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## (54) IONIZATION FIRE ALARM

(71) I, Hartwig Beyersdorf, a citizen of Germany, of Konsulweg 29, Scharbeutz 2409, West Germany, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to an ionization fire alarm with a test chamber accessible to ambient air; a reference chamber axially staged behind and electrically series-switched with it, which is rated more inaccessible to ambient air; at least one radiation source ionizing the chambers, and a housing containing the chambers with a tubular housing section, whereby an insulator surrounding the reference chamber with an approximately tubular wall section having a diameter smaller than that of the tubular housing section comprises a further tubular wall section adjoined to the inside of the tubular housing section, and an approximately ring shaped wall section interconnecting both tubular wall sections; which insulator carries an internal electrode in the reference chamber placed across the alarm axis, and a center electrode common to both chambers being parallel to and having approximately the same diameter as the internal electrode.

Such a fire alarm is known from German Offenlegungsschrift 20 29 485. In this case the ring shaped wall section of the insulator is located approximately in the plane of the internal electrode, and the tubular wall section adjoined to the inside of the tubular housing section extends, viewed from the test chamber, axially inward or rearward, so that it surrounds a space behind the reference chamber, where the switching elements of the electrical analyzer circuit connected to the chamber electrodes can be accommodated. This results in a relatively extensive design height of the alarm. Furthermore with the known alarm the housing is bowl-like developed and simultaneously is shaped as an external electrode for the test chamber. For the inlet of ambient air into the test chamber a plurality of openings is provided on the circumference of the tubular housing section near its frontal side. This results in alarm sensitivity being a detrimentally strong function of the approach flow direction of ambient air; on radial approach flow the ambient air can enter the test chamber from openings facing each other and leave it by producing a strong thru-flow, while on axial approach no direct entrance of ambient air into the test chamber is possible.

Furthermore, from German Offenlegungsschrift 22 50 820 on ionization fire alarm is known, where a ring shaped insulator component carrying the center electrode lies approximately in the latter's plane, and whereby a tubular insulator component placed near the inside of the tubular housing section extends from the ring shaped insulator component outward in an axial direction by way of surrounding part of the test chamber.

In this case air is admitted into the test chamber, however, in a manner similar to that of above explained fire alarm, which results again in sensitivity being a substantial function of the approach flow direction. Fruthermore, in this case the switching elements of the analyzer circuit are axially placed behind the reference chamber, which results in a relatively extensive axial design length.

With another ionization fire alarm known from German Auslegungsschrift 21 30 889 test chamber and reference chamber are axially spaced apart to accommodate between them the switching elements of the analyzer circuit, and in the chambers two interconnected electrodes producing a center electrode are provided. The alarm has an insulator, where a ring shaped wall section lies approximately in the plane of the rear electrode component of the center electrode, and where a tubular wall section each applied to the inside and outside of a tubular housing section axially extends—by surrounding the space taken up by the analyzer circuit—from the ringshaped wall section approximately to the plane of the forward component of the center electrode. Because of the axial separation of both chambers again this type of design requires a relatively extensive axial design height, and because of the presence of two electrodes being part of the center electrode requires higher design expenditures. The housing simultaneously serves as an external electrode of the test chamber, and for protection against strong air currents and for achieving a degree of sensitivity unaffected by various approach flow directions is developed in a dual-walled way; whereby the opening provided in the inner housing wall are offset against the openings in the outer wall. This type of housing design equally means relatively high design expenditures.

With another ionization fire alarm known from German Offenlegungsschrift 24 15 479 a bowl-like, air permeable external electrode is provided for the test chamber. Furthermore, aside from its tubular section the housing is equipped with a frontally closing cover for same. This cover consists of an approximately flat bottom set parallel to the center electrode, spaced at a minor axial distance from the plane of the outer end of the tubular housing component with its diameter identical to the outer diameter of the tubular housing component, and of a jacket which being connected to the inside of the bottom turned toward the center elecrode has an outer diameter smaller than the inner diameter of the tubular housing section and larger than the diameters of center and external electrodes, and has a length approximately equal to half the distance between the bottom and the center electrode-carrying planar insulator. Furthermore the cover has connector elements, which connect the jacket to the inside of the tubular housing section and are spaced apart from each other on the jacket circumference. Based on this design there remains a gap on the one hand between the bottom outer edge projecting from the jacket and the outer end of the tubular housing section, and on the other hand between the inside of the jacket and the inside of the tubular housing section (this being a gap interrupted by connector elements), through which ambient air can enter the test chamber. The drawback here is, however, that a complicated housing design is required, which cannot be manufactured in a one-piece shell mold. Also again approach-flow ambient air can enter the test chamber easier on radial approach than on axial approach. Finally also the external electrode seated on the center electrode-carrying insulator is only minimally spaced apart from the attachment point of the center electrode, so that there can be insulation problems.

The smallest ionization fire alarm practiced up till now and immune against a differential of ambient-air approach flow directions is shown by German utility patent 74 02 420. It relates to a fire alarm similar to the initially noted type, however, whereby the centre electrode has a substantially larger diameter than has the inner electrode. In this case the ring shaped wall section inter-connecting both tubular wall sections of the insulator is put approximately in the plane of the centre electrode and carries same. The switching elements of the alarm transmitter circuit are accommodated in a reference chamber-surrounding ring shaped space, so that profitably an increase in axial design height can be avoided, however, the tubular wall section of the insulator adjoined to the inside of the tubular housing section is put in the same axial area with the reference chamber-surrounding tubular wall section having a smaller diameter, so that the reference chamber-surrounding ring shaped space is reduced in its available volume.

The object of the invention is so to improve a fire alarm of the initially indicated type, that both a decrease in design size and a better uniform sensitivity under various wind approach flow conditions is achieved.

According to the invention there is provided an ionization fire alarm comprising a test chamber accessible to ambient air; a reference chamber axially staged behind and electronically series-switched with the test chamber and which is more inaccessible to ambient air; at least one radiation source ionizing the chambers; a housing containing the chambers with a tubular housing section; an insulator surrounding the reference chamber with first approximately tubular wall section having a diameter smaller than that of the tubular housing section, a second tubular wall section adjoined to the inside of the tubular housing secion, and an approximately ring shaped wall section interconnecting both tubular wall sections; said insulator carrying an internal electrode in the reference chamber placed across the alarm axis, and carrying a centre electrode which is common to both chambers parallel to and having approximately the same dimension as the internal electrode; said ring shaped wall section lies approximately in the plate of the centre electrode, the second tubular wall section adjoining the inside of the tubular housing section extends axially from the ringlike wall section away from the first tubular wall section and surrounding the test chamber, a bowl-like outer electrode of the test chamber equipped with a flat bottom parallel to the centre electrode, lying approximately in the plane of the end of the second tubular wall section remote from the ring-shaped wall section, smaller than the inner dimensions of said second tubular wall section and larger than the centre electrode in dimension, said bowl-like electrode having a skirt extending axially inward from the outer edge of the flat bottom towards the ring shaped wall section, and being smaller than the distance from the flat bottom to the cenre elecrode in axial lengh; and connector elements spaced over the skirt circumference to connect said skirt to the inside of outward extending tubular wall section.

With the fire alarm according to the invention a circular gap lies between the jacket of outer electrode and the outward extending, tubular shaped wall section of the insulator, which is interrupted only by connector elements between outer electrode and said wall section, through which gap the ambient air can enter the test chamber from the outer frontal side of the alarm. On an alarm radial approach flow, therefore, the air cannot directly enter the test chamber, so that it is protected against higher air moving speeds effective in it, through which in a counter productive sense ions may be removed from it. On the other hand on test chamber axial approach flow equally there is no ambient air flow through the test chamber possible, because then the air hitting the alarm frontal side is dammed up in the test chamber. Furthermore, between both of these electrodes a sufficiently high insulator resistance is produced because the outer electrode is connected to the insulator only at certain points so-to-speak of a few connector devices, because the electrode has a larger diameter than has the center electrode, and because the jacket of the outer electrode does not extend to the plane of the center electrode. Immunity against strong ambient air flows and various approach flow directions is achieved without any increase in the outer dimensions of the alarm. Contrarily, they can be decreased, because in the ring space around the reference chamber up to the inside of the tubular housing section there is sufficient space available for accommodating the switching elements of the alarm transmitter circuit.

Improvements made on the invention are listed in sub-claims.

Further improvements and advantages of the invention will be explained in more detail below with reference to the accompanying drawings, in which an exemplified embodiment is shown.

Fig. 1 shows a perspective view of an alarm according to the invention;

Fig. 2 is a partially broken-up, perspective view of the associated base;

Fig. 3 a cut through alarm and base according to figs. 1 and 2 along intersecting line III-III in fig. 5;

Fig. 4 a detail of fig. 3 on a cut along line IV-IV;

Fig. 5 a top view of alarm and base according to figs. 1 thru 4.

The alarm shown in fig. 1 subsequently will be designated as 10, because also the base 12 shown in fig. 2 forms part of the complete alarm. As shown in fig. 3 this complete alarm can be set up with topside alarm insert 10 and base 12 below, i.e., in a vertical alarm axial way. In most cases, however, practically the alarm is mounted with bottomside alarm insert 10 suspended from a ceiling or mounted on a wall with horizontal alarm axis, whereby in any case base 12 is attched on a support. As far as the expressions "top" or "bottom" will be used subsequently, they refer only to the positions shown in the figures. In any case the alarm insert 10 and base 12 upper sides visible in figs. 1 thru 3, and fig. 5 will be designated as outer or frontal sides, and the sides turned toward the support (not shown), on which the base 12 is attached, as rear or back sides.

The perspective view of fig. 1 shows an alarm insert 10 with its free front side turned away from base 12 (fig. 2). Located here is the flat bowl-like outer electrode 14, which is attached to the inside of an insulator 22 with radially outward projecting tongues 16, 18, 20. The latter and the chambers not shown in fig. 1 are surrounded by housing 24, which comprises a tubular housing section 26 and a ring shaped wall section 28. The latter lies in the plane of flat bottom 30 of outer electrode 14 perpendicular to the alarm axis.

The alarm insert 10 is detachably attached to the base 12 shown in a perspective front view in fig. 2. This will be discussed later in more detail. First the internal design of alarm insert 10 will be viewed more closely on hand of fig. 3.

Fig. 3 shows a typical design of an ionization fire alarm with test chamber 32 accessible to ambient air and axially post-staged by reference chamber 34. The latter is smaller than test chamber 32 and specifically has a smaller diameter than has said chamber 32. At the rear end of reference chamber 34 an inner electrode 36 is located. A center electrode 38 parallel to said electrode 36 and of approximately the same size is common both chambers, so that same are electrically series-switched. The flat bottom 30 of outer electrode 14 being parallel to center electrode 38 has a considerably larger diameter than has center electrode 38. All electrodes 36, 38, 14 are surrounded and carried by insulator 22, which surrounds also test chamber 32 and reference chamber 34 on their sides not locked by electrodes 14, 38, 36. The ionization of chambers 32, 34 takes place by means of a radiation source 40 and/or 42 located in fig. 3 beneath bottom 30 and/or the front side of inner electrode 36.

The insulator 22 substantially has a bowl shape strongly shouldered-off at the level of the center electrode. At its rear end it is locked by a disk shaped wall section 44 in the center of which the inner electrode 36 is held and is axially adjustable by set screw 46. To wall section 44 there is connected a tubular shaped wall section 48 which surrounds reference chamber 34. The outer diameter of this section, which subsequently will be designated as the small tubular wall section, amounts to approximately half the inner diameter of tubular housing section 26. Adjoined to the front (in fig. 3 upper) end of the small tubular wall section 48 is a radially outward extending, ring shaped wall section 50 of insulator 22. This ring shaped wall section 50 is approximately located in the plane of outer electrode 38, because it so carries the latter on its front side, that it just about covers the inner diameter of the small tubular wall section 48.

Finally the insulator 22 comprising a further tubular wall section 52, which adjoins the inside of tubular housing section 26, has a diameter relatively larger than that of the small tubular wall section 38 and therefore, subsequently will be designated as the large tubular wall section. This large tubular wall section 52 axially extends—surrounding test chamber 32—outward, i.e., not rearward as with known solutions, in the direction of base 12. This way in small tubular wall section 48 and reference chamber 34 — surrounding ring space 54 there is sufficient space left up against tubular housing wall 26 for accommodating switching elements, e.g., a field effect transistor 56. Even if such switching elements do not fill up ring space 54 in particular, it is advantageous for reasons of a good heat dissipation and a high-grade electrical insulation to have available ample space for switching elements.

The axial height of the large tubular wall section 52 approximates that of test chamber 32; to be more precise, in the exemplified embodiment the bottom 30 of outer electrode 14 is so located that its outer side aligns with the outside of ring shaped wall section 28 of housing 24. Bottom 30 as was noted has a diameter rated larger than that of center electrode 38, but rated smaller than the inner diameter of large tubular wall section 52. A tubular jacket 58 extending inward from the outer edge of bottom 30 to ring shaped wall section 50, however, has an axial length smaller than the distance between bottom 30 and center electrode 38; in the exemplified embodiment the axial length of jacket 58 is only a little more than half of the noted distance. By way of a mutually effective dimensioning of outer electrode 14 and large tubular wall section 52 a circular gap 60 is produced between them except for short interruptions by tongues 16, 18, 20 (fig. 1) comprising connector points, through which gap ambient air can enter and leave the test chamber.

Between tongues 16, 18, 20 the axially inner edge of jacket 58 of outer electrode 14 is adjoined by a radially outward projecting edge 62 of a width rated less than that of the radial width of gap 60. Furthermore, on its outside the ring shaped wall section 50 is equipped with a ring shaped shoulder 64 around center electrode 38, which radially outward projects in the direction of edge 62. Its inner- and outer diameters approximate those of edge 62 of outer electrode 14, and the axial length of shoulder 64 and that way its axial spacing from edge 62 is so selected that between shoulder 64 and edge 62 a jet exit 68 is produced, the cross-sectional area of which is generally rated at 20% to 50%, and in the exemplified embodiment at about 30% of the cross-sectional area of gap 60. The effect of jet exit 68 located between gap 60 and the inside of test chamber 32 is that the ambient air entering test chamber 32 is swirled and retarded, whereby strong air currents in test chamber 32 are avoided and the suspension time of air vortex circulating ions in test chamber 32 is prolonged. This way an increased indifference to high ambient air speeds is achieved. Aside from that the shoulder 64 has the positive effect of enlarging the inner surface of insulator 22 and consequently of increasing the insulator resistance on the one hand between center electrode 38 and outer electrode 14 and on the other hand between center electrode 38 and housing 24.

Another measure taken for protecting test chamber 32 against strong flow speeds is that gap 60 has an outward jet exit 70 at the level of bottom 30. This is so accomplished that the radially inward projecting, ring shaped wall section 28, which is connected in the above described manner to the outer end of tubular housing section 26, has its axially inner side (as is exemplified in the embodiment) supporting the outer end of the large tubular wall section 52, and that further, as is noted above, the bottom 30 of outer electrode 14 at least approximately lies in the plane of ring shaped wall section 28, and that the latter radially inward projects over the inside of large tubular wall section 52. An especially practically proven feature is that as with the exemplified embodiment not only the outer mouth of gap 60 is narrower than its center section but also that the inner connection of gap 60 to test chamber 32 is effected by jet exit 68. Thus, a particularly good protection against sudden ambient air blasts is produced without on the other-hand, weak air currents producing a strong blocking effect on entering ambient air. This effect probably is based on the fact that a compensatingly effective air volume lies on the one hand between jet exit 70 produced on the inner edge 72 of ring shaped wall section 28 and on the other hand between jet exit 68 lying between edge 62 and shoulder 64, that furthermore said volume is increased by the volume of gap 60 lying radially beyond shoulder 54 and extending with one edge 66 to the outside of ring shaped wall section 50; the gap 60 works as a pre-chamber, which puts a damper on any stronger air blasts.

If providing both jet exits 68 and 70 in the manner as described with the exemplified embodiment, then the practical application for jet exit 70 would be that the cross-sectional area of gap 60 between outer electrode 14 and radial inner edge 72 of ring shaped wall section 28 approximates three-quarters of the cross-sectional area in the inward adjoining axial area. As with jet exit 68, however, also a still narrower jet exit width can be selected, in case higher air speeds can be expected. As especially positive effect is produced, however, if the cross-sectional area of jet exit 70 is somewhat larger than that of jet exit 68, because this way under low ambient airflow speed conditions the air can easily enter test chamber 32 despite the presence of jet exits 70, 68.

Another result of the described alarm design is that any contamination in the area of gap 60 or test chamber 32 practically have no effect on alarm operation. To understand this resultant effect first the electrical design of the alarm will be briefly described:

Voltage supply of the alarm is by battery (not shown) accommodated in base 12 or by a voltage source located in a remote center and connected to the alarm by feeder lines. One pole of the voltage source is directly applied—except for electrical connector elements of negligable resistance value—to outer electrode 14. The other pole of the voltage source is connected to electrically conducting housing 24; with the examplified embodiment housing 24 carries on its outside a coating 74 (solid-line drawn in fig. 3 for amplification). The inner electrode 36 has applied thereto a potential, e.g., by means of a voltage source connected voltage divider, which lies between the potentials of outer electrode 14 and coating 74, however, for practical purposes, is closer to the potential of coating 74. Based on the ionization currents flowing in chambers 32, 34, a potential is effective on center electrode 38, which approximately is centered between the potentials of the outer elecrode 14 and inner electrode 36. The potential of center electrode 38 controls the alarm transmission circuit which is accommodated in space 54 with its switching elements seated on a switch plate 76. Field effect transistor 56 forms the input of the alarm transmission circuit, and its base connector 78 is connected to center electrode 38. If test chamber 32 is entered by ambient air loaded with fire byproducts such as smoke the ionization flow is changed; test chamber 32 becomes higher ohmic. This way the potential of inner electrode 36 starts drifting, which changes the conductivity state of field effect transistor 56 and triggers a response from the alarm transmission circuit. To keep the alarm transmission circuit if so desired in an operational state even in absence of a cause for alarm, a feedback can be so provided, that on responding the resistance value of the resistance circuit effective between voltage source connector connected to coating 74 and inner electrode 36 is reduced, so that now the potential of inner electrode 36 approximates to an increased degree that of coating 71. Practically, a voltage of 20V can be applied, e.g., between coating 74 and outer electrode 14, whereby coating 74 is grounded, and under quiescent conditions a voltage of 12 V can be applied to series-switched chambers 32, 34, namely 5 V to test chamber 32 and 7 V to reference chamber 34. (In this and subsequent cases voltages are listed only according to their amount, not their plus or minus signs.) The alarm transmitter circuit then responds, e.g. if the voltage across test chamber 32, that is the voltage differential between outer electrodes 14 and center electrode 38, has risen to 7 V. The original voltage differential of 8 V between inner electrode 36 and coating 74 then is reduced to a substantially lower value by feedback means.

If during the service life of the alarm and dust particles and/or under sudden temperature changed conditions and dewdrop liquid particles are deposited in gap 60 on the inside of large tubular wall section 52 and the rest of the inner surfaces of insulator 22, said inner surfaces assume weak finite conductivity values, while in the original pure state the conductivity of insulator 22-surfaces with respect to the conductivity of chambers 32, 34 is negligibly low-valued because of their ionization. On the one hand there exist conductive surface paths leading from the edge of center electrode 38 to tongues 16, 18, 30 of outer electrode 14, e.g., in fig. 3 from the left edge of center electrode 38 to tongue 16 via inner corner 80. On the other hand there are inner surface areas of insulator 22, of the radial inner area of the inner and in fig. 3 lower side of ring shaped wall section 28, and of the latter's inner edge 72, which lie in a circumferential direction between connector points comprising tongues 16, 18, 20, via which a weak-conductive connection exists between center electrode 38 and the conductive coating 74 of housing 24. The conductive inner surfaces on the one hand between center electrode 38 and outer electrode 14 and on the other hand between center electrode 38 and coating 74 produce a voltage divider, the junction point of which is center electrode 38, and the danger exists that this way the potential of center electrode 38 is tampered with and the alarm transmission circuit is wrongly made to response or kept from responding. This can be avoided, however, if above voltage divider of inner surfaces is so dimensioned, that in absence of other conditions affecting its potential with respect to outer electrode 14 a voltage is applied to center electrode 38 by at least approximating its value under quiescent conditions even with unpolluted and, therefore, nonconducting insulator inner surfaces and a nonconducting layer of housing 24.

In practice the alarm design so facilitates a checkup of the applicable dimensioning of the voltage divider being affected by conducting inner surfaces in that inner electrode 36 is cut off from any voltage supply, that at least the radiation source 40 in test chamber 32 preferably, is removed from radiaion sources 40, 42, that the alarm with an operational voltage applied between coating 74 and outer electrode 14 is exposed to a high dust content type of atmosphere and is allowed to become highly dust polluted and that then the voltage applied to center electrode 38 is measured by means of an instrument, which has a sufficiently higher internal resistance over the dust reduced insulator resistances effective on the one hand between outer electrode 14 and center electrode 38 and on the other hand between coating 74 and center electrode 38. If now the insulation resistance between outer electrode 14 and center electrode 38 is too low, then the effect is that the voltage differential between outer electrode 14 and center electrode 48 is lower than it should be under quiescent conditions (known also as the monitoring state); with above listed numerical examples (a 20-V supply voltage applied between coating 74 and outer electrode 14, a 5-V off-load voltage applied between center electrode 38 and outer electrode 14) the voltage differential then between center electrode 38 and other electrode 14, e.g., amounts to 4 V. In this case the insulation between outer electrode 14 and center electrode 38 must be improved and/or the insulation distances between coating 74 and center electrode 38 must be reduced. For this purpose, e.g., the amount of connector points provided on the circumference of outer electrode 14 can be reduced; if instead of the three connector points provided in the exemplified embodiment only two are provided, then the insulation resistance between outer electrode 14 and center electrode 38 is increased 1.5 times, while simultaneously the insulation resistance between coating 74 and center electrode 38 is somewhat reduced because of the increased inner surface inserted between them. It is equally feasible to cut down the height of jacket 58 and that way to increase the distance between tongues 16, 18, 20 and center electrode 38 whereby, however, to maintain the measures taken against wind insensitivity (gap 60) the axial height of jacket 58 should not be reduced below half of the distance between bottom 30 and ring shaped wall section 50 of insulator 22. It is further feasible also for shifting the potential of center electrode 38 in the direction of that of coating 74 to extend same in the direction of center electrode 38, by metallizing the inner edge 72, if required the inner (in fig. 3 the lower) side of ring shaped wall section 28, and finally if also required a small area at the outer end of the inside of large tubular wall section 52.

Conversely, if on examining the dust pollution produced voltage divider an excessive voltage differential is produced between center electrode 38 and outer electrode 14, then by reversing above measures, e.g., the amount of connector points provided on the circumference of outer electrode 14 can be increased, the axial length of jacket 58 can be extended and the coating 74 on the outside of ring wall section 28 can be so reduced, that it does not reach inner edge 72.

The effect of dust pollution on the potential of operational center electrode 38 is of a dual type. First the potential of center elecrode 38 can be tampered with so that in the monitoring state it assumes a value other than the original one. With above numerical examples, where the polluted-alarm rated potential differential between center electrode 38 and outer electrode 14 at equilibrium rest is 5 V, and under polluted-surface voltage divider effects — in absence of other potential affecting factors —is 4 V, then under operational conditions with electrical-connected inner electrode 36 and present radiation sources 40, 42, a potential differential of 4.5 V, e.g., because of pollution in the monitoring state is produced between center electrode 38 and outer electrode 14. The result is that the threshold value of 7 V, at which the alarm transmission circuit is triggered, is reached only on higher smoke concentrations. This negative effect, as previously noted, is substantially eliminated by so setting the voltage divider by way of above described practical measures that in absence of a voltage applied to the inner electrode and preferably at least of radiation source 40, and in the presence of a voltage operationally effective between coating 74 and outer electrode 14, and with an inner surface made weak-conducting up to coating 74 the center electrode assumes a votage with respect to center (read outer) electrode 14, which is operationally effective (with inner electrode 36 connected in the presence of radiation sources 40, 42) with non-conductive made inner surfaces. The dust pollution still has a second negative divider effect on sensitivity, which is produced even on above noted voltage divider selection. This effect is that the voltage divider in a way inhibits the potential of center electrode 38, so that the voltage jump of center electrode 38 produced on smoke entering the test chamber 32 is lower than it is with clean inner surfaces. For this effect too a type of compensation can be made. For this purpose the voltage divider practically is so set that— in the absence of other potential affecting factors— it has the center electrode 38 assume a voltage with respect to outer electrode 14, which is shifted to a minor degree toward the threshold value with which the alarm transmission circuit is triggered. Meaning that if with above numerical example the voltage differential rated at non-polluted inner surfaces between center electrode 38 and outer electrode 14 amounts to 5 V in the monitoring state and a triggering is timed at a threshold value of 7 V, then practically the voltage divider is so dimensioned, that center electrode 38 assumes— in the absence of other factors affecting its potential—a 6-V voltage differential with respect to outer electrode 14. In practice, under alarm monitoring operational conditions, then any dust pollution still results in a minor increase of voltage differential effective between center electrode 38 and outer electrode 14, e.g., to 5.5 V, but this has no effect on sensitivity, because the same smoke density as in the original clean state has the result that center electrode 38 reaches the threshold value of 7 V with respect to outer electrode 14.

At connector points between outer electrode 14 and insulator 22 radially outward extending tongues 16, 18, 20 as noted above, lie in the plane of the axially inner end of outer electrode 14- jacket 58. Tongues 16, 18, 20 are attached on the outer foreparts of extensions, of which extensions 82, 84 are visible in figs. 1 and 3. They extend from ring wall section 50 of insulator 22 to the level of the inner end of jacket 58 and project radially inward from the inside of large tubular wall section 52 to shoulder 64, so that they produce a bridge between large tubular wall section 52 and shoulder 64. Their outer surfaces form part of the insulation sections between center electrode 37 (read 38) and tongues 16, 18, 20 so that with dust polluted inner surfaces in addition to above practical measures taken for affecting the voltage divider the feasibility be considered for boosting the insulation resistance between center electrode 38 and outer electrode 14 by providing the extensions, e.g. extensions 82, 84, with a surface having circumferential-run ribs instead of a smooth surface. For the same purposes provisions could be made that extensions not be radially inward extended to the shoulder but between them leave a slit, in fig. 3 extending downward to the plane of center electrode 38.

On the backside of ring wall section 52 of insulator 22 at least two range spacers 86 (in this case for practical purposes diametrically facing each other) and in the exemplified embodiment three range spacers are arranged at uniform angular distances, adjoined at and attached to the rear ends of which there is a switch plate 76 ringlike surrounding the reference chamber 34. Range spacers 86 are aligned with each of insulator 22-extensions provided in reference chamber 32, e.g., with extensions 82, 84. This makes it possible to attach electrode 14 and switch plate 76 by means of a number of screwbolts 88, 90, 92 (fig. 1,5) equivalent to that of extensions and range spacers. Screwbolts 88, 90, 92 each are put through one of tongues 26, 18, 20, one of the extensions, e.g. 82, 84, one space ranger 86 and switch plate 76 in an axial direction. One of the screwbolts 88 simultaneously serves as an electrical connection of outer electrode 14 to one of the electrical conductors provided (but not shown) on switch plate 76, and as a connection to the terminal of a voltage source via latch extension 94 and leaf spring 96 provided in base 12. Latch extension 94 is attached equally by means of a screwbolt 88 put through it.

Because the supply voltage of the alarm is effective between outer electrode 14 and coating 74 of the housing, it seems practical for the avoiding of short circuits to cover the outside of outer electrode 14 with an insulator layer. For this purpose an insulator cover 98 shown only in fig. 3 of the exemplified embodiment is put on outer electrode 14, which has a bowl shape equivalent to that of outer electrode 14. Above tongues 16, 18, 20 and screw bolts 88, 90, 92 the insulator cover 98 is equipped with extensions 100 run radially outward under the inside of ring wall section 28 of housing

24 and from there axially inward to the level of screwbolt 88, 90, 92-heads. Said extensions, as is visible in fig. 3, are so bowl-like bent in their inward run section that they embrace each head of a screw bolt 88, 90, 92 on part of its circumference. This completely prevents and inadvertent twisting of insulator cover 98, while it is kept in an axial direction behind edge 72 of housing 24-ring wall section 28, radially inward projecting over large tubular wall section 52. Viewed from the front the radial extensions 100 cover tongues 16, 18, 20 and the heads of screwbolts 88, 90, 92, and, therefore, protect them too against a short circuit connection with coaing 74 of housing 24, while simultaneously a twisting of screwbolts 88, 90, 92 by unauthorized persons is made impossible, and because of the covering up of the internal hexagonal screwbolt heads an esthetically improved appearance is achieved.

On the backside of housing 24 a flat metal sheet 102 is attached, which extends perpendicularly to the alarm axis up to the outer edge of tubular housing section 26 and is attached to it at diametrically facing points by means of screws, of which one screw 103 is visible in fig. 3. The screws are screwed into threaded holes, which are accommodated in outward projecting noses 104, 105 (see also fig. 5) of housing 24. Metal plate 102 adjoins the backside of wall section 44 of insulator 22 and holds same inside housing 24. On removing plate 102 the timing screw 46 of inner electrode 26 is accessible from the backside of insulator 22 for adjusting the spacing between center electrode 38 and inner electrode 36. With the plate 102 present it provides—as does the coating 74 of housing 24 electrically connected to it — a protective screen for the alarm transmission circuit and chambers 32, 34. On its edge plate 102 has two recesses 106, into which latch extension 94 and a further switchplate 76—attached latch extension 108 equally used for electrical connection fits as is visible in fig. 5. Latch extension 108 can be spring 110-locked in a manner equivalent to spring 96—locked latch extension 94. Further latch extensions 112, 114 are developed as radial extensions of plate 102 and project outward under noses 104, 105. These latch extensions 112, 114 can be locked by springs 116, 118 equivalently again to spring 96 — locked latch extension 94. Thus, all latch extensions 94, 114, 112, 108 project, as can be seen by comparing figs. 1 and 3 with fig. 5, radially outward from the rear circumference of tubular housing section 26.

As is visible in figs. 2, 3 and 5 the base 12 has the shape of a can open in front. It comprises a cylindrical jacket 120 and a ring shaped edge 122 radially inward projecting from it, the inner opening of which is adapted to the outer diameter of tubular housing wall 26 of alarm insert 10. On edge 122 cutouts 124, 126, 128, 130 are located, through which latch extensions 94, 114, 108, 112 can be inserted. From the inside of jacket 120 several ribs extend radially inward of which ribs 132, 134, 136 are visible in the figures. These ribs are connected at their front (and in the figures upper) ends to edge 122, while with their rear ends they extend not quite to the rear end of jacket 120. Their rear ends are adjoined by switch plate 128 of base 12, which for screening purposes is covered on its backside with cover 140 set a stand-off distance from it. The backside of cover 140 is aligned with the rear edge of jacket 120. To keep a distance between switchplate 138 of base 12 and cover 140 two insulated range spacers (not shown) can be interpolated between them, and as shown in fig. 3, the cover 140 can be equipped with an upward flanged shoulder 142. Cover 140 and switchplate 138 are connected to jacket 120 by flat-head screws screwed from the backside of cover 140 into ribs 132, 134, 136. Springs 96, 118, 110, 116 are in mechanical connection with switchplate 138 and in electrical connection with connector paths provided on it. Connector paths provided on switchplate 138 can run on its topside and/or bottomside, as is only schematically indicated in fig. 2 with conductor paths 144 and in fig. 3 with conductor paths 146.

Springs 96, 118, 110, 116 extend from switchplate 138 radially outward and in the figures upward to edge 122, and at the outer ends within base 12 are radially inward bent at an angle, so that their angular bends produce a radially outward flexible type of latch elements for latch extensions 94, 114, 108, 112.

Alarm insert 10 is detachably attached to base 12 by pushing the alarm insert into the inner opening within the edge 122 of base 12. This is possible only if accompanied by aligning latch extensions 94, 114, 108, 112 with associated springs 96, 118, 110 and/or 116, because latch connections are coded by an unsymmetrical type distribution. On pushing them in the latch extensions 114, 108, 112 lock behind the angular bends of springs 96, 118, 110, 116 and the alarm insert 10 is put with its plate 102 on the seating surfaces 148, 150 of ribs 134, 136 and on the like seating surface of at least another such rib not visible in the figures. Ribs 134, 136 and the additional type of rib extend, namely, from jacket 120 even further radially inward than does edge 122.

The angular bends of springs 96, 118, 110, 116 do not run exactly in a common-planar circumferential direction but at a slant toward this plane set perpendicular to the alarm axis. This is shown in a more precise manner in fig. 4 on the angular bend 152 of spring 96. This way the applicable latch extension, in fig. 4 the latch extension 94, in its locked state is imparted a tangential force, through which it is shifted — without any assistance from the person pushing in the alarm insert 10 — in a clockwise direction according to the embodiment and to the right in fig. 4. Any possible twisting of the alarm insert is limited to such a minor angular amount by means of a limit stop 154 produced by rib 132, that the rear end (in a rotary direction) of latch extension 94 is still caught by the angular bend 152 of spring 96. However, in its position twisted in relation to spring 96 the latch extension 94 abuts with its frontal upper end on a further, axially rearward pointing limit stop 156 of rib 132. This way it becomes impossible for safety reasons to pull out the now locked-in alarm insert 10 from base 12 by a simple axial motion. To apply this also to the alarm insert 10 side approximately in diametrical opposition to rib 132, a rib (not shown) equivalent to rib 132 is arranged also in base 12 next to spring 116, through which a latching of latch extension 112 is effected.

Other types of described limit stop designs, of course, are equally feasible. Rib 132, e.g., can be so developed that it produces a limit stop 156, while limit stop 154 is produced on rib 134 in such a way that the latter unlike in fig. 2 is moved nearer to spring 118 in a counterclockwise sense. It is equally feasible to combine rib 132-type and rib 134-type designs. Furthermore, a limit stop that can prevent the axial removal of twisted positioned alarm insert 10 can be effective also between housing 24 and edge 122 of base 12; noses 104, 105, for example, could be developed sufficiently wide for them to leave the area of recesses 126 and/or 130 on a twisting of alarm insert 10 and to pick up edge 122 with their leading, in the figures upper foreparts.

This special lockup of alarm insert 10 with base 12 has a key advantage over conventional bayonet lock types. Namely, the alarm inset 10 can be connected also to inaccessible locations, e.g., the ceiling of a room, without any special tools and complex motional stages, just by plugging it into the base. On the other hand the advantage remains that alarm insert 10 can be removed from base 12 only by a combined rotational and axial movement, which presents an insurance against any unauthorized removal of alarm insert 10.

With the exemplified embodiment not only the spring angular bendings, e.g. the bending 152 of spring 96, but also the latch extensions 94, 114, 108, 112 are positioned the same slanted way to facilitate the sliding between angular bendings and latch extensions. To achieve a tangential torque between springs or other latch elements and latch extensions, and, thus, between base 12 and alarm insert 10 it is conceivable also, of course, that only latch extensions 94, 114, 108, 112 are set at a slant to have them interact, e.g., with conical latch extensions.

Developments of base 12 are indicated in the figures only in a partial and schematic way. For example, the bottom of base 12 consisting of switchplate 138 and cover 140 can be equipped (as shown in fig. 2) with openings 158 for feed-throughs of attachments means, and in this bottom or jacket 120 feed-through openings (not shown) for cabling can be produced. Furthermore, in the interior of base 12 switching means can be arranged on switchplate 138, e.g. a binding post block 160 visible in fig. 2, and a relay shown in figs. 2 and 3. The base can carry also on its edge 122, as shown in figs. 2 and 5, a light-emitting diode 164, which indicates the applicable operating state of the alarm, for example, by blinking in a stand-by state, and in a responding state switching over to a steady burning light.

WHAT I CLAIM IS:

1. An ionization fire alarm comprising a test chamber accessible to ambient air; a reference chamber axially staged behind and electronically series-switched with the test chamber and which is more inaccessible to ambient air; at least one radiation source ionizing the chambers; a housing containing the chambers with a tubular housing section; an insulator surrounding the reference chamber with a first approximately tubular wall section having a diameter smaller than that of the tubular housing section, a second tubular wall section adjoined to the inside of the tubular housing section, and an approximately ring shaped wall section interconnecting both tubular wall sections; said insulator carrying an internal electrode in the reference chamber placed across the alarm axis, and carrying a centre electrode which is common to both chambers parallel to and having approximately the same dimension as the internal electrode; said ring shaped wall section lies approximately in the plane of the centre electrode, the second tubular wall section adjoining the inside of the tubular housing section extends axially from the ringlike wall section away from the first tubular wall section and surrounding the test chamber; a bowl-like outer electrode of the test chamber equipped with a flat bottom parallel to the centre electrode, lying approximately in the plane of the end of the second tubular wall section remote

form the ring shaped wall section smaller than the inner dimension of said second tubular wall section and larger than the centre electrode in dimension, said bowl-like electrode having a skirt extending axially inward from the outer edge of the flat bottom towards the ring shaped wall section, and being smaller than the distance from the flat bottom to the centre electrode in axial length; and connector elements spaced over the skirt circumference to connect said skirt to the inside of outward extending tubular wall section.

2. A fire alarm according to claim 1, wherein a radially outward projecting edge adjoins the axially inner edge of the skirt of the outer electrode.

3. A fire alarm according to claim 1 or 2, wherein on its outside, the ring shaped wall section has a ring shaped shoulder at a through-flow type slitlike jet exit adjoining the axially inner edge of the skirt of the outer electrode.

4. A fire alarm according to claim 3, wherein the cross-sectional area of the jet exit amounts to 20% to 50% of the cross-sectional area of a gap in its axial area outward adjoning the jet exit.

5. A fire alarm according to any preceding claim, wherein adjoining an end of the tubular housing section there is a radially inward projecting ring shaped wall section of the housing, on the axially inner side of which the end of the second tubular wall section remote from the first tubular wall section is anchored, the bottom of the outer electrode lies at least approximately in the plane of the ring shaped wall section of the housing, and radially inward projects over the inside of the second extending tubular wall section.

6. A fire alarm according to claim 5, wherein the cross-sectional area of a gap between the outer electrode and a radially inner edge of the housing ringlike wall section approximates three-quarters of the gap cross-sectional area or less in the latter's inward adjoining axial area.

7. A fire alarm according to any preceding claim, wherein the axial length of the skirt of the outer electrode approximates half of the distance between the bottom of the outer electrode and the centre electrode.

8. A fire alarm according to any preceding claim, wherein the connector elements from the axially inner end of the skirt of the outer electrode extending radially inward in the plane of the axial inner end of the skirt, are tongues which are attached to extensions radially inward projecting from the inside of second tubular wall section, and extending from the ringlike wall section of the insulator to the level of the inner end of the skirt.

9. A fire alarm according to any preceding claim, wherein the housing is electrically conductive and, in use, is applied to a fixed potential, preferably earth or mass potential, and wherein, in use, the potential differential between the housing and the outer electrode is approximately as high and preferably higher than that between inner electrode and outer electrode.

10. A fire alarm according to claim 9, wherein the amount of connector elements and their spacings from the centre electrode measured over the inner surface of the insulator turned toward the reference chamber are so dimensioned that in the absence of voltage applied to the inner electrode and preferably at least of the reference chamber ionizing radiation source, in the presence of voltage operationally effective between the housing and the outer electrode, and with the inner surface of the insulator made weakly conducting and with an applicably non-conducting housing layer up to the conducting housing and/or a conducting layer of the housing, the centre electrode approximately assumes an off-load voltage state with respect to outer electrode, which under operational conditions is effective with the inner surface of insulator and the applicable layer of housing non-conducting, preferably a voltage rated between above off-load voltage and a voltage threshold value, at which the alarm transmission circuit connected to the electrodes is triggered.

11. A fire alarm according to any preceding claim, wherein the outer electrode is covered on its outside with an insulative layer.

12. A fire alarm according to any preceding claim, wherein on the backside of the ringlike wall section of the insulator at least two range spacers are produced, at the rear ends of which a switch plate surrounding the reference chamber in a preferably ringlike way as part of an alarm transmission circuit connected to the electrodes in carried approximately in the plane of the inner electrode.

13. A fire alarm according to claims 8 and 12, wherein the range spacers are aligned applicably with one of the extensions radially inward projecting from the inside of the second extending tubular wall section and applicably one tongue, one extension, one range spacer and the switch-plate is passed through by an axially parallel-run attachment element preferferably a screwbolt.

14. A fire alarm according to any preceding claim, wherein the backside of the housing is covered by flat cover, preferably a metal plate.

15. A fire alarm according to any preceding claim, wherein the housing and the

chambers contained therein produce an alarm insert, which is detachably connected to a stationary installable base, wherein the alarm insert for its mechanical and preferably also electrical connection to the base on the backside circumference of the tubular housing section is equipped with at least two radially outward projecting latch extensions and wherein the base latch elements being outwardly flexible in a radial direction are provided which can be axially locked behind the latch extensions.

16. A fire alarm according to claim 5, wherein the latch extensions and/or latch elements of the base are so slanted against the plane perpendicular to the alarm axis and which is common to them, that the latch elements have such a tangential force effect on the latch extensions that the resultant rotational motion of alarm insert is limited at least by one limit stop provided in base, and that in the bast at least two stops are provided, which prevent any axial movement of alarm insert out of the base by way of a stressing limit stop.

17. A fire alarm substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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1586694 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

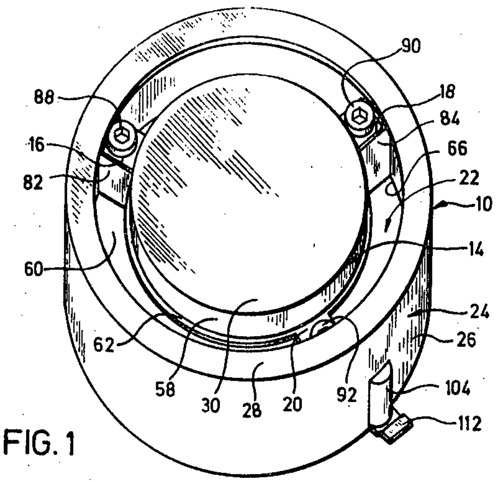


FIG. 1

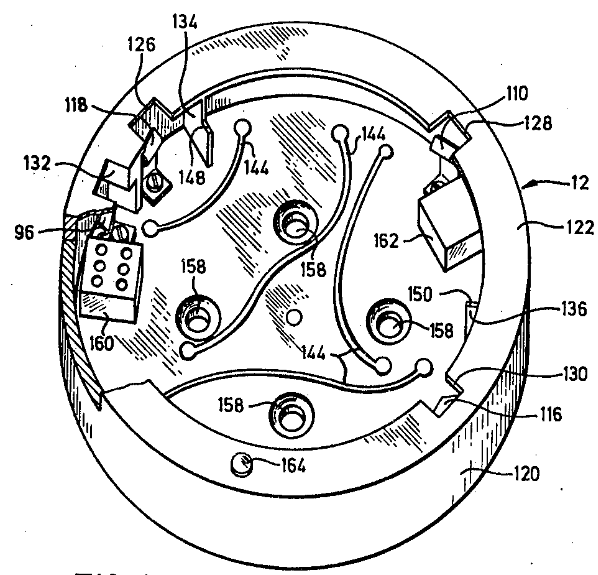


FIG. 2

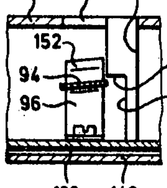


FIG. 4

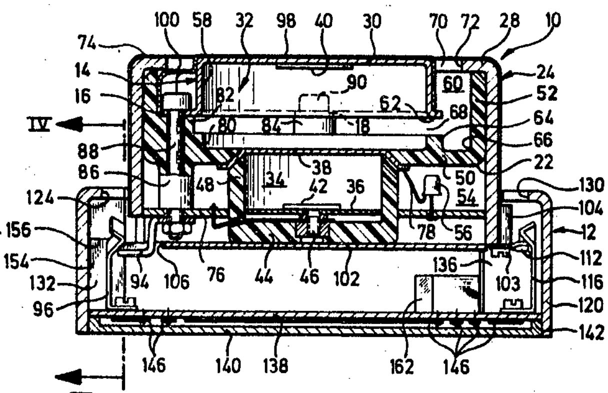


FIG. 3

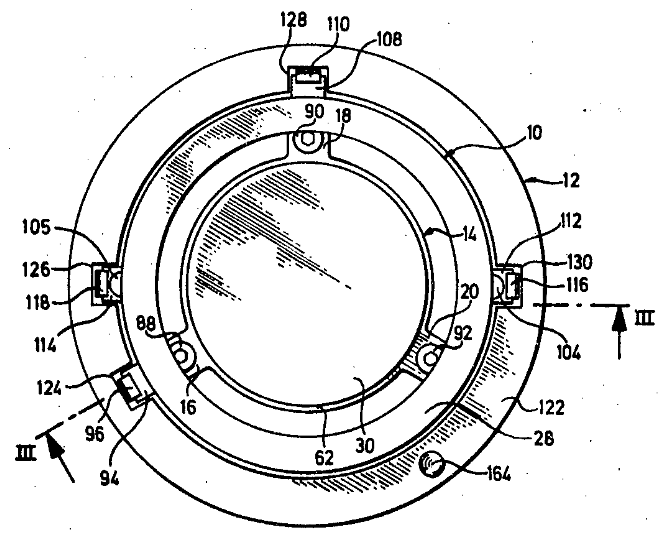


FIG. 5