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(54) IONISATION FIRE ALARM

(71) We, CERBERUS AG., a corporation organised under the laws of the confederation of Switzerland, of CH-8708 Mannedorf, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

- 10 The present invention relates to an ionization fire alarm sensor device, and more particularly to a device in which at least one radioactive substance is located within an ionization chamber, accessible to the ambient atmosphere, which is included in an electrical circuit arranged to generate and transmit an electrical alarm signal under predetermined conditions of ionization within the chamber.
- 15 Ionization fire alarm sensor devices for use in fire alarm systems include a measuring chamber in which atmosphere is ionized by a radioactive substance located within the chamber. An ionization current may be produced between electrodes located in the ionization chamber. If smoke, smoke aerosols, or other particles penetrate through openings into the ionization chamber, then the ionization current will change and this change in current can be utilized to provide an alarm signal, for example to a central fire station. The electrical circuits are usually arranged as close as possible to the ionization chamber and include a resistance element, for example, a second or reference ionization chamber which is completely or almost completely sealed against smoke aerosols, smoke or the like. The potential difference at the junction between the two chambers is then determined by means of a high resistance amplifier element, for example a field effect transistor (FET). The charge on the electrodes in the ionization chamber can also be determined, from time to time, for example by

[Price 25p]

scanning in order to determine the presence of smoke aerosols or smoke, and thus the existence of an actual or incipient fire.

Ionization chambers as usually provided frequently have resistances of more than 50 $10^{10}\Omega$. The electrical circuit must, therefore, have an extremely high input resistance which should preferably be substantially higher than the resistance of the ionization chamber. Thus, ionization-type fire alarm sensor devices are very sensitive to contamination, dirt, and other interfering effects which decrease the insulation resistance. Additionally, particles in the immediate vicinity of the sensor, such as dust, are also ionized and transported within the measuring chamber, to be deposited therein. Smoke aerosols are likewise deposited. Thus, such fire alarm sensor devices have to be cleaned frequently and, in particular, the ionization chamber requires cleaning. Such cleaning and maintenance is time-consuming, frequently difficult and sometimes dangerous.

The sensor devices are usually constructed as compact, plug-in units which can be plugged into a mounting surface, for example into a socket located at the ceiling of the space or area to be supervised. The various components of the fire alarm sensor are usually interconnected with each other, for example by being riveted or screwed. To open and clean the sensing element, and thus to clean the ionization chamber is therefore time consuming; additionally, the sensor devices have to be removed from their sockets which frequently are located at ceiling height or above substances liable to be damaged by fire, for example shelving or the like, and it is frequently difficult and sometimes almost impossible to reach the sensor devices directly from the ground without the use of ladders or the like.

Opening an ionization-type fire alarm

Price 75p

sensor device is not without hazard, since the ionization chambers include radioactive substances. Additionally, casual accidental contact with the high resistance input to the electrical circuit, for example the field effect transistor at the input, may cause damage to electrical components. Thus, thoroughly trained and safety conscious personnel are necessary to carry out the maintenance and cleaning work.

If a fire should start, the increase in temperature can melt plastics parts located within the socket and the ionization sensor device. In some constructions of sensor device the entire sensor device, or at least parts thereof containing the radioactive source may fall off, thus causing radioactive contamination of the site of the fire.

It is an object of the present invention to provide an ionization-type fire alarm sensor which can be interchanged rapidly and simply, which can be checked and cleaned by essentially unskilled personnel without causing any hazards to the personnel and which is so constructed that the sensor itself cannot be damaged by accidental contact with its circuit component. Additionally, the construction should be such that radioactive substances cannot be released from the sensor even if plastics parts therein should melt.

According to the present invention there is provided an ionization fire alarm sensor device comprising a housing structure having at least three interconnected parts formed with engaging, independently separable interlocking means to permit individual separation of the parts from each other, a first of said parts forming a socket adapted to be secured to a support and being formed with electrical contacts and adapted for electrical connection to a fire alarm system, a second of said parts comprising separable contacts engaging with the contacts of said first part, means defining one portion of an ionization chamber having therewithin a radioactive ionizing substance, and an electrical circuit arrangement responsive to changes in the electrical characteristics of the atmosphere within the chamber, and a third part comprising the remaining portion of the ionization chamber and being independently separable from said other parts, said third part covering at least a portion of said second part and being shaped to deter the ingress of dust and dirt into said second part.

The construction in accordance with the invention permits separation of the third part, which forms, together with a portion of the second part, the ionization chamber to be separately removed and cleaned; the construction is preferably so selected that all surfaces subject to contamination by dust or dirt are separated upon removal

of the third part, the ionizing element itself being shielded from such contamination. The second part, together with the radioactive substance and the electrical circuit which is sensitive to touch can remain in the socket. If desired, the second and third part can be removed together, or the second part can be removed separately after removal of the third. Screw connections, for example by set screws can be provided to prevent separation of the second part containing the ionizable substance so that this portion can be removed only by trained personnel under appropriate safety regulations.

Separable, independent interlocking interconnections are arrangements in which one or both parts have spring elements which are pressed from their rest or normal position and which then can snap into holes, notches, grooves or recesses in order to retain the parts together, if and only if they are in the proper locking position. The spring elements, at least in part, are accessible from the outside, with or without any separate tools, so that they can be pressed from their rest position in order to release the interconnecting parts. Snap springs, spring rings, bayonet connections or other arrangements with similar function are suitable.

In a preferred form, the interlocking connections are so made that they can be reached from ground level directly, or by means of a simple separating tool which can be raised to the ceiling. If the springy elements are movable in different directions, then, by selecting the direction of movement, only the third part or the second and third part together can be, selectively, removed.

The invention will be described by way of example with reference to the accompanying drawings, wherein:

Figure 1 is a vertical sectional view of the three portions of the ionization sensing device, in exploded, removed form; and

Figure 2 is a generally perspective view of a similar ionization-type sensor, partly cut open, with the second and third part connected and the second part removed from the first; and illustrating further a removal tool, in schematic form, aligned in engagement with the sensor.

The socket, which forms one part of the separable ionization sensor is a cylindrical housing 1 having a base 2 which can be secured to a support surface, for example a ceiling. This housing, preferably, is of metal. The housing is formed at various portions of its circumference with slits 3; the material punched out from the slits is bent inwardly as an inwardly projecting angle 4. A part 5, for example of plastics or ceramic, is secured to the bottom shell

2 of the housing. Part 5 carries at its bottom side a plurality of contact springs 6 which are readily movable in a vertical direction. The contact springs 6 are connected with electric connection wires 7 which interconnect the various sensors among each other, and with a fire alarm central station. The contact springs 6 additionally form the connection between these lines and matching suitably arranged contact surfaces 8 on the second part of the sensor. An outer shell 9 which may consist, for example, of plastics can be used to adapt the sensor to various types of attachments, for example to fire alarm outlet boxes or the like.

The second portion of the fire alarm sensor includes a ring 10 of insulating material, for example plastics, and having suitably shaped grooves and projections. A plate 11 of insulating material is secured to ring 10. The upper surface part of plate 11 has a printed circuit formed thereon. The circumference of plate 11 is formed with various slits 12 through which the inwardly extending angles 4 can pass. By relative rotation of the second part with respect to the first, the angle 4 will slide over a camming element 13, formed, for example, as a punched projection and lock in position by means of the pressure of springs 6 on the insulating plate 11. The extent of rotation is limited by the extent of slits 14 in the plastics ring 10. The lower side of the insulating plate 11 has a metallic ring 15 secured thereto which is formed at various points of its circumference with pinching or friction holding springs 16 to secure the third part of the sensor thereto. On those points where the insulating plate 11 engages with inwardly extending angles 4, metallic ring 15 is formed into projections 17 which extend from the upper side of insulating plate 11. If, for example, due to excessive heating, for example due to a fire, insulating plate 11 deforms, metallic ring 15 will still secure the sensing element together by catching on, and bearing against the angles 4 of the socket part.

The upper side of the insulating plate 11 has a metallic hood 18 secured thereto, defining therein a reference ionization chamber. Hood 18 has one or more cam projections 19 which fit into slits 20 of part 5 and provide a guide for the proper fitting together of the first and second portion of the sensor. A double electrode 21 is located centrally of the plastics ring 10. Double electrode 21 is formed with double-sided end faces, like a double mushroom, and radioactive substances 22, 23 are located at the flat faces of the double-sided electrode 21. The various components of an electrical circuit 24 are located in

the space between ring 10 and insulating plate 11. Connecting wires are connected to appropriate points of the printed circuit on the upper side of the insulating plate 11. The embodiment illustrated utilizes two ionization chambers, connected to a field effect transistor (FET)₂₅ having highly insulated input. In order to improve isolation between the adjacent connecting wires, the field effect transistor is encapsulated within a suitable insulating mass, and located in the space between plate 10 and plate 11. A control lamp 26, visible from the outside, indicates the state of sensing of the ionization sensor.

The third portion of the sensor comprises a metallic shroud 27, having openings 28, 29 for the entry of the surrounding atmosphere. The upper edge 30 of shroud 27 is bent over outwardly, so that, upon attaching together the second and the third portions, it will catch over holding springs 16. Removal of this inter-engagement is possible only when springs 16 are pressed outwardly, so that shroud 27 can be removed.

A labyrinth 31, made of highly insulating plastics material, is located in the interior of shroud 27. It includes a series of annular projections 32 to increase the surface leakage path, that is the leakage distance between the housing of the shroud and the inner electrode 21. Opening 33 is formed in the interior of the labyrinth 31 to permit the lower mushroom end of electrode 21 to pass therethrough. Labyrinth 31 is securely pressed to annular projections 34 formed on the plastics ring 10, when the sensor is assembled together. Thus, the surface leakage path between the centre electrode 21 and the shroud 27, forming the counter electrode, is increased by approximately four times the minimum distance. Additionally, the surface of plastics ring 10 is sealed by the presence of labyrinth 31, so that smoke and dust will precipitate in those portions of the measuring chamber which form part of the third element of the fire alarm sensor. The sensor can thus be effectively cleaned by mere removal of the third part without removing the sensitive portions of the electrical circuit or the radioactive substances therein. This completely prevents damage of the fire alarm sensor during maintenance, and any danger to personnel handling the third portion during cleaning or repair thereof.

The second portion may, additionally, be secured against undesired and unauthorized removal by means of a set screw 35 located in ring 10 which presses the insulating plate 11 to angle 4 to such an extent that angle 4 can no longer pass over cam 13. The third portion, that is the third element of the sensor, can be removed without diffi-

culty, whereas the second portion can be removed only by additional loosening of the safety set screw.

The upper side of the labyrinth 31 is formed with an annular projection 36 which, when the parts are assembled together, fits into a corresponding groove 37 of ring 10. This presses pin 38 upwardly, thus opening a short circuit switch. Field effect transistor 25 is thus protected from damage by accidental contact of the electrodes when shroud 27 is removed (see Swiss Patent 460,594 for a full disclosure, which is hereby incorporated by reference). If necessary, shroud 27 may have a second shroud 39 applied thereover (see Swiss Patent 475,614, hereby incorporated by reference) which has atmospheric inlet openings 40 offset with respect to openings 28, 29 of shroud 27. This substantially decreases the sensitivity of the ionization fire alarm sensor to air currents.

Figure 2 additionally shows a suitable removal tool, adapted for the removal of the components of the sensor of the present invention. It essentially comprises a cylindrical shell 41 which fits exactly in the space between shroud 27 and ring 10. Placing shell 41 in this space compresses springs 16, by pressing them radially outwardly, thus releasing the third element of the sensor from the second and permitting its longitudinal removal. If, additionally, the element is rotated, then angles 4 will slip over the cams 13 (provided set screw 35 is loosened, or absent) to enter slits 12, and the second part of the sensor can be removed from socket 1 together with shroud 27. This shell can readily be secured to a long pole so that portions of the sensor can be replaced or cleaned from the floor surface without requiring that personnel carry and mount ladders. This substantially decreases the period of time per sensor for maintenance. Simple and fast cleaning of the sensing element is thus possible without danger that potentially hazardous, or delicate parts of the sensor might be touched. Maintenance can thus be entrusted to less than highly skilled personnel.

The arrangement in accordance with the present invention is so made that, if the sensor is subjected to a temperature high enough that all plastic parts therein will melt, constructional integrity of the sensor itself is not impaired. None of the three three portions of the sensor will separate and particularly the radioactive substance will not fall out of the sensor but remain therein. This effectively inhibits radioactive contamination of the location of a fire.

Various equivalent constructions can be used, and the present invention is not limited to the specific arrangement of parts de-

scribed in detail. The sensor is formed of at least three interconnected parts, of which a first part secures the assembly to a support, such as a ceiling, a second part includes all the sensitive and potentially hazardous parts, and a third part provides a shield or shroud protecting the sensitive and potentially hazardous parts against dust, dirt or other contamination. All the parts are so constructed that they are independently separable and connected by independently operable interlocking arrangements. The specific type and arrangement of the interlocks themselves can be selected depending on the specific form and shape of the sensing elements.

The third part of the sensor which is particularly subject to dirt and dust is so constructed that all sensitive elements of the second part, and particularly the insulation path between the electrodes of the ionization chamber are so covered, when the third part is attached to the second, that contamination by deposit of dust, or the like is avoided.

WHAT WE CLAIM IS:—

1. An ionization fire alarm sensor device comprising a housing structure having at least three interconnected parts formed with engaging, independently separable interlocking means to permit individual separation of the parts from each other, a first of said parts forming a socket adapted to be secured to a support and being formed with electrical contacts and adapted for electrical connection to a fire alarm system, a second of said parts comprising separable contacts engaging with the contacts of said first part, means defining one portion of an ionization chamber having therewithin a radioactive ionizing substance, and an electrical circuit arrangement responsive to changes in the electrical characteristics of the atmosphere within the chamber, and a third part comprising the remaining portion of the ionization chamber and being independently separable from said other parts, said third part covering at least a portion of said second part and being shaped to deter the ingress of dust and dirt into said second part.

2. A sensor device in accordance with claim 1, wherein the interconnection means comprises spring elements secured to at least one engaging part and engaging another part with an over-centre action.

3. A sensor device in accordance with claim 1 or claim 2, wherein the interconnection means between a first pair of said parts are separable by relative motion between said pair of parts in a predetermined direction, and the interlocking means formed between one of said first pair of parts and the remaining part are separable upon relative motion in a different direction be-

culty, whereas the second portion can be removed only by additional loosening of the safety set screw.

The upper side of the labyrinth 31 is formed with an annular projection 36 which, when the parts are assembled together, fits into a corresponding groove 37 of ring 10. This presses pin 38 upwardly, thus opening a short circuit switch. Field effect transistor 25 is thus protected from damage by accidental contact of the electrodes when shroud 27 is removed (see Swiss Patent 460,594 for a full disclosure, which is hereby incorporated by reference). If necessary, shroud 27 may have a second shroud 39 applied thereover (see Swiss Patent 475,614, hereby incorporated by reference) which has atmospheric inlet openings 40 offset with respect to openings 28. 29 of shroud 27. This substantially decreases the sensitivity of the ionization fire alarm sensor to air currents.

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scribed in detail. The sensor is formed of at least three interconnected parts, of which a first part secures the assembly to a support, such as a ceiling, a second part includes all the sensitive and potentially hazardous parts, and a third part provides a shield or shroud protecting the sensitive and potentially hazardous parts against dust, dirt or other contamination. All the parts are so constructed that they are independently separable and connected by independently operable interlocking arrangements. The specific type and arrangement of the interlocks themselves can be selected depending on the specific form and shape of the sensing elements.

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2. A sensor device in accordance with claim 1, wherein the interconnection means comprises spring elements secured to at least one engaging part and engaging another part with an over-centre action.

3. A sensor device in accordance with claim 1 or claim 2, wherein the interconnection means between a first pair of said parts are separable by relative motion between said pair of parts in a predetermined direction, and the interlocking means formed between one of said first pair of parts and the remaining part are separable upon relative motion in a different direction be-



tween said one part and said remaining part.

4. A sensor device in accordance with claim 3, wherein said first motion is a relative rotary motion between said parts and said motion in a different direction is a longitudinal motion.

5. A sensor device in accordance with claim 4, wherein the interconnection means interconnecting said first pair of parts comprises a bayonet-type interlock requiring both rotary and longitudinal movement for engagement and separation of said parts, the longitudinal movement being against a spring bias.

6. A sensor device in accordance with any one of the preceding claims, wherein the interconnection means comprises metallic interengaging elements remaining engaged even upon melting of non-metallic elements of the sensor device.

7. A sensor device in accordance with any one of the preceding claims, wherein said second housing part comprises an electrode terminal connected to the electrical circuit means, and wherein said third housing part comprises a metallic housing member and an insulating labyrinth separating said electrode terminal from said metallic housing, said labyrinth being long enough to extend the surface leakage path between the electrode terminal and the housing by approximately four times the minimum distance therebetween.

8. A sensor device in accordance with any one of the preceding claims, wherein said second housing part includes an insulating plate carrying thereon a printed

circuit forming a part of said electrical circuit arrangement.

9. A sensor device in accordance with any one of the preceding claims, wherein the electric circuit means includes a field effect transistor encapsulated in an insulating mass.

10. A sensor device in accordance with any one of the preceding claims and including additional locking means securing the first and second housing parts together and permitting separation of the first and second part only upon disengagement of said additional locking means.

11. A sensor device in accordance with claim 10, wherein the additional locking means comprises a set screw.

12. A sensor device in accordance with any one of the preceding claims, wherein the second housing part includes a second or reference ionization chamber.

13. A sensor device in accordance with any one of the preceding claims, wherein the interlocking means are so arranged that separation of the second part from the first part and separation of the third part from the second part may be effected by movement in different directions of the same tool applied to said sensor device.

14. An ionization fire alarm sensor device substantially as described with reference to the accompanying drawing.

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