against the external air, may be situated on the other side of the base plate 2 or 17, as generally indicated by reference character 40, as might be other components and electrical circuits.

In ionization fire alarms intended for surface mounting or suspended operation, the other parts of the circuit of the ionization fire alarm are normally combined with the measuring chamber into a single compact unit. In this instance, the mounting plane for the two sheath portion would lie approximately in the plane of the insulating base plate 2 or 17. One of the two sheath portions for the measuring chamber can, in this instance, also serve as a casing for the circuit components.

FIG. 5 depicts a further embodiment of the instant invention in which the outer portion of the sheathing for the measuring chamber is formed as a part of a mounting base 28 for mounting the fire alarm. The measuring chamber here consists of the base plate 24, the electrode 25 with the radioactive substance 26, and the inner sheath portion 27 which here acts as the second electrode. In this instance, the access aperture in the outer sheath portion is considered as being formed by the circular aperture 29 in the base 28 which, so as to further reduce the effect of air currents, may be provided with a non-illustrated cover pierced by small apertures. Here again, the inner apertures 30 are displaced from the aperture in the base by more than the separation between the inner wall of the base and the inner sheathing portion.

In all of the embodiments herein disclosed in FIGS. 1 to 5 the outer and inner sheathing portions are separable from one another, which can be easily accomplished, for instance, if the outer sheathing portion is removably clamped or otherwise conveniently attached for instance to the support or base plate, or the support surface by way of example. This is advantageous since the removable feature of the sheathing portions allows for convenient cleaning of the interspace between such portions which may become deposited with dust particles and other contaminants. Cleaning can therefore be easily performed from time to time by simply dismantling the removable outer sheathing portion.

Up to now the details of the sheathing arrangement for various constructions of ionization fire alarms have been disclosed and discussed in conjunction with FIGS. 1 to 5 herein. These ionization fire alarm constructions are used in the environment of low direct-current ionization fire alarm systems of the transistorized type wherein screening of the interior of the measuring chamber against the affects of wind is of importance. It will be recalled that previously it was indicated that modern day transistorized ionization fire alarms which operate at low voltages, typically with a direct-current voltage supply of less than 60 volts and generally with a chamber voltage of 20 volts, or less, and thus, a field strength corresponding to a value of less than 5 V/cm are extremely sensitive to the influence of any wind currents. Thus, the velocity of the ions that move between the electrodes is so drastically reduced in these type ionization fire alarm systems that even a low wind speed or slight air circulation within the ionization chamber is sufficient to affect the ion current and thus similarly affect the operational integrity of the system. Transistorized circuitry for such low voltage ionization fire alarm systems is well known to the art, as evidenced, by way of example, in the commonly assigned U.S. Pat. NO. 3,521,263, granted July 21, 1970 of Thomas Lampart and Andreas Scheidweiler, entitled "Ionization Fire-Alarm And Improved Method Of Detecting Smoke And Combustion Aerosols." Yet, to fully comprehend the environment of use of the instant invention it is thought appropriate to here explain a typical circuit arrangement of transistorized ionization fire alarm system wherein the ionization chamber can be equipped with any of the heretofore disclosed constructions of wind screening devices.

Hence, by now referring to FIG. 6 which schematically depicts a simple embodiment of ionization fire alarm, it will be understood that the ionization or measuring chamber 110 is electrically coupled at its inner electrode 52 with the negative pole of the operating voltage voltage U_b through the agency of the resistor 111 which conceptually may be considered to define a reference chamber and the conductor line 100 and at its chamber housing 1 is electrically coupled with the positive pole of such operating voltage U_b through the agency of the conductor line 101. This operating voltage is a direct-current voltage of less than 60 volts. Also, it is here again indicated that the ionization chamber 110, only schematically illustrated in FIG. 6, can embody any of the heretofore disclosed constructions of ionization chambers discussed in conjunction with FIGS. 1 to 5, and therefore there has only been schematically illustrated in FIG. 6 the inner sheathing

102 and the outer sheathing 103 which may conform to the constructions of any of the heretofore discussed embodiments. By way of example, at the inner electrode 52 there is provided a radioactive source 53 similar to the arrangement of FIGS. 3, 4 and 5. Naturally, there also could be provided a plurality of radioactive sources, such as shown for instance in the embodiment of FIGS. 1 and 2. In any case, the voltage U_k across the measuring or ionization chamber 110 is, at the same time, the gate voltage for a suitable semiconductor element, namely the field-effect transistor 120 providing a sensing or indicating means which senses voltage changes across the electrodes 51 and 52 of the ionization chamber 110. This voltage U_k is chosen such that the field-effect transistor 120 in its quiescent state blocks current flow, that is to say, at the working resistor 130 there is no voltage drop. Moreover, it should be appreciated that in the absence of smoke and combustion aerosols the voltage across the ionization chamber 110 is advantageously of a magnitude smaller than 20 volts. The gate-controlled rectifier 140 is therefore likewise blocked and the relay 150 is not energized. Now, if smoke or combustion gases penetrate into the measuring or ionization chamber 110 then the chamber voltage U_k increases and upon exceeding a predetermined threshold triggers ignition of the controlled rectifier 140, whereby the relay 150 triggers a suitable alarm. Triggering of the alarm can be carried out in any appropriate manner, as for instance shown and described in commonly assigned U.S. Pat. No. 3,233,100 of Thomas Lampart, entitled "Determining Presence of Aerosols In Gases," and granted Feb. 1, 1966. In this instance, the field-effect transistor 120 operates both as a threshold device as well as also as an amplifier element.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:

1. An ionization fire alarm, comprising at least one ionization chamber to which the external air has access, said ionization chamber including at least one radioactive substance and two electrodes, said ionization chamber being connected in series with a resistance element and across two conductor lines supplied by a D.C. voltage which is less than 60 volts, the connecting point of said ionization chamber and said resistance element being connected to a gate electrode of a field-effect transistor, said ionization chamber further including sheathing means for reducing the velocity of air flow within said ionization chamber, said sheathing means comprising a respective outer and inner sheathing portion, said outer and said inner sheathing portions being separable from each other, the inner surface of said outer portion having a geometric form substantially similar to that of the outer surface of said inner portion, said two surfaces being disposed in spaced relationship with regard to one another, said inner and outer sheathing portions each being pierced by at least one respective aperture, said aperture in said outer portion is displaced with respect to said aperture in said inner portion such that said apertures are disposed in a non-overlapping relationship to provide a tortuous air path of substantially non-linear characteristics through said ionization chamber thereby greatly reducing undesirable wind effects on the ionization current in said ionization chamber.

2. An ionization fire alarm in accordance with claim 1, wherein said apertures in said two sheathing portions are formed in respective surfaces which are inclined to one another.

3. An ionization fire alarm in accordance with claim 1, wherein said aperture in said outer sheathing portion is so disposed in relation to said aperture in said inner sheathing portion that no rectilinear path exists from a point in an outer aperture to any point of an inner aperture.

4. An ionization fire alarm in accordance with claim 1, wherein said alarm is axially symmetrical, and further wherein said apertured surface of said outer sheathing portion forms an angle of between 30° and 60° with the axis of symmetry of the fire alarm.

5. An ionization fire alarm in accordance with claim 1, wherein the separation between said inner surface of said outer sheathing portion from said outer surface of said inner sheathing portion is smaller than the dimensions of said ionization chamber.

6. An ionization fire alarm in accordance with claim 1, wherein said outer sheathing portion is removable.

7. An ionization fire alarm in accordance with claim 1, wherein said aperture in said inner sheathing portion at least partially consists of grids.

8. An ionization fire alarm in accordance with claim 1, wherein one electrode of the ionization chamber is formed by the wall thereof.

9. An ionization fire alarm in accordance with claim 1, wherein said electrodes in said ionization chamber are supplied by a voltage which is less than 20 volts D.C.

10. An ionization fire alarm in accordance with claim 1, wherein said resistance element defines a reference chamber.

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