(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 358 053 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
**24.04.2024 Bulletin 2024/17**

(21) Application number: **22201782.4**

(22) Date of filing: **17.10.2022**

(51) International Patent Classification (IPC):
***G08B 29/18*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
**G08B 17/107; G08B 29/18;** G08B 17/113

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
**BA**
Designated Validation States:
**KH MA MD TN**

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(54) **SELF-CLEANING SMOKE DETECTOR DEVICE AND METHOD THEREOF**

(57) A self-cleaning smoke detector device for detecting a presence of smoke particles in ambient air, comprising: at least one emitter for emitting a light with one or more light wavelengths; at least one receiver for providing an output signal of the light received from the emitter; a dark chamber with one or more inlet openings for receiving the smoke particles of the ambient air, within which the emitter and receiver are oppositely mounted for scattering the light towards the receiver and preventing the light from the emitter from being directly received by the receiver; characterized by comprising: a vibration motor coupled to the dark chamber for shaking dust build-up within the dark chamber; at least one outlet opening arranged inside dark chamber, for letting out shaken dust; an electronic data processor configured for actuating the vibration motor for shaking the dust inside the dark chamber.

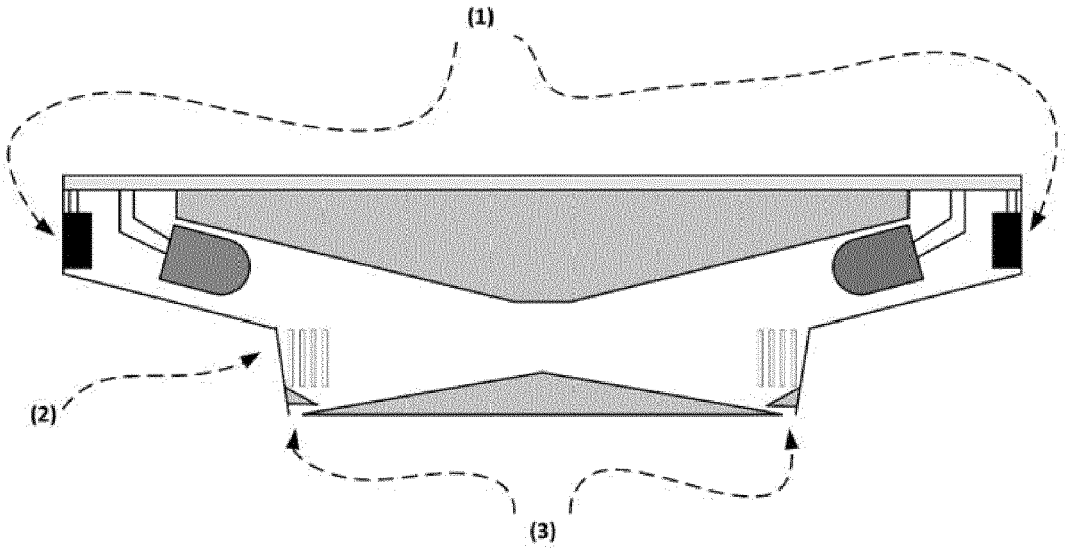


**Fig. 1**

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## Description

### TECHNICAL FIELD

**[0001]** The present disclosure belongs to the technical field of smoke detectors, and more particularly to self-cleaning smoke detectors, also interchangeably referred to as fire detectors.

### BACKGROUND

**[0002]** The main operating principle of existing commercial automatic fire detector devices is based on multi-sensorial systems for the detection and measurement of three main fire phenomena: (i) heat, (ii) carbon monoxide, and (iii) smoke. The sensorial system for the latter phenomenon (smoke) typically exploits the Rayleigh light scattering effect to detect the concentration (and possibly the size) of smoke particles in the surrounding environment.

**[0003]** Due to the slots normally present in fire detectors, contamination of the air intakes, and dust accumulation inside the smoke chamber, represent a common issue in these devices. Besides affecting the sensitivity of the detector, dust accumulation can, in extreme cases, block the air intake to the smoke and render the detector completely insensitive. To keep the correct operational condition, these devices are subject to periodical maintenance and manual cleaning a process that requires specialized personnel and is extremely time-consuming and costly.

**[0004]** Document EP1857989B2 providing a fire alarm device e.g. smoke alarm unit, for use in e.g. apartment, has self-testing unit for testing permeability of smoke entrance openings in housing, and sensor for optically and/or acoustically sensing opening. The device has a housing and a self-testing unit for testing permeability of smoke entrance openings in the housing. A sensor is provided for optically and/or acoustically sensing the opening, where the sensor is a distance sensor and/or light sensor. The sensor is arranged in such a manner that a space is formed from the opening up to a fire detection sensor inside the fire alarm device. A reference sensor is provided for measuring an ambient light of the fire alarm device. An independent claim is also included for a method for testing a functional capability of the fire alarm device.

**[0005]** Document EP1728224B1 discloses an invention related to a fire detector according to the scattered radiation principle with at least one radiation transmitter and at least one radiation receiver, the radiation paths of which form a scattering volume. The fire detector comprises, in addition to at least one first radiation transmitter (5.1) and a first radiation receiver, at least one second radiation transmitter (5.2) and a second radiation receiver, which form at least two locally spaced scattering volumes with their radiation paths.

**[0006]** These facts are disclosed in order to illustrate the technical problem addressed by the present disclosure.

### GENERAL DESCRIPTION

**[0007]** The present disclosure discloses a self-cleaning smoke device for detecting a presence of smoke particles in an ambient air within a monitored space.

**[0008]** The present disclosure is composed of three components: (i) light-emitting sources, e.g., light-emitting diode (LED), for possibly different light wavelengths, (ii) light-sensing receptors, e.g. photodiodes, and (iii) a so-called "smoke chamber", an enclosure to contain the former elements in a dark environment. The detection principle is simple: the LEDs send light into the smoke chamber, where it is absorbed by a labyrinth structure; in the event of a fire, smoke particles enter the chamber through small inlet openings, scattering light towards the photodiodes that then convert the quantity of light into a proportional electrical signal.

**[0009]** Here, it is proposed the adaptation and inclusion of one or more of the aforementioned techniques in our fire detectors to limit, or even prevent, dust build-up in the smoke chamber and keep the correct operational condition of our devices. This feature can significantly reduce the necessary maintenance interventions and prolong device life-time, providing added-value to our products and a clear differentiator among our competitors.

**[0010]** It is also disclosed a self-cleaning smoke detector device for detecting a presence of smoke particles in ambient air, comprising: preferably at least one emitter for emitting a light with one or more light wavelengths; preferably at least one receiver for providing an output signal of the light received from the emitter; a dark chamber with one or more inlet openings for receiving the smoke particles of the ambient air, preferably within which the emitter and receiver are oppositely mounted for scattering the light towards the receiver and preventing the light from the emitter from being directly received by the receiver; characterized by comprising: a vibration motor coupled to the dark chamber for shaking dust build-up within the dark chamber; at least one outlet opening arranged inside dark chamber, for letting out shaken dust; an electronic data processor configured for actuating the vibration motor for shaking the dust inside the dark chamber. The light is preferably visible light with wavelengths between 380 nm and 800 nm and/or ultraviolet light and/or infrared light.

**[0011]** In an embodiment, the outlet opening is placed at a central position in respect of the dark chamber to let out shaken dust from inside dark chamber.

**[0012]** In an embodiment, the outlet opening is placed at a peripheral position in respect of the dark chamber to let out shaken dust from inside dark chamber.

**[0013]** In an embodiment, the outlet opening comprises a meandering channel for reducing an exterior light to enter the dark chamber.

**[0014]** In an embodiment, the meandering channel comprises one or more inclined surfaces for reducing dust build-up.

**[0015]** In an embodiment, said device comprises an additional vibration motor, wherein the two vibration motors are oppositely mounted inside the dark chamber.

**[0016]** In an embodiment, said electronic data processor is further configured for controlling each vibration motor such that only a vibration motor is actuated at a time or both vibration motors are actuated simultaneously.

**[0017]** In an embodiment, said electronic data processor is further configured for changing a vibration frequency of the motor such that only the vibration frequency of the vibration motor is actuated at a time or both vibration frequencies of the vibration motors are changed simultaneously.

**[0018]** In an embodiment, said device comprises a dust repellent coating inside the dark chamber.

**[0019]** In an embodiment, the dust repellent coating is nano-phase silica, titania, oxide, hydrophobic resin with nanometre particulates, or combinations thereof.

**[0020]** In an embodiment, the dark chamber comprises a further electrostatic repulsion circuitry for reducing dust build-up inside the dark chamber and the electronic data processor is further configured for actuating the electrostatic repulsion circuitry for reducing dust build-up inside the dark chamber.

**[0021]** In an embodiment, the vibration motor is an eccentric rotating mass vibration motor or a piezoelectric vibrator.

**[0022]** In an embodiment, the vibration motor is coupled to the dark chamber (2) for shaking dust build-up on the emitter and/or receiver.

**[0023]** It is also disclosed a computer-based method for sensing a presence of smoke particles in an ambient air, using a self-cleaning smoke detector device comprising: preferably at least one emitter for emitting a light with one or more light wavelengths; preferably at least one receiver for providing an output signal of the light received from the emitter; a dark chamber with one or more inlet openings for receiving the smoke particles of the ambient air, preferably within which the emitter and receiver are oppositely mounted for scattering the light towards the receiver and preventing the light from the emitter from being directly received by the receiver; a vibration motor coupled to the dark chamber for shaking dust build-up; at least one outlet opening arranged inside dark chamber, for letting out shaken dust; an electronic data processor; wherein the method comprises the step of the electronic data processor actuating the vibration motor for shaking the dust inside the dark chamber.

**[0024]** In an embodiment, said dark chamber comprises a further electrostatic repulsion circuitry for reducing dust build-up inside the dark chamber and the method further comprises the step of the electronic data processor actuating the electrostatic repulsion circuitry for reducing dust build-up inside the dark chamber.

**[0025]** In an embodiment, said dark chamber comprises an additional vibration motor, wherein the two vibration motors are oppositely mounted inside the dark chamber (2) and the method further comprises the step of the electronic data processor controlling each vibration motor such that only a vibration motor is actuated at a time or both vibration motors are actuated simultaneously.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0026]** The following figures provide preferred embodiments for illustrating the disclosure and should not be seen as limiting the scope of invention.

**Figure 1:** Schematic representation of an embodiment of a self-cleaning smoke chamber component.

**Figure 2:** Schematic representation of an embodiment of a self-cleaning smoke chamber design.

## DETAILED DESCRIPTION

**[0027]** The present disclosure relates to a self-cleaning smoke detector device for detecting a presence of smoke particles in an ambient air within a monitored space.

**[0028]** **Figure 1** presents an overview of some of the main components of the present disclosure for a self-cleaning smoke chamber. The cornerstone of the solution is the attachment to the smoke chamber body of eccentric rotating mass vibration motors, similar to those widely found in the haptic systems for smartphones, or piezoelectric vibrators **1.** Although a single motor may suffice, the attachment of two units allows for the generation of alternate vibration patterns (e.g. motor 1 only -> motor 2 only -> both motors simultaneously). Additionally, the vibration frequency can be dynamically changed. By combining patterns and vibration frequencies, particles of different sizes and mass can be loosened up from the multiple surfaces inside the smoke chamber.

**[0029]** The smoke chamber **2** must be designed so there are no perfectly flat walls and surfaces that can collect and trap the loosen dust particles. Additionally, these surfaces guide the particles into the lower levels of the chamber and into specialized outlet holes **3.** For this, two possible chamber designs are proposed **(Figure 1** and **Figure 2).** In the first design, loosen dust particles slide from the lateral surfaces into multiple holes around the lower surface circumference. The lower surface chamfers from the middle to the edge outlet holes so particles falling, for example, from the middle of the chamber also slide into the outlets. In the second design, a single outlet hole is placed in the middle of the chamber. The lower surface also chamfers towards the hole. Note that all outlet holes may require a light trapping labyrinth structure to reduce the amount of exterior light entering the chamber.

**[0030]** To further reduce dust build-up and facilitate particle displacement, the interior of the smoke chamber is treated with a dust repellent coating. For example, the

dust repellent coating consist of nano-phase silica, titania, or other oxide coatings. Alternatively, the chamber walls might be lined with an electrostatic repulsion circuitry for more demanding environments.

**[0031]** **Figure 1** shows an embodiment, comprising: at least one emitter for emitting a light with one or more light wavelengths; at least one receiver for providing an output signal of the light received from the emitter; a dark chamber **2** with one or more inlet openings **2** for receiving the smoke particles of the ambient air, within which the emitter and receiver are oppositely mounted for scattering the light towards the receiver and preventing the light from the emitter from being directly received by the receiver; characterized by comprising: a vibration motor coupled to the dark chamber **2** for shaking dust build-up; at least one outlet opening 3 arranged inside dark chamber **2,** for letting out shaken dust; an electronic data processor configured for actuating the vibration motor for shaking the dust inside the dark chamber **2.**

**[0032]** **Figure 2** shows an embodiment, wherein the outlet opening **3** is arranged to be placed at a peripheral position to let out shaken dust inside dark chamber **2.** According **Figure 1,** the outlet opening **3** is arranged to be placed at a central position to let out shaken dust inside dark chamber **2.**

**[0033]** The term "comprising" whenever used in this document is intended to indicate the presence of stated features, integers, steps, components, but not to preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

**[0034]** The disclosure should not be seen in any way restricted to the embodiments described and a person with ordinary skill in the art will foresee many possibilities to modifications thereof. The above-described embodiments are combinable. The following claims further set out particular embodiments of the disclosure.

## Claims

**1.** A self-cleaning smoke detector device for detecting a presence of smoke particles in ambient air, comprising:

a dark chamber (2) with one or more inlet openings (2) for receiving the smoke particles of the ambient air;
**characterized by** comprising:

a vibration motor coupled to the dark chamber (2) for shaking dust build-up within the dark chamber (2);
at least one outlet opening (3) arranged inside dark chamber (2), for letting out shaken dust;
an electronic data processor configured for actuating the vibration motor for shaking the dust inside the dark chamber (2).

**2.** The self-cleaning smoke detector device according to claim 1, wherein the outlet opening (3) is placed at a central position in respect of the dark chamber (2) to let out shaken dust from inside dark chamber (2).

**3.** The self-cleaning smoke detector device according to any of the previous claims, wherein the outlet opening (3) is placed at a peripheral position in respect of the dark chamber (2) to let out shaken dust from inside dark chamber (2).

**4.** The self-cleaning smoke detector device according to any of the previous claims, wherein the outlet opening (3) comprises a meandering channel for reducing an exterior light to enter the dark chamber (2).

**5.** The self-cleaning smoke detector device according to the previous claim, wherein the meandering channel comprises one or more inclined surfaces for reducing dust build-up.

**6.** The self-cleaning smoke detector device according to any of the previous claims, wherein said device comprises an additional vibration motor, wherein the two vibration motors are oppositely mounted inside the dark chamber (2).

**7.** The self-cleaning smoke detector device according to the previous claim, wherein said electronic data processor is further configured for controlling each vibration motor such that only a vibration motor is actuated at a time or both vibration motors are actuated simultaneously.

**8.** The self-cleaning smoke detector device according to the previous claims 6 or 7, wherein said electronic data processor is further configured for changing a vibration frequency of the motor such that only the vibration frequency of the vibration motor is actuated at a time or both vibration frequencies of the vibration motors are changed simultaneously.

**9.** The self-cleaning smoke detector device according to any of the previous claims, wherein said device comprises a dust repellent coating inside the dark chamber (2).

**10.** The self-cleaning smoke detector device according to any of the previous claim, wherein the dust repellent coating is nano-phase silica, titania, oxide, hydrophobic resin with nanometre particulates, or combinations thereof.

**11.** The self-cleaning smoke detector device according to any of the previous claims, wherein the dark chamber (2) comprises a further electrostatic repulsion circuitry for reducing dust build-up inside the dark

chamber (2) and the electronic data processor is further configured for actuating the electrostatic repulsion circuitry for reducing dust build-up inside the dark chamber (2).

**12.** The self-cleaning smoke detector device according to any of the previous claims, wherein the vibration motor is coupled to the dark chamber (2) for shaking dust build-up on a emitter for emitting light and/or receiver for detection light.

**13.** Computer-based method for sensing a presence of smoke particles in an ambient air, using a self-cleaning smoke detector device comprising:

a dark chamber (2) with one or more inlet openings (2) for receiving the smoke particles of the ambient air;
a vibration motor coupled to the dark chamber (2) for shaking dust build-up; at least one outlet opening (3) arranged inside dark chamber (2), for letting out shaken dust; an electronic data processor;
wherein the method comprises the step of the electronic data processor actuating the vibration motor for shaking the dust inside the dark chamber (2).

**14.** Method according to the previous claim, wherein the dark chamber (2) comprises a further electrostatic repulsion circuitry for reducing dust build-up inside the dark chamber (2) and the method further comprises the step of the electronic data processor actuating the electrostatic repulsion circuitry for reducing dust build-up inside the dark chamber (2).

**15.** Method according to the previous claims 13 or 14, wherein the dark chamber (2) comprises an additional vibration motor, wherein the two vibration motors are oppositely mounted inside the dark chamber (2) and the method further comprises the step of the electronic data processor controlling each vibration motor such that only a vibration motor is actuated at a time or both vibration motors are actuated simultaneously.

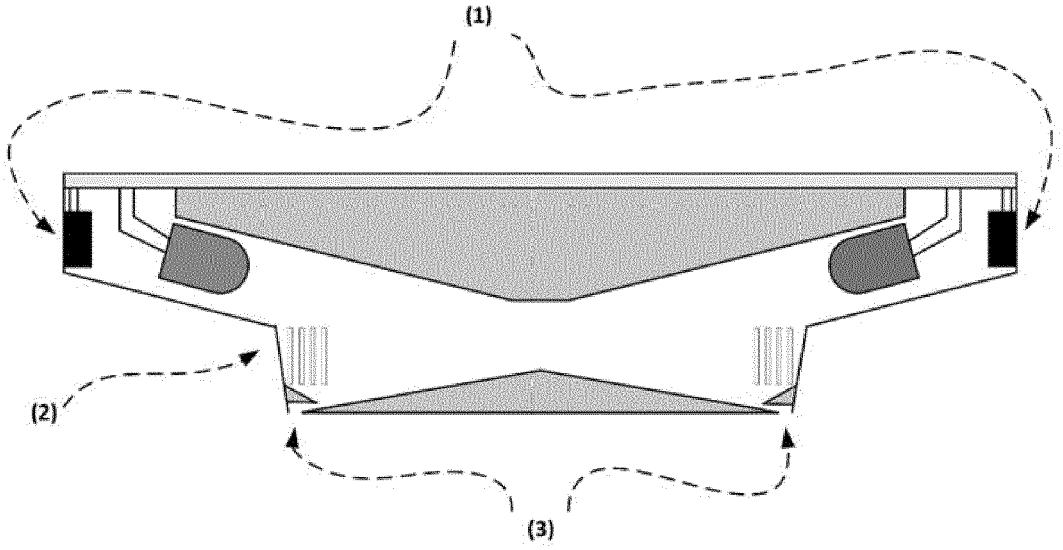


Fig. 1

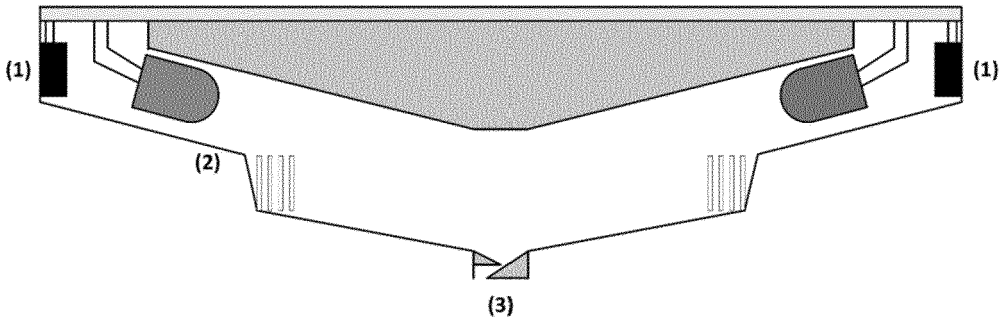


Fig. 2

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# EUROPEAN SEARCH REPORT

Application Number
EP 22 20 1782

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| Y<br>A | US 3 681 603 A (SCHEIDWEILER ANDREAS ET AL) 1 August 1972 (1972-08-01)<br>* column 3, line 47 - line 58 *<br>* column 4, line 47 - line 50 *<br>* column 6, line 19 - line 41 *<br>* column 6, line 57 - column 7, line 2 *<br>* figures 1,3 * | 1-3,9, 10,13<br>4-8,11, 12,14,15 | INV. G08B29/18 |
| Y<br>A | US 2021/302303 A1 (CORDOBA GALERA ANDRÉS [ES] ET AL) 30 September 2021 (2021-09-30)<br>* paragraph [0002] *<br>* paragraph [0011] *<br>* paragraph [0016] *<br>* paragraph [0031] *<br>* paragraph [0036] * | 1-3,13<br>4-12,14, 15 | |
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| | | | TECHNICAL FIELDS SEARCHED (IPC)<br>G08B<br>G01N |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 29 March 2023 | Meister, Mark |

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 20 1782

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## REFERENCES CITED IN THE DESCRIPTION

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- EP 1728224 B1 **[0005]**