

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN IONIZATION FIRE SENSORS

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

The present invention relates to an ionization fire sensor including a housing which has openings to permit the entry of ambient air to an ionization chamber, containing two electrodes and a radioactive source to provide an ion current. The ion current changes when smoke or combustion aerosols are present in the ambient air.

Ionization fire sensors must meet many, simultaneously applicable requirements. Their sensitivity should be high, that is the ion current should change by a relatively great amount upon presence of even a very small smoke or fire aerosol concentration within the ionization chamber. Using a low field strength of the electric field within the ionization chamber results in high change in ion current in response to the presence of smoke, or combustion aerosols.

Ionization fire sensors are quite sensitive to air movements. It is, therefore, necessary to limit the velocity of any air movement within the ionization chamber by means of air retarding or air deflecting elements. Dust which is carried by air flowing into the chamber is apt to become separated from the air stream at positions at which the air stream changes direction and thus to be deposited upon the air deflecting elements, so that certain zones of the fire sensor housing become quickly coated with dust and dirt. Such deposits are particularly noticeable in the vicinity of the openings to the housings. Known ionization fire sensors therefore require frequent cleaning of the housing to remove

deposited dust and dirt. This requires a good deal of labour and is expensive.

Ionization-type fire sensors contain sensitive parts; which are exposed upon opening of the housing. When the housing is opened, for example for cleaning, the danger is always present that such sensitive parts may be damaged. Low voltage ionization fire sensors which use a field-effect transistor in their sensing circuit are particularly subject to damage; touching that electrode of the sensor which is connected to the control electrode of the field effect transistor may lead to destruction of the transistor. It has, therefore, been found necessary to protect the field effect transistor upon opening of the housing by suitable circuitry, for example by protective switches, in order to avoid destruction thereof. This circuitry is additional to the normal sensor circuitry and hence adds to the cost.

It is an object of the present invention to provide a sensor which is so designed that it is little subject to contamination by dirt and dust, can be cleaned simply, and is so arranged that the danger of damage of components thereof by touching sensitive elements is essentially avoided, without decreasing the sensitivity of the sensor, or increasing the tendency to give false alarms based on air currents.

According to the present invention there is provided an ionization fire sensor assembly including a housing enclosing an ionization chamber comprising a source of ionizing radiation and two electrodes, so arranged that an ion current produced between the electrodes changes in the presence of fire or smoke aerosols within the chamber, wherein the housing comprises at least two portions separated from each other by an essentially continuous annular slit, the parts of the assembly in the vicinity of the slit being arranged to cause the

direction of air flow through the slit into the chamber to be deflected from an essentially straight path, at least one of said portions being removable, and wherein one of said electrodes comprises an air-pervious grid or mesh located to inhibit mechanical access to the other of said electrodes and hence to prevent accidental contact with the other electrode.

An embodiment of the invention will be described by way of example with reference to the drawings, in which:

Figure 1 is a transverse sectional view through one embodiment of a sensor which, in plan view, may be circular; and

Figure 2 is a schematic side view of another embodiment, in which the opening to the housing is differently arranged.

The ionization fire sensor of Figure 1 has a mounting portion 1 and a sensor portion 2. Mounting portion 1 is formed with a lateral opening in which is located an indicator lamp 3, for example a light-emitting diode.

The sensor portion 2 has a cylindrical or, as shown, somewhat tapering housing 4 and a bottom cover 5. Housing 4 and bottom cover 5 are separated by an annular slit 13, which is preferably no more than 0.5 cm wide. Air can pass through slit 13 into the interior of the housing. The inside of the cover 5 is provided with an upwardly projecting cylindrical baffle wall 12. The height of the baffle wall 12 is, preferably, at least 1 cm, and it extends cylindrically around the inside of the slit 13 to deflect air entering into the sensor upwardly in vertical direction.

The spacing of the baffle 12 from housing 4 may be approximately equal to the width of the slit 13, or somewhat greater or somewhat less. This spacing need not necessarily be of constant width, but may increase towards the top, for example if, as shown, the baffle 12 is cylindrical and the housing 4 is conical (Figure 1). The spacing may alternatively decrease towards the upper opening, for example if the baffle 12 is of conical form with a greater conical angle than that of housing 4. The bottom cover 5 and the baffle 12, which may be made integral therewith, for example by being welded or soldered to the cover 5, are secured to the housing 4 by fastening elements connecting the cover 5 with the housing 4 in such a manner that the ring-shaped labyrinth slit permitting ingress of air is obstructed as little as possible. Cover 5 may be permanently secured to the housing 4, for example by a few wire pins connecting the housing 4 to the cover 5, or it may be removably attached to the housing, for example by three equidistantly circumferentially spaced screws of which one is shown at 41, similar to the known

arrangement holding for lamp globes in electric lamp fittings. Any other suitable attachment of the bottom cover 5 to the housing 4 may be used, rigidly or removably interconnecting these two parts, if care is taken that the slit 13, or the inner portion of the slit is interrupted as little as possible. The diameter of the cover 5 may be larger than the diameter of the housing 4 if desired.

The air inlet system has particularly advantageous characteristics if the following conditions are met:

(a) the height H of the baffle 12 should be at least twice the width B of the slit 13;

(b) the maximum dimension of the distance A between the baffle 12 and the housing 4 should be at most twice the dimension of the width B of the slit 13;

(c) the depth T of the slit 13 should be at least half the width B of the slit 13.

In one form of the invention which has been found advantageous, and which is given by way of example, the width B of the slit 13 was 3 mm; the height H of the baffle 12 was 9.5 mm the maximum distance A between the baffle 12 and the housing 4 was 3.5 mm; the depth T of the slit 13 was 5 mm. The maximum diameter of the housing 4 was 70 mm.

The relationships of the above dimensions, to each other, and particularly the relative values of H, T and A with respect to the width B are of importance, rather than the absolute dimensions.

Within housing 4, is secured a carrier plate 6 made of insulating material. Carrier plate 6 supports all other elements of the sensor. A central bore within the carrier plate has located therein a metallic bolt 7 carrying a disk-shaped central electrode 8 on which is located a radioactive source 9, such as a preparation including Americium 241. A wire mesh member 11, entirely surrounding electrode 8 and of cup form is located beneath carrier plate 6 to form a counter electrode. Wire mesh electrode 11 entirely surrounds the inner electrode 8 and prevents contact with the inner electrode 8, for example accidentally. The central electrode 8 and the counter electrode 11 define between them the ionization chamber 10. An electrical circuit, which may, for example, be an integrated circuit or alternatively an entirely encapsulated circuit 14, is located above the carrier plate 6. Electrical circuit 14 preferably includes an FET input transistor, and is arranged to evaluate changes in the ionization current flowing within the chamber 10. A further chamber, (not shown) entirely or almost entirely separated from outer atmosphere can be provided in order to form a reference ionization chamber connected in known manner in series to the ionization

(H)
3 (12)

chamber 10. The carrier plate 6 is preferably secured to the base portion 1, for example by holding brackets such as 42 moulded into the carrier plate 6 or otherwise attached thereto, which brackets, in turn, may be spot-welded, or otherwise suitably connected to the base portion 1, to securely hold the plate 6 to the base portion 1. These holding brackets 42 may, alternatively, be removably secured to the base portion, so that the carrier plate 6 can be removed as a unit with the housing from the socket. In this case, suitable connectors must be provided from the electrical circuit 14 to a connecting cable 14a which, in turn, connects to outside terminals at the side of the sensor, as schematically shown.

In order to keep dust and dirt from the interior of the ionization chamber 10, the housing 4 and the bottom cover 5 are preferably made of metal and held at a voltage which is different from that of the voltage applied to the mesh or grid electrode 11. A connection, therefore, is brought out from electrode 11 through the insulating plate 6 to terminal 11' which, preferably, is connected to a source of positive voltage. Alternatively, the entire housing may be made of non-conductive material, so that dust particles will precipitate on the housing, due to static charging of the material, rather than being carried into the ionization chamber.

In a preferred embodiment, the cover 5 of the housing is made removable from the housing 4 in order to facilitate cleaning.

The housing 4 is secured to the plate 6 by suitable means, for example by slight depressions formed circumferentially around the plate 6, in which punched-in resilient projections, formed in housing 4, can engage. Thus, housing 4 can be removed from the plate 6, as a unit with the bottom cover 5, if desired; for assembly, housing 4 is merely pushed onto the plate 6 until the resilient projections engage in the depressions. Alternatively, the plate 6 may be formed with an annular groove, in which spring fingers engage, or with projections engaging bayonet-holes in the shield portion 4 which are then covered internally by the plate 6, or by other suitable separable fastening arrangements.

The construction of the ionization-type sensor provides a slit-ring-shaped opening 13 in which the air is retarded and constricted immediately within the opening and is also deflected in the vertical direction by the baffle 12. The deflection is so arranged that the air flow is tangential to the grid or mesh 11. The relatively heavy dust particles will largely precipitate in the restricting region; the much lighter smoke particles will precipitate only slightly how-

ever and will largely be carried into the chamber 10. Dust particles, therefore, will precipitate on the housing, or at least in the immediate vicinity of the entry slit 13 and will not penetrate into the ionization chamber 10. Ingress of smoke is, however, hardly impeded. By removing housing 4 from the carrier plate 6, or even by merely removing the bottom cover 5 from the housing 4, dust which has precipitated can be easily removed, thus permitting easy cleaning of the sensor. Rather than screws 41, resilient snaps or bayonet-slits in the housing 4, engaging bent-over lugs projecting from bottom cap 5 or the baffle 12 may be used for simple disassembly. The mesh or grid 11 protects the centre electrode 8 connected to the control electrode of an FET in the circuit 14 when the housing 4, or the cover 5 has been removed from the sensor. Thus, upon cleaning, damage to the sensitive electrical circuit and particularly to the FET is prevented.

In the embodiment of Figure 2, the housing 21 is separated by an annular slit 22 from the surface of a mounting member 27. The measuring ionization chamber 20 has a central electrode 23 and an outer electrode 24 which is formed as a fine mesh grid. The housing 21 is removably secured to a base plate 26 which, preferably, is of insulating material, such as a plastic block. The attachment of the housing 21 to the plastic block 26 may, for example, be by means of pins 29 moulded into block 26 and projecting radially outwardly therefrom, passing through holes and slits formed in the housing 21, in the form of a bayonet connection. The air which passes into the chamber 20 is restricted and deflected upon entry through the slit 22 by the side surfaces 25 of the insulating block 26. This construction, also, provides for restriction and deflection of air passing into the sensor. Dust will usually mostly precipitate at the inner wall of the housing 21. Mesh electrode 24 rejects dust particles, without preventing the passage of air, carrying smoke or fire aerosols along. The mesh or grid electrode 24 further protects the field effect transistor connected to centre electrode 23. The electrical circuit is preferably contained within a hollowed portion of the block 26, and then sealed therein by means of a casting compound. The electrical connections have been omitted from Figure 2.

The metal portions of the housing—if metal is used—for example base portion 1, are preferably grounded. If the housing 4 (Figure 1) is metal, a metallic connection is made between the base portion 1 and the housing 4, for example by engagement of the base portion 1 with a depressed resilient projection 1b formed on a cross

plate 1a of the base portion 1. The block or plate 6 likewise is attached to cross plate 1a, which can also support such releasable plug-socket connections for the electrical circuit as may be needed. The luminescent diode 3 is shown connected in circuit with the sensor.

For a circuit for use with a sensor, reference is made to Patent No. 1 412 164.

10 WHAT WE CLAIM IS:—

1. An ionization fire sensor assembly including a housing enclosing an ionization chamber comprising a source of ionizing radiation and two electrodes, so arranged that an ion current produced between the electrodes changes in the presence of fire or smoke aerosols within the chamber, wherein the housing comprises at least two portions separated from each other by an essentially continuous annular slit, the parts of the assembly in the vicinity of the slit being arranged to cause the direction of air flow through the slit into the chamber to be deflected from an essentially straight path, at least one of said portions being removable, and wherein one of said electrodes comprises an air-pervious grid or mesh located to inhibit mechanical access to the other of said electrodes and hence to prevent accidental contact with the other electrode.

2. A sensor in accordance with claim 1, and comprising an evaluation circuit including a field-effect transistor, the other said electrode being connected to an input electrode of the field-effect transistor.

3. A sensor in accordance with claim 1, wherein the housing comprises a sleeve-like shield portion and a cover portion, the slit forming the inlet opening for air to the ionization chamber being formed between the end of the sleeve portion and the cover portion.

4. A sensor in accordance with claim 3, wherein the cover portion is removable and separable from the sleeve portion.

5. A sensor in accordance with claim 3, wherein the slit between the sleeve portion and the cover portion has a width not exceeding 0.5 cm.

6. A sensor in accordance with claim 3, wherein the inner side of the cover portion is formed with an inwardly projecting baffle arranged to deflect air passing into the slit.

7. A sensor in accordance with claim 6, wherein the projecting baffle is an essentially cylindrical, or slightly conical projecting baffle ring.

8. A sensor in accordance with claim 6, wherein the projecting baffle has a height of at least 1 cm.

9. A sensor in accordance with claim 6, wherein the height of the projecting baffle

is at least twice the width of the slit.

10. A sensor in accordance with claim 9, wherein the maximum spacing of the baffle from the interior of the housing sleeve portion is at most twice the width of the slit, and the depth of the slit is at least half the width of the slit.

11. A sensor in accordance with claim 1, wherein the housing is formed as a cap, the sensor is secured to a planar mounting plate, the slit being formed by an annular gap between the cap and said mounting plate.

12. A sensor in accordance with claim 11, wherein the sensor includes a member of insulating material located inside said cap and formed with its peripheral lateral surfaces located behind the gap and forming deflecting surfaces for air passing through said path.

13. A sensor in accordance with claim 12, wherein the mesh or grid electrode is secured to the block of insulating material.

14. A sensor in accordance with any one of claims 1 to 13 wherein the housing is of metal, and the grid or mesh electrode and the housing are arranged to be connected across a source of voltage.

15. A sensor in accordance with any one of claims 1 to 13 wherein the housing is formed of electrically non-conductive material.

16. A sensor in accordance with any one of claims 1 to 15 wherein the housing parts defining said labyrinth path, and the grid electrode, are relatively shaped to provide air flow in a path which is approximately tangential to the grid or mesh electrode.

17. A sensor in accordance with any one of the preceding claims wherein said electrodes are supported from an essentially horizontal plate-like support member of insulating material and said grid or mesh-shaped electrode is shaped in form of a cup depending by its rim from said plate-like member to define the ionization chamber within said cup, the other electrode being located within the chamber enclosed by said cup-shaped grid or mesh electrode.

18. A sensor in accordance with claim 17 as dependent upon claim 3 wherein said sleeve portions of said housing is removably attached to said support member.

19. An ionization fire sensor substantially as described with reference to Figure 1 or Figure 2 of the drawings.

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plate 1a of the base portion 1. The block or plate 6 likewise is attached to cross plate 1a, which can also support such releasable plug-socket connections for the electrical circuit as may be needed. The luminescent diode 3 is shown connected in circuit with the sensor.

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WHAT WE CLAIM IS:—

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2. A sensor in accordance with claim 1, and comprising an evaluation circuit including a field-effect transistor, the other said electrode being connected to an input electrode of the field-effect transistor.

3. A sensor in accordance with claim 1, wherein the housing comprises a sleeve-like shield portion and a cover portion, the slit forming the inlet opening for air to the ionization chamber being formed between the end of the sleeve portion and the cover portion.

4. A sensor in accordance with claim 3, wherein the cover portion is removable and separable from the sleeve portion.

5. A sensor in accordance with claim 3, wherein the slit between the sleeve-portion and the cover portion has a width not exceeding 0.5 cm.

6. A sensor in accordance with claim 3, wherein the inner side of the cover portion is formed with an inwardly projecting baffle arranged to deflect air passing into the slit.

7. A sensor in accordance with claim 6, wherein the projecting baffle is an essentially cylindrical, or slightly conical projecting baffle ring.

8. A sensor in accordance with claim 6, wherein the projecting baffle has a height of at least 1 cm.

9. A sensor in accordance with claim 6, wherein the height of the projecting baffle

is at least twice the width of the slit.

10. A sensor in accordance with claim 9, wherein the maximum spacing of the baffle from the interior of the housing sleeve portion is at most twice the width of the slit, and the depth of the slit is at least half the width of the slit.

11. A sensor in accordance with claim 1, wherein the housing is formed as a cap, the sensor is secured to a planar mounting plate, the slit being formed by an annular gap between the cap and said mounting plate.

12. A sensor in accordance with claim 11, wherein the sensor includes a member of insulating material located inside said cap and formed with its peripheral lateral surfaces located behind the gap and forming deflecting surfaces for air passing through said path.

13. A sensor in accordance with claim 12, wherein the mesh or grid electrode is secured to the block of insulating material.

14. A sensor in accordance with any one of claims 1 to 13 wherein the housing is of metal, and the grid or mesh electrode and the housing are arranged to be connected across a source of voltage.

15. A sensor in accordance with any one of claims 1 to 13 wherein the housing is formed of electrically non-conductive material.

16. A sensor in accordance with any one of claims 1 to 15 wherein the housing parts defining said labyrinth path, and the grid electrode, are relatively shaped to provide air flow in a path which is approximately tangential to the grid or mesh electrode.

17. A sensor in accordance with any one of the preceding claims wherein said electrodes are supported from an essentially horizontal plate-like support member of insulating material and said grid or mesh-shaped electrode is shaped in form of a cup depending by its rim from said plate-like member to define the ionization chamber within said cup, the other electrode being located within the chamber enclosed by said cup-shaped grid or mesh electrode.

18. A sensor in accordance with claim 17 as dependent upon claim 3 wherein said sleeve portions of said housing is removably attached to said support member.

19. An ionization fire sensor substantially as described with reference to Figure 1 or Figure 2 of the drawings.

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