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Description

The present invention broadly relates to a photoelectric smoke detector and, more specifically, pertains to a new and improved construction of a small-size or miniature photoelectric smoke detector.

In its more particular aspects, the present invention specifically relates to a new and improved construction of a photoelectric smoke detector which is equipped with a light emitter for radiating light into a measuring chamber and a light receiver for detecting scattered light caused by the entry or presence of smoke in the measuring space.

Dark chambers of conventional photoelectric smoke detectors have a complicated labyrinth construction or double covers and/or additional light shielding plates to prevent the environmental light from entering the dark chamber but to facilitate entry of smoke into the same, see, for example, US—A—3,708,675.

However, such photoelectric smoke detectors as mentioned above, being large in size, are not suitable for use as photoelectric smoke detectors to be built-in into equipment such as electronic computers or to be installed in lavatories in aircraft. These photoelectric smoke detectors also have the disadvantage that miniaturization thereof by merely reducing the size of their dark chambers result in lowering the SN ratio.

To improve the sensitivity of conventional photoelectric smoke detectors it has been suggested to reflect the light beam of a light emitter more than once by a couple of reflecting plates and to arrange a light receiver outside the path of the reflected light, see, for example JP—A—57,42,842. However, while this construction is suitable to improve the sensitivity, simultaneously the noise caused by light scattered from the reflecting plates is enhanced.

Therefore, with the foregoing in mind, it is a primary object of the present invention to provide a new and improved construction of a photoelectric smoke detector which does not exhibit the aforementioned drawbacks and shortcomings of the prior art constructions.

An important and more specific object of the present invention is directed to the provision of a new and improved construction of a photoelectric smoke detector which, although being a small-sized construction, possesses a favourable signal-to-noise ratio for smoke detection.

Yet a further significant object of the present invention aims at providing a new and improved construction of a photoelectric smoke detector which is relatively simple in construction and design, extremely economical to manufacture, highly reliable in operation, not readily subject to breakdown or malfunction and requires a minimum of maintenance and servicing.

Now in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the photoelectric smoke detector of the

present development is manifested by the feature that, a dark chamber forming the measuring space comprises at least one wall comprising planar or curved surfaces arranged substantially in front of the light emitter for reflecting the light radiated from the light emitter at a predetermined angle to the optical axis of the light emitter. The dark chamber also possesses side walls arranged substantially parallel to the optical axis defined by the light emitter.

The photoelectric smoke detector according to the present invention is equipped with a dark chamber of the aforesaid construction such that the dark chamber itself is capable of performing the light trap function. More specifically, the dark chamber is designed in such a way that the light beam radiated by the light emitter is reflected from the wall surfaces of the dark chamber several times without allowing the initially reflected light to reach the light receiving element of the light receiver. The reflected light, if any, reaching the light receiver or receiving element is attenuated to a very weak intensity. Therefore it is not necessary to specially provide a light trap means. Thus a small-sized photoelectric smoke detector with a narrow measuring space is obtained.

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein throughout the various figures of the drawings there have been generally used the same reference characters to denote the same or analogous components and wherein:

Figures 1a and b respectively show a cross-section and a traverse section through a first exemplary embodiment of the invention photoelectric smoke detector;

Figures 2a and b respectively show a cross-section and a traverse section through a second exemplary embodiment of the inventive photoelectric smoke detector;

Figures 3a and b respectively show a cross-section and a traverse section through a third exemplary embodiment of the inventive photoelectric smoke detector;

Figure 4 is a graphical representation of the signal-to-noise ratio S/N of the photoelectric smoke detector according to the present invention as a function of the angle θ formed between two adjacent side surfaces of both a front wall and a rear wall of the dark chamber in the inventive photoelectric smoke detector as shown in Figures 1b, 2b and 3b; and illustrates two different angles θ formed between the two adjacent side surfaces of both the front wall and the rear wall of the dark chamber in the inventive photoelectric smoke detector as shown in Figures 1a, 1b and 3b.

The following describes embodiments of the photoelectric smoke detector according to the present invention in reference to Figures 1 through 3. In these figures, (a) is a cross section and (b) is a transverse section of the dark

chamber according to the present invention, wherein the components are indicated by numerals as follows: 1 — a light emitter which is equipped with a light source such as light emitting diode and a lens, and radiates a convergent light beam; 2 — a light receiver comprising a light receiving element such as solar cell and a lens; 3 — a light shielding plate provided between the light emitter 1 and the light receiver 2; 4, 5 — side walls arranged nearly in parallel with the optical axis of the light beam radiated from the light emitter 1; 6 — a front wall with a plane or curved surface which is arranged in front of the light emitter 1 to reflect the light at a predetermined angle to the optical axis; 7 — a rear wall with plane or curved surface which is arranged in the rear of the light emitter 1 to reflect the reflected light from side walls 4, 5 at a predetermined angle so that the reflected light does not directly irradiate the light receiving element of the light receiver 2; 8, 9 — a bottom wall and a top wall with apertures through which smoke can flow in (not shown on the drawing) and which are provided in the center of the bottom wall 8 and near both ends of the top wall 9. The wall surfaces are of black color and finished up like a mirror. Further in the figures, s — a starting point of the light beam; arrow — a point where the light beam reaches; black dots — reflection points on the side wall 4; white dots — reflection points on the side wall 5; triangle — a reflection point on the top wall 9.

According to preferred embodiment of the invention the walls of the dark chamber have mirror-like surfaces with good absorbance. In this case, for example, the convergent light beam radiated from the light emitter 1 impinges on the left side surface of the front wall 6 and is absorbed by the black surface. Unabsorbed light is reflected from the mirror-like surface nearly as it is, i.e. in the form of convergent light beam without being diffused, and from the left wall 4, the right and left walls 5, 4, further from the top wall 9, the right wall 5, the left wall 4, the left side of the rear wall 7, and then impinges on the outer wall of the light receiver 2. As can be seen from the above description, the dark chamber acts as light trap, where the light radiated from the light emitter 1 is absorbed by the black surfaces and attenuated while being reflected several times, and eventually becomes a very weak light.

Further describing the idea in reference to Fig. 2, the light radiated from the light emitter 1 is reflected from the left side of the front wall 6, the left wall 4, the right, left, right walls, the top wall 9, the left wall 4, the right wall 5, and the right side of the rear wall 7 and then impinges on the outer wall of the light receiver 2. In Fig. 3, the light radiated from the light emitter 1 is reflected from the left side of the front wall 6, the left wall 4, the top wall 9, the right, left, right, left walls and the left of the rear wall 7, and then impinges on the outer wall of the light emitter 1, thus being attenuated to a very weak light.

On the other hand, if a fire breaks out and

smoke enters the dark chamber, scattered light irradiates the light receiving element of the light receiver 2, where an output to give a fire alarm develops. Fig. 4 shows characteristics of the dark chamber, with S representing output of the light receiving element when a predetermined density of smoke for decision on fire entered the dark chamber, N representing output of the light receiving element in normal condition, and θ representing angles of the front and rear walls 6, 7. According to this Figure, a sufficient SN ratio for practical use is obtained at θ of not more than 140° or not less than 210° .

The photoelectric smoke detector according to the present invention is equipped with a dark chamber of the above composition whereby the dark chamber itself is capable of performing a light trap function. More specifically, the dark chamber is designed in such a way that the light beam radiated by the light emitter is reflected several times from the side walls via the front and rear walls, without allowing the initially reflected light to reach the light receiving element of the light receiver, and that reflected light reaching the light receiving element if any is attenuated to a very weak one. Therefore, this idea has such an effect that a small-sized photoelectric smoke detector which has a narrow measuring space and does not require special provision of a light trap means is obtained.

Claims

1. A photoelectric smoke detector, comprising: a front wall (6), two opposite side walls (4, 5), a rear wall (7), a top wall (9) and a bottom wall (8) bounding a measuring space; a light emitter (1) for radiating light along a predetermined optical axis; a light receiver (2) for detecting scattered light scattered in the presence of smoke from the light radiated into said measuring space; said front wall (6) being arranged substantially opposite to said light emitter (1) for receiving said light radiated by said light emitter (1) and said two opposite side walls (4, 5) being arranged substantially parallel to said predetermined optical axis; characterized in that at least said front wall (6) and said two opposite side walls (4, 5) possess reflective surfaces facing said measuring space; and that said front wall (6) possesses two adjacent substantially planar side surfaces forming between themselves a predetermined angle and constituting said reflective surface facing said measuring space and reflects said received light at a substantially perpendicular angle relative to a plane formed by said predetermined optical axis of said light emitter (1) and the optical axis of said light receiver (2); said reflective surfaces of said front wall (6) and said two opposite side walls (4, 5) constituting light trap means for said light radiated from said light emitter (1) and which light trap means multiply reflect said light through said measuring space; and said light receiver (2) being arranged outside the path of said multiply reflected light.

2. Photoelectric smoke detector according to claim 1, characterized in that said two adjacent side surfaces of said front wall (6) form between themselves an angle which is smaller than 140° or greater than 210°.

3. Photoelectric smoke detector according to claim 1, characterized in that said light emitter (1) for radiating light into said measuring space along said predetermined optical axis, emits a convergent light beam.

4. Photoelectric smoke detector according to claim 1, characterized in that said light receiver (2) is placed outside said predetermined optical axis along which said light is radiated by said light emitter (1).

5. Photoelectric smoke detector according to any of claims 1 to 4, characterized in that said measuring space constitutes a dark chamber; said dark chamber being faced by reflective light-absorbing surfaces of at least said front wall (6), said rear wall (7) and said two opposite side walls (4, 5).

6. Photoelectric smoke detector according to claim 4, characterized in that said selective surfaces of at least said front wall (6), said rear wall (7) and said two opposite side walls (4, 5) have mirror-like surfaces with good absorbance.

Patentansprüche

1. Ein photoelektrischer Rauchdetektor mit einer Vorderwand (6), zwei sich gegenüberliegenden Seitenwänden (4, 5), einer Rückwand (7) einer Decke (9) und einem Boden (8), welche zusammen einen Meßraum begrenzen; mit einer Lichtquelle (1) zum Aussenden von Licht entlang einer vorbestimmten optischen Achse; mit einem Lichtempfänger (2) zur Detektion von gestreutem Licht, welches bei Anwesenheit von Rauch von dem Licht gestreut wird, das in den Meßraum eingestrahlt wird; wobei die Vorderwand (6) praktisch gegenüber der Lichtquelle (1) angeordnet ist, um Licht zu empfangen, das von der Lichtquelle (1) ausgesandt wurde und die beiden einander gegenüberliegenden Seitenwände praktisch parallel zu der optischen Achse angeordnet sind; dadurch gekennzeichnet, daß wenigstens die Vorderwand (6) und die beiden einander gegenüberliegenden Seitenwände (4, 5) dem Meßraum zugewandte reflektierende Oberflächen aufweisen und daß die Vorderwand (6) zwei benachbarte, praktisch ebene Seitenflächen aufweist, welche zwischen sich einen vorbestimmten Winkel bilden und die dem Meßraum zugewandte reflektierende Oberfläche darstellen und welche das empfangene Licht in einem praktisch rechten Winkel zu einer durch die vorbestimmte optische Achse der Lichtquelle (1) und der optischen Achse des Lichtempfängers (2) gebildeten Ebene reflektieren; wobei die reflektierenden Oberflächen der Vorderwand (6) und der beiden einander gegenüberliegenden Seitenwände (4, 5) Lichtfallen für das von der Lichtquelle (1) ausgesandte Licht darstellen und dieses Licht vielfach durch den Meßraum reflektieren und wobei der Lichtem-

pfänger (2) außerhalb des Strahlengangs dieses vielfach reflektierten Lichts angeordnet ist.

2. Photoelektrischer Rauchdetektor gemäß Patentanspruch 1, dadurch gekennzeichnet, daß die beiden benachbarten Seitenflächen der Vorderwand (6) zwischen sich einen Winkel bilden, der kleiner als 140° oder größer als 210° ist.

3. Photoelektrischer Rauchdetektor gemäß Patentanspruch 1, dadurch gekennzeichnet, daß die Lichtquelle (2) zur Aussendung von Licht entlang der vorbestimmten optischen Achse in den Meßraum einen konvergenten Lichtstrahl aussendet.

4. Photoelektrischer Rauchdetektor gemäß Patentanspruch 1, dadurch gekennzeichnet, daß der Lichtempfänger (2) außerhalb der vorbestimmten optischen Achse, entlang der das Licht von der Lichtquelle (1) ausgesandt wird, angeordnet ist.

5. Photoelektrischer Rauchdetektor gemäß einem der Patentansprüche 1 bis 4, dadurch gekennzeichnet, daß der Meßraum eine Dunkelkammer darstellt; wobei diese Dunkelkammer durch reflektierende, lichtabsorbierende Oberflächen von mindestens der Vorderwand (6) der Rückwand (7) und den beiden einander gegenüberliegenden Seitenwänden (4, 5) begrenzt wird.

6. Photoelektrischer Rauchdetektor gemäß einem der Patentansprüche 1 bis 4, dadurch gekennzeichnet, daß die reflektierenden Oberflächen von mindestens der Frontwand (6), der Rückwand (7) und den beiden einander gegenüberliegenden Seitenwänden (4, 5) spiegelähnliche Oberflächen mit guter Absorptionsfähigkeit aufweisen.

Revendications

1. Détecteur photoélectrique de fumée comportant: une paroi frontale (6), deux parois latérales opposées (4, 5), une paroi arrière (7), une paroi supérieure (9) et une paroi inférieure (8) délimitant un espace de mesure; un émetteur de lumière (1) pour émettre de la lumière le long d'un axe optique prédéterminé; un récepteur de lumière (2) pour détecter de la lumière dispersée, diffusée en présence d'une fumée à partir de la lumière émise dans cet espace de mesure; ladite paroi frontale (6) étant disposée sensiblement en face dudit émetteur de lumière (1) pour recevoir ladite lumière émise par ledit émetteur de lumière, et lesdites deux parois frontales opposées (4, 5) étant sensiblement disposées parallèlement audit axe optique prédéterminé, caractérisé par le fait qu'au moins ladite paroi frontale (6) et lesdites deux parois latérales opposées (4, 5) possèdent des surfaces réfléchissantes du côté dudit espace de mesure; et que ladite paroi frontale (6) possède deux surfaces latérales adjacentes, sensiblement planes, formant entre elles un angle prédéterminé et constituant ladite surface réfléchissante située du côté dudit espace de mesure, et réfléchit ladite lumière reçue sensiblement suivant un angle droit par rapport à un plan formé par ledit axe optique dudit émetteur de

lumière (1) et l'axe optique dudit récepteur de lumière (2); lesdites surface réfléchissantes de ladite paroi frontale (6) et les deux parois latérales opposées (4, 5) formant des moyens qui constituent un piège de lumière pour ladite lumière émise par ladite source lumineuse (1); lesdits moyens qui constituent piège de lumière provoquant des réflexions multiples de ladite lumière dans cet espace de mesure; et ledit récepteur de lumière (2) étant disposé hors de la trajectoire de ladite lumière ayant subi lesdites réflexions multiples.

2. Détecteur photoélectrique de fumée selon la revendication 1, caractérisé par le fait que lesdites deux surfaces latérales adjacentes de ladite paroi frontale (6), forment entre elles un angle qui est inférieur à 140° ou supérieur à 210° .

3. Détecteur photoélectrique de fumée selon la revendication 1, caractérisé par le fait que ledit émetteur de lumière (1) pour irradier de la lumière dans ledit espace de mesure, le long dudit axe optique prédéterminé, émet un faisceau de

lumière convergent.

4. Détecteur photoélectrique de fumée selon la revendication 1, caractérisé par le fait que ledit récepteur de lumière (2) est placé hors dudit axe optique prédéterminé le long duquel ladite lumière est émise par ledit émetteur de lumière (1).

5. Détecteur photoélectrique de fumée selon l'une quelconque des revendications 1 à 4, caractérisé par le fait que ledit espace de mesure constitue une chambre noire; ladite chambre noire étant revêtue par des surfaces réfléchissantes absorbant la lumière d'au moins ladite paroi frontale (6), ladite paroi arrière (7) et lesdites deux parois latérales opposées (4, 5).

6. Détecteur photoélectrique de fumée selon la revendication 4, caractérisé par le fait que lesdites surfaces réfléchissantes d'au moins ladite paroi frontale (6), de ladite paroi arrière (7) et desdites deux parois latérales opposées (4, 5) ont des surfaces analogues à un miroir, présentant un bon degré d'absorption.

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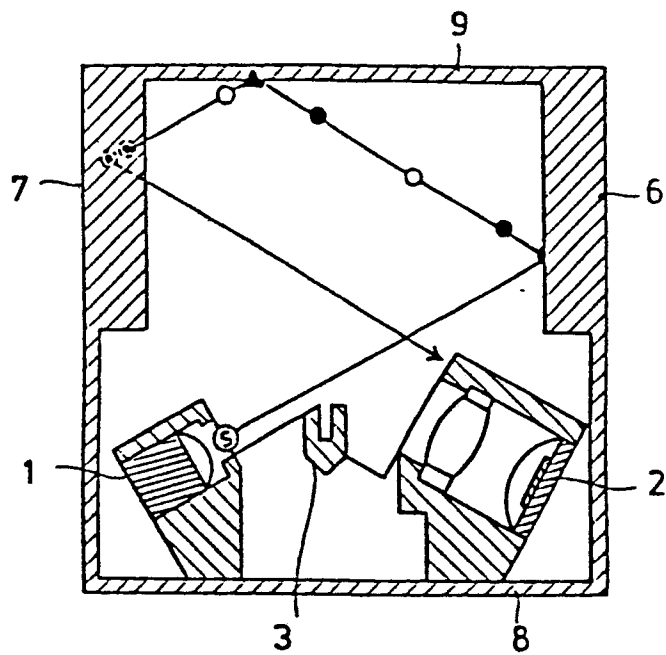
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65

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Fig. 1

(a)



(b)

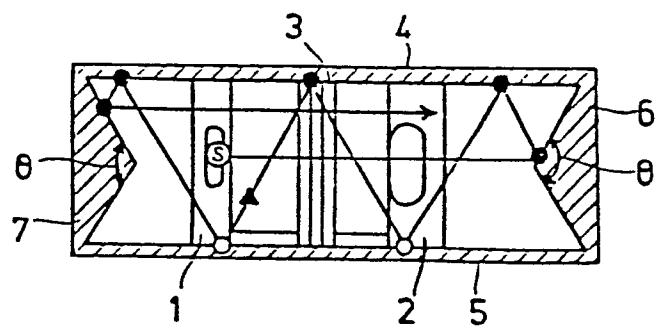
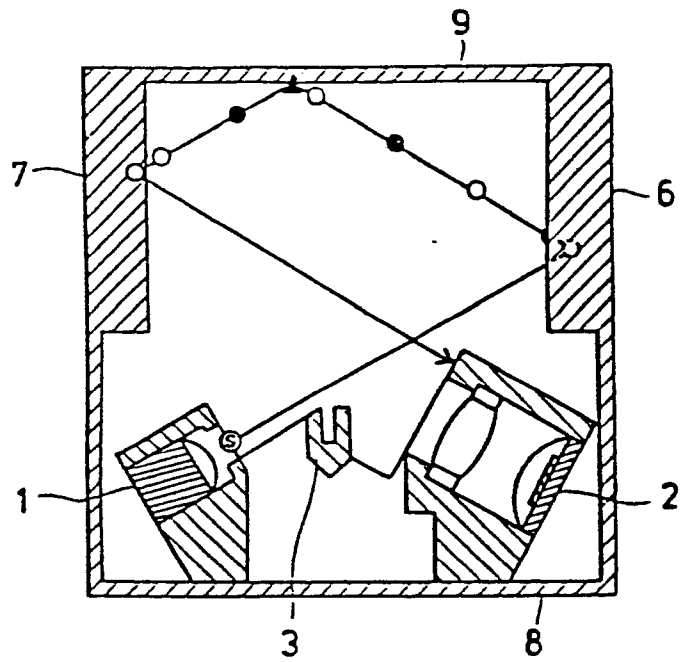


Fig. 2

(a)



(b)

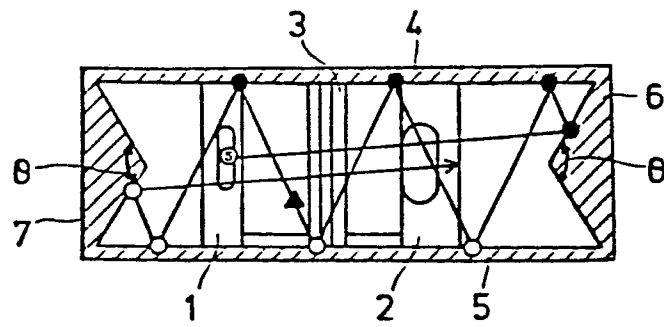


Fig. 3

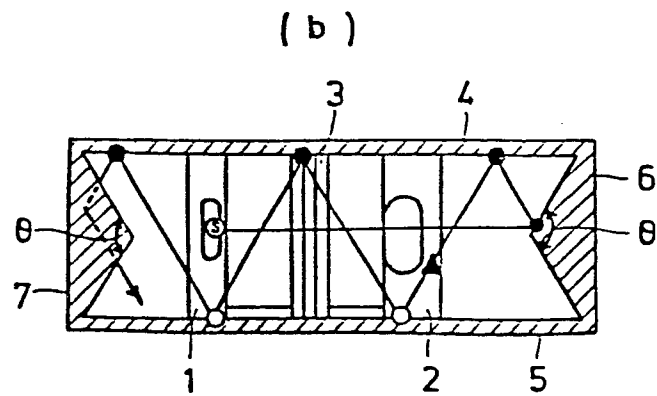
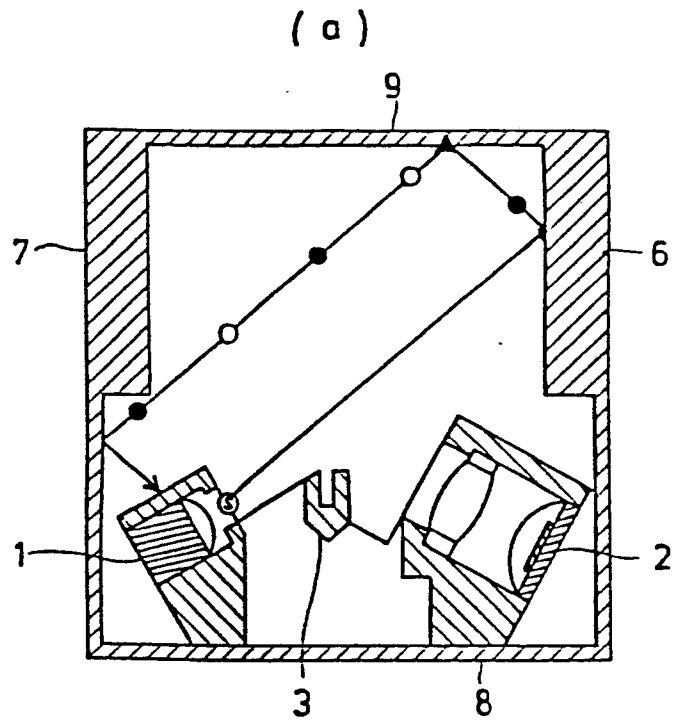


Fig. 4

