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(54) **Smoke detection device and method**

(57) The invention relates to a smoke detection device which comprises a detection chamber comprising a base, a ceiling and a side wall that links the base to the ceiling. The side wall of the chamber allows smoke to enter the chamber while blocking light. The smoke detection device also comprises an emitter device which transmits an electromagnetic radiation within the chamber, and a detector device which receives it.

A control unit connected to the detector device and to the emitter device determines the presence of smoke and generates an alarm signal if the quantity of radiation received by the detector exceeds a preset value.

The emitter and detector devices are crossed by a median plane extending between the base and the ceiling of the chamber.

In addition, a smoke detection method is also described.

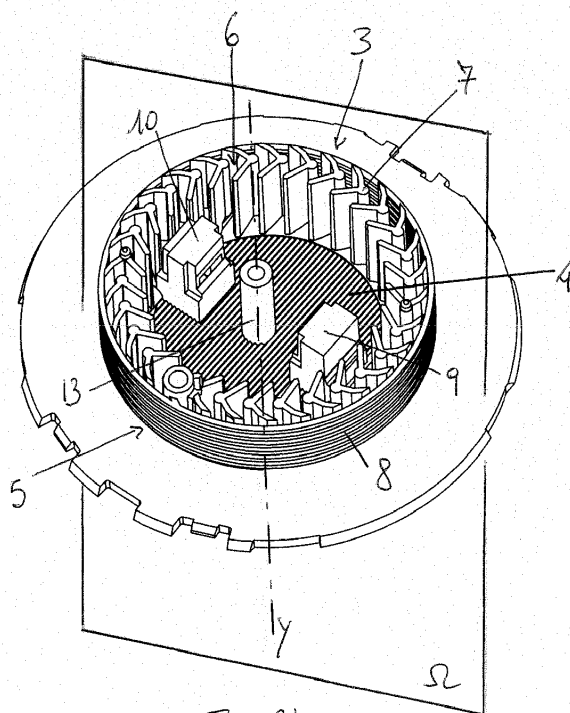


Fig 2b

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Description

[0001] The present invention relates to a smoke detection device according to the preamble of claim 1, as well as to a related smoke detection method.

[0002] In particular, the invention relates to optical smoke detectors based on Tyndall's effect, and it specifically tackles two problems which are commonly found in detectors of this type.

[0003] The first problem concerns the uniformity of the detector response as a function of the direction and speed of the smoke entering the detection chamber.

[0004] The second problem concerns the possibility of discriminating true alarms from false alarms caused by foreign bodies entering the detection chamber.

[0005] Smoke detectors based on Tyndall's effect consist of a detection chamber, called "smoke chamber", characterized in that (thanks to a labyrinth located on the edge of the chamber) light cannot enter the chamber from the outside, while smoke can.

[0006] The detection chamber houses a receiver diode and an emitter diode, the respective reception and emission fields intersecting within the chamber.

[0007] In detectors of this type, the reciprocal positioning of the emitter and receiver diodes typically forms an angle between 95 and 150 degrees.

[0008] The intersection between the emission beam and the reception cone creates within the chamber a space portion which represents the sensitive zone of the smoke chamber.

[0009] This arrangement of the emitter and receiver diodes is normally used in order to obtain that, in the absence of smoke, the receiver diode detects a very low radiation (used as a control signal for the correct operation of the detector), which is not sufficient to trigger the smoke alarm.

[0010] If, on the contrary, there is smoke entering the chamber, then the receiver diode will detect a high quantity of radiation and a detector control unit will trigger the alarm.

[0011] However, this arrangement suffers from the drawback that all the smoke chamber volume behind the emitter and receiver diodes is a blind zone where smoke is not detected until it has crossed all of the blind volume and has entered the sensitive zone of the detector.

[0012] If the speed of the intake smoke is slow, when the smoke comes in through the blind zone its detection is considerably delayed compared to the case wherein the smoke comes in through the sensitive zone of the detector.

[0013] Consequently, the sensitivity of the detector depends on the direction of the intake smoke.

[0014] As known, it is important that the sensitivity of the sensor is as uniform as possible, so that its operation is not dependant on how it has been installed.

[0015] It is for this very reason that regulations are in force (EN54) which set a certain range between a minimum value and a maximum value for the ratio between

the minimum and maximum sensitivity values detected.

[0016] An additional drawback of known detector solutions concerns false alarms caused by the presence of foreign bodies inside the detectors (e.g. insects) or by deposited dust or dirt particles.

[0017] An alarm triggered in a fire detection system may give way to a number of very expensive actions, such as calling the Fire Department, evacuation plans, and the activation of automatic systems in order to extinguish the fire.

[0018] It is therefore very important to be able to discriminate a true alarm from a false one caused by the presence of a foreign body.

[0019] It is the main object of the present invention to reduce the variation of the smoke detector sensitivity as a function of smoke speed and intake area in the detector itself.

[0020] It is another object of the present invention to improve the overall efficiency of the detection system by recognizing false alarm conditions, thus avoiding useless activations of the aforementioned very expensive procedures.

[0021] These and further objects of the present invention are achieved through a smoke detection device and a smoke detection method incorporating the features set out in the appended claims, which are intended as an integral part of the present description.

[0022] The invention is based on the idea of arranging the device that emits the electromagnetic radiation in line with the device that receives it. De facto, this alignment translates into the emitter and detector devices being arranged in a manner such that they are crossed by a median plane extending between the base and the ceiling of the detection chamber.

[0023] Between the emitter device and the detector device there is an obstacle having a shape and a size which are suitable for exploiting Tyndall's effect for smoke detection purposes.

[0024] Preferably, the emitter device is adapted to emit radiation in a symmetrical manner with respect to said median plane, thus ensuring a uniform detection within the chamber.

[0025] This solution allows to eliminate all blind spots in the detection chamber, since the beam emitted by the emitter device illuminates the whole chamber in a substantially uniform manner.

[0026] Thus, detector sensitivity variations depending on smoke speed and intake direction are considerably reduced.

[0027] Furthermore, the emitter device advantageously comprises two radiation sources, in particular two LED diodes which can be controlled separately in order to choose which part of the chamber must be sensed.

[0028] When an alarm is detected, the two sources are controlled in such a manner that they are turned on one at a time, and each time it is verified if the quantity of radiation received by the detector exceeds the alarm threshold over which it is determined that smoke is

present. If the quantity of received radiation does not exceed the threshold when either source is off, then a false alarm will be detected.

[0029] Further objects and advantages of the present invention will become apparent from the following description and from the annexed drawings, wherein:

- Fig. 1 is a general view of a smoke detection device,
- Figs. 2a and 2b are two views of a detection chamber of a device according to the present invention.

[0030] Referring now to Fig. 1, smoke detection device 1 (hereafter also called "smoke detector") comprises a cap 2 enclosing a detection chamber 3, which will be described in detail with reference to Figs. 2a and 2b.

[0031] Detection chamber 3 comprises a base 4, a ceiling (not shown in the drawing for simplicity's sake), and a side wall 5 adapted to allow smoke and not allow light to enter chamber 3.

[0032] For this purpose, side wall 5 comprises a labyrinth 6 which follows the chamber perimeter and which consists of a plurality of V-shaped elements (designated by reference numeral 7) that let air and smoke into the chamber while blocking light.

[0033] Labyrinth 6 is wound by a thin-mesh grid 8 which prevents any foreign bodies from entering chamber 3.

[0034] Chamber 3 takes up a volume having a substantially axial symmetry, with an axis of symmetry y .

[0035] Inside chamber 3 there are two housings 9 and 10, which accommodate a device 11 emitting an electromagnetic radiation and a device 12 capable of receiving said radiation, respectively.

[0036] For clarity, the emitter and receiver devices have been schematically drawn with a dashed line inside the respective housings.

[0037] According to the preferred solution described below, the emitter device consists of a pair of smd LEDs (light emitting diodes) that emit a radiation within the infrared range, while receiver device 12 consists of a photodiode that detects radiation within the same band.

[0038] Emitter device 11 and receiver device 12 are aligned along median plane Ω extending between the base and the ceiling of chamber 3 and crossing devices 11 and 12.

[0039] The LEDs are preferably mounted to a PCB (printed circuit board) arranged vertically in the housings and connected electrically to a motherboard (not shown) installed under the chamber, as described in patent application TO2006A000676 in the name of the present Applicant.

[0040] The radiation emitted by the LEDs spreads inside chamber 3 in a symmetrical manner with respect to median plane Ω and is detected by the photodiode.

[0041] The photodiode, preferably THT (through hole technology) type, is also connected to the motherboard.

[0042] As known, a photodiode generates a current signal, the amplitude of which is proportional to the radiation detected.

[0043] When the photodiode detects a quantity of radiation exceeding a preset value (alarm threshold), then the amplitude of the generated signal is such that it is interpreted as an alarm signal by a control unit (e.g. a microprocessor) mounted to the motherboard.

[0044] Such a signal is interpreted as an alarm for the possible presence of smoke in the chamber.

[0045] Between the emitter device and the receiver device there is a dimmer device 13.

[0046] Dimmer device 13 is positioned and sized in such a manner that it can intercept a portion of the radiation emitted by the emitter LEDs, so that in the absence of smoke the quantity of radiation received by the detector is below the alarm threshold over which the signal generated by the photodiode has such an amplitude that it is interpreted as an alarm signal indicating the presence of smoke in the chamber.

[0047] When smoke enters chamber 3, the radiation emitted by the LEDs propagates through the effect of its interaction with the smoke and, in spite of the presence of dimmer 13, the photodiode detects a radiation having such an intensity that the signal generated by said photodiode is read by the control unit as an alarm signal.

[0048] Dimmer device 13 has a symmetry plane which coincides with median plane Ω .

[0049] This leads dimmer 13 to intercept the radiation of both emitter LEDs and provides symmetry in the smoke detection taking place within both chamber portions C1 and C2, which are ideally defined by the outer chamber perimeter and median plane Ω .

[0050] The dimmer device has preferably a cylindrical shape, or anyway a profile which is convex in the emitter direction.

[0051] These shapes offer the advantage that only a very small portion of the radiation that hits the dimmer device is sent towards the emitter.

[0052] For the purpose of further reducing the radiation returning back towards the emitter (thus interfering with the emitted radiation), the dimmer device may have a knurled surface.

[0053] Under normal operating conditions, both emitter LEDs are on and emit infrared radiation.

[0054] When the control unit receives a signal having such an amplitude that it is interpreted as an alarm signal, the control unit activates a procedure for detecting false alarms.

[0055] According to said procedure, the two emitter LEDs are turned off alternatively, therefore keeping only one switched on at the time, in order make the two chamber portions C1 and C2 alternatively sensitive.

[0056] At each deactivation, the control unit verifies whether the amplitude of the signal transmitted by the photodiode is such that said signal must be read as an alarm signal or not.

[0057] If during this procedure an alarm is detected in just one of the chamber portions C1 and C2, this means that there has been a false alarm condition caused by a foreign body.

[0058] On the contrary, if the signal transmitted by the photodiode is an alarm signal for both chamber portions C1 and C2, then this condition is interpreted as a true smoke alarm.

[0059] The advantages of the smoke detection device and method according to the present invention are apparent from the above description.

[0060] It is also clear that many changes may be made thereto by those skilled in the art without departing from the teachings of the present invention set out in the appended claims.

[0061] For example, the emitter LEDs may be replaced with THT diodes or other sources which can be used for exploiting Tyndall's effect.

[0062] Likewise, the detection device may consist of a plurality of photodiodes or CCD sensors.

[0063] It is also apparent that, although the above-described preferred embodiment utilizes two radiation sources for being able to detect false alarms, according to a less advantageous solution the LED diodes may be replaced with a single electromagnetic radiation source (e.g. a single diode). In the latter case, the arrangement of the emitter and receiver devices is nonetheless such as to ensure a good sensitivity of the smoke detector.

Claims

1. Smoke detection device, comprising:

- a detection chamber (3) comprising a base (4), a ceiling and a side wall (5) that links said base to said ceiling, said side wall (5) being adapted to allow smoke and not allow light to enter the chamber (3),
- an emitter device (11) adapted to emit an electromagnetic radiation inside said chamber,
- a detector device (12) adapted to receive said radiation,
- a control unit connected to said detector device (12) and to said emitter device (11) and adapted to generate an alarm signal if the quantity of radiation received by said detector (12) exceeds a preset value, and
- a dimmer device (13) arranged within said chamber (3) and adapted to intercept at least a portion of the radiation emitted by said emitter device (11), so that in the absence of smoke the quantity of radiation received by said detector device (12) is smaller than said preset value,

characterized in that said emitter device (11) and said detector device (12) are crossed by a median plane (Ω) extending between the base (4) and the ceiling of the chamber (3).

2. Device according to claim 1, wherein said emitter device (11) is adapted to emit said radiation in a sub-

stantially symmetrical manner with respect to said median plane (Ω).

3. Device according to claim 1 or 2, wherein said chamber (3) takes up a volume having a substantially axial symmetry with respect to an axis of rotation (y) lying in said median plane (Ω).
4. Device according to any of claims 1 to 3, wherein said median plane (Ω) is a symmetry plane of said dimmer device (13).
5. Device according to any of the preceding claims, wherein said dimmer device (13) has a convex profile in the direction of said emitter device (11).
6. Device according to claim 5, wherein said dimmer device (13) has a substantially cylindrical shape.
7. Device according to claim 6, wherein said dimmer device (13) has a substantially semicylindrical shape.
8. Device according to any of the preceding claims, wherein said dimmer device (13) has a knurled surface.
9. Device according to any of the preceding claims, wherein said emitter device (11) comprises at least two radiation sources arranged symmetrically in relation to said median plane (Ω).
10. Device according to claim 9, wherein said control unit is adapted to control said two sources separately.
11. Device according to claim 10, wherein said control unit is so programmed that, if the quantity of radiation received from the emitter device exceeds said preset value, then said control unit controls said sources in a manner such that they are turned on one at a time, and each time it verifies whether the quantity of radiation received by said detector exceeds said preset value or not, thus recognizing a false alarm if said quantity of radiation does not exceed said preset value when either of said two sources is off.
12. Smoke detection method, wherein:
 - an emitter device (11) emits an electromagnetic radiation inside a detection chamber (3) comprising a base (4), a ceiling and a side wall (5) that links said base (4) to said ceiling, said side wall (5) being adapted to allow smoke and not allow light to enter the chamber (3),
 - a detector device (12) receives said radiation,
 - a control unit determines the presence of smoke if the detector device (12) detects a quan-

tity of radiation exceeding a preset value,
- a dimmer device (13) intercepts at least a portion of the radiation emitted by said emitter device (11), so that in the absence of smoke the quantity of radiation received by said detector is smaller than said preset value,

characterized in that said emitter device (11) and said detector device (12) are crossed by a median plane (Ω) extending between the base (4) and the ceiling of the chamber (3).

- 13.** Method according to claim 12, wherein said emitter device (11) emits said radiation in a substantially symmetrical manner with respect to said median plane (Ω).
- 14.** Method according to claim 12 or 13, wherein the radiation is emitted by two radiation sources which can be controlled separately.
- 15.** Method according to claim 14, wherein, if the control unit determines the presence of smoke, then said two sources are controlled in such a manner that they are turned on one at a time and each time it is verified whether the quantity of radiation received by said detector exceeds said preset value or not; if said quantity of received radiation does not exceed said preset value when either of said two sources is off, then a false alarm is detected.

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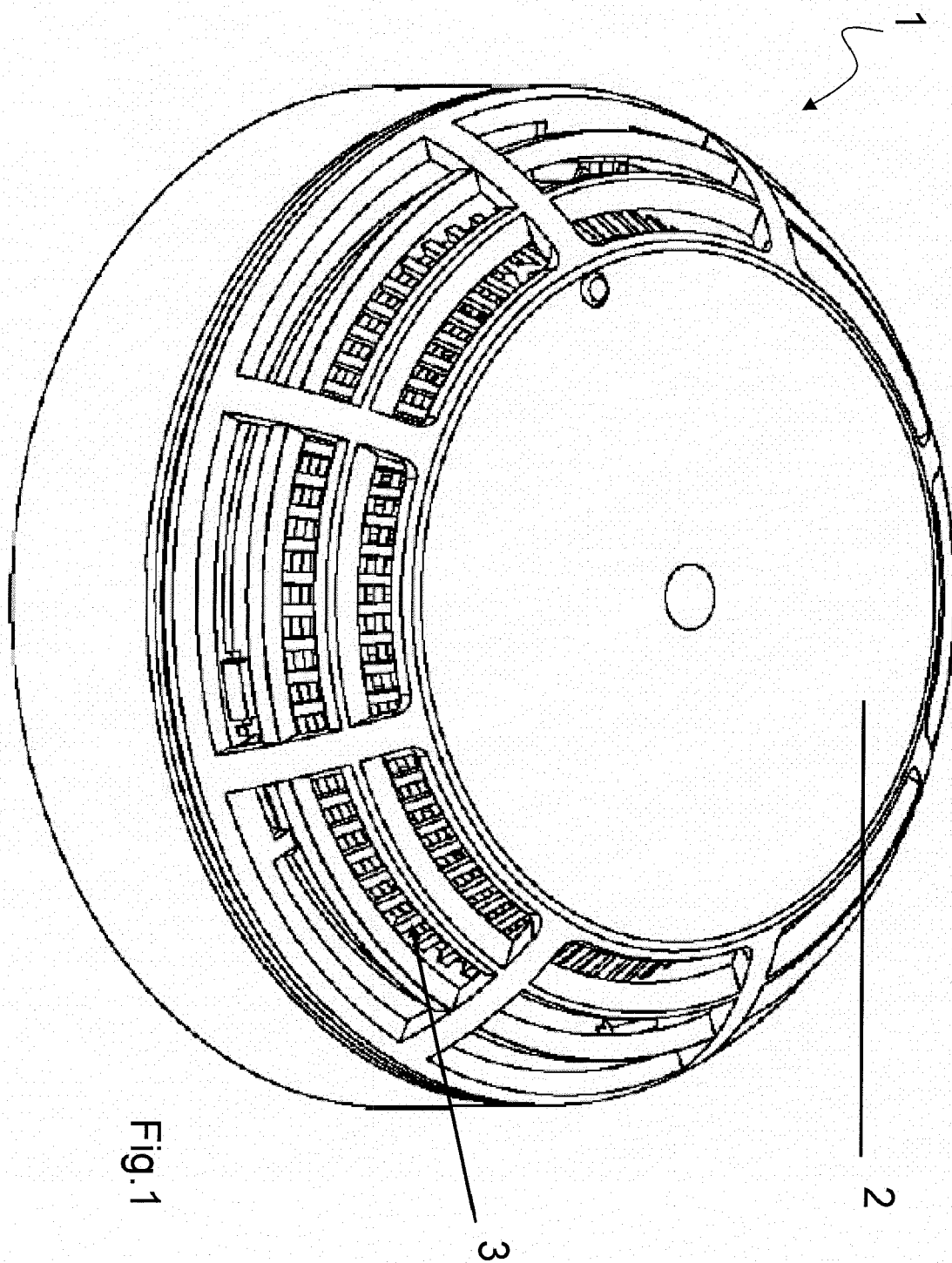


Fig. 1

