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(54) **Segmented Fresnel lens**

Segmentierte Fresnel-Linse

Lentille de Fresnel segmentée

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Description

[0001] The present invention relates to a segmented Fresnel lens, to be used as concentrator of infrared rays on a light-sensitive element (optical sensor), particularly for application in anti-intrusion systems or in occupancy detection systems in general.

[0002] As is known, infrared occupancy detection devices, or sensors, comprise an element able to collect and concentrate rays to maximise the signal gain and an electro-optical sensor able to receive the radiation signal.

[0003] Associated with the sensor is electronic circuitry able to detect fluctuations in the output signal from the sensor which are the result of the variations in the radiation signal.

[0004] The principle on which these passive infrared sensors are based is the following.

[0005] Since people and objects in general normally have temperature differentials with respect to the surrounding environment, they emit levels of infrared radiation that generally differ from the background levels. Consequently, they produce fluctuations in the intensity of radiation when they pass through the optical field which, suitably amplified, can be detected by the electronic circuitry associated with the sensor.

[0006] Using said radiation concentrators, temperature differentials of less than one degree Celsius are sufficient for the presence of a moving person or object to be detected.

[0007] Fresnel lens or segmented Fresnel lens, that is lens consisting of a plurality of bands or segments of Fresnel lens, each of which is able to cover a certain zone of the room to be monitored, are usually used as radiation concentrating elements.

[0008] US 4 930 864 describes a domed system of segmented Fresnel lens associated with an infrared occupancy sensor.

[0009] The system of lens comprises a plurality of segments of Fresnel lens distributed on the surface of a spherical hood, each able to receive the radiation from a distinct zone centered around a corresponding optical axis and focus it in the focal region.

[0010] Italian utility model No. 218696 filed on 10 August 1987 describes a similar sensor with a segmented Fresnel lens, able to be inserted in a standardized wall-mounted boxes for holding electrical modules.

[0011] EP-0484293 describes an infrared occupancy sensor comprising a hood lens with a plurality of segments of Fresnel lens disposed in three bands one on top of the other to cause the radiation coming from the upper part, the central part and the lower part, respectively, of the room being monitored to converge on the infrared sensitive element. In the solutions of the prior art a visual correspondence normally exists between the segments of the Fresnel lens formed on the plastic hood and the corresponding segments or ray beams that are directed onto the sensitive element by said plastic seg-

ments. This allows easy identification of the direction of the rays even at a distance.

[0012] Furthermore, the arrangement of the bands determined by the Fresnel lens segments does not always offer an absolute barrier to intercept any attempt at intrusion.

[0013] The object of the invention is to eliminate the drawbacks of the solutions of the prior art.

[0014] In particular, one object of the invention is to provide a segmented Fresnel lens in which there is no visual correspondence between the beams of radiation and the plastic segments, so as to hide the direction of the beams.

[0015] Another object of the invention is to provide such a segmented Fresnel lens with an orientation of the beams that allows the creation of a complete barrier able to intercept any attempt at intrusion into the room monitored by the sensor combined with the lens.

[0016] The above objects are achieved by the segmented Fresnel lens according to the invention, which has the characteristics of appended independent claim 1.

[0017] Advantageous embodiments of the invention are set forth in the dependent claims.

[0018] Essentially, the lens according to the invention comprises two horizontal bands of plastic segments, to which four horizontal bands of radiation segments or radiation beams correspond. There is therefore no correspondence between the plastic segments and the radiation segments or intercept beams.

[0019] The four bands of radiation or intercept segments are of different vertical sizes and are divided into a different number of segments.

[0020] In particular, starting from the bottom, the first band has three segments, the second five, the third six and the fourth three.

[0021] The angular horizontal extension of the field of coverage of the lens is about 112 degrees, whilst the angular vertical extension is about 36°, plus 6° on the horizontal and -30° beneath the horizontal.

[0022] The first and lowest band has a coverage limited to a maximum of 1.5 metres, whilst the others create a barrier at about 7 metres.

[0023] The third band from the bottom with six segments has practically no inclination with respect to the horizontal.

[0024] Further characteristics of the invention will be made clearer by the detailed description that follows, referring to a purely exemplary and therefore non-limiting embodiment thereof, illustrated in the appended drawings, in which:

Figure 1 is a diagrammatic axonometric view of a segmented Fresnel lens according to the invention;

Figure 2 is a development of the lens of Figure 1;

Figure 3 is a top plan view showing the angular cov-

erage of the lens on the horizontal plane;

Figure 4 is a side view showing the angular coverage of the lens on the vertical plane.

[0025] With reference to said figures, and for now in particular to Figures 1 and 2, the lens according to the invention has been designated as a whole with reference numeral 1.

[0026] The lens 1 according to the invention is called a segmented Fresnel lens because it consists of a plurality of segments or lengths of Fresnel lens, as will be described better hereunder.

[0027] The lens 1 proper, as shown in Figure 1, has a spherical surface and is supported by a box-shaped body 2 consisting of pairs of flat opposite facing walls.

[0028] The lens 1 and the supporting body 2 are normally formed in a single body by molding of plastic material.

[0029] As can be seen schematically in Figure 1, guides 3 and coupling means 4 for fixing of the lens, for example to an electrical module that can be inserted in a wall-mounted box, are provided on the body 2.

[0030] As shown diagrammatically in Figure 1, the lens 1 is geometrically divided by a line L into two horizontal bands 5, 6, each comprising nine plastic segments, seen better in the development of Figure 2. The plastic segments, diagrammatically indicated with S in Figures 1 and 2, related to the external geometry of the lens, do not correspond to the same number of optical segments, that is, radiation segments.

[0031] On the contrary, as can be seen in Figure 2, and better in Figures 3 and 4 which illustrate the angles of coverage of the lens, the two bands 5 and 6 of plastic segments S coincide with four bands A, B, C, D of radiation segments, of which the corresponding foci F_A , F_B , F_C and F_D are shown in Figure 2.

[0032] In particular, proceeding from bottom to top, band C comprises three radiation segments, band B five segments, band A six segments and band D three segments again.

[0033] The lack of visual correspondence between the plastic segments S and the radiation segments makes it possible to hide the direction of the radiation beams. This is especially useful in anti-theft applications.

[0034] The orientation of the radiation beams which are directed into the focal region 11 of the lens (shown hatched in Figure 2), where an optical sensor 10 is disposed, can be seen from Figures 3 and 4.

[0035] In particular, considering that the sensor, in normal wall-mounted box installations, is disposed at a height of about 1.2 metres from the ground, the lower band C is directed downward and has an extension of about 1.5 metres (Figure 4) with an angular coverage on the horizontal plane of about 75°.

[0036] The remaining three bands B, A and D create a barrier at about 7.5 metres and overall determine an

angular coverage, on the horizontal plane, of about 112 degrees.

[0037] Figure 3 shows the radiation beams corresponding to the segments of the different bands A, B, C and D.

[0038] As can be seen from Figure 4, the angular extension on a vertical plane is about 36°, with an inclination of +6° upward and -30° downward. Band A with six segments, the third from the bottom, has no inclination with respect to the horizontal, so as to determine the greatest concentration of rays at the typical intercept height for a person, corresponding to the level of installation of the sensor, that is, about 1.2 metres.

[0039] The division of the lens into four radiation bands, with a total of 17 segments, makes it possible, compared with conventional solutions, to have a greater angular coverage both on the vertical and on the horizontal, the geometrical size of the lens remaining the same.

[0040] The creation of a barrier able to intercept anyone who approaches the sensor is in any case ensured.

[0041] The advantages of the segmented Fresnel lens according to the invention are obvious from the above description, but its construction is nevertheless not limited to what has been described and illustrated in the annexed drawings, but is liable to numerous modifications of detail within the reach of a person skilled in the art, without departing from the scope of the invention, as set forth in the claims that follow.

Claims

1. A segmented Fresnel lens with a spherical shape, comprising a plurality of segments of Fresnel lens able to concentrate respective beams of radiation onto an optical sensor (10) disposed in the focal region (11) of the lens, and a plurality of external bands (5, 6) of plastic segments (S), one on top of another (5, 6), **characterized in that**, the number of plastic segments (s) is different from the number of Fresnel lens segments so that there is no direct visual correspondence between said plastic segments (S) and said Fresnel lens segments or radiation segments.
2. A segmented Fresnel lens according to claim 1, **characterised in that** it comprises two bands (5, 6) of plastic segments (S) and four bands (A, B, C, D) of radiation segments.
3. A segmented Fresnel lens according to claim 1 or 2, **characterised in that** it comprises eighteen plastic segments (S) and seventeen radiation segments.
4. A segmented Fresnel lens according to claim 3, **characterised in that** said seventeen radiation

segments occupying the four bands one on top of another, proceeding from bottom to top, are thus distributed: three in the lower band (C), five in the middle band (B), six in the middle band (A) and three in the upper band (D).

5. A segmented Fresnel lens according to any one of the preceding claims, **characterised in that** the angular coverage of said radiation segments, in a horizontal plane, is about 112° .

6. A segmented Fresnel lens according to any one of the preceding claims, **characterised in that** the angular coverage of said radiation segments in a vertical plane is about 36° , $+6^\circ$ above the horizontal and -30° below the horizontal.

7. A segmented Fresnel lens according to claim 4, **characterised in that** said band (A) with six radiation segments has no inclination with respect to the horizontal.

8. A segmented Fresnel lens according to claim 4, **characterised in that** said lower band (C) has a coverage of about 1.5 metres in distance, whilst the remaining three bands (B, A, D) create a barrier at about 7.5 metres.

9. A Fresnel lens according to any one of the preceding claims, **characterised in that** it has a box-shaped body (2) and is mounted together with said optical sensor (11) and the relative control electronic circuitry in a wall-mounted box at a height of about 1.2 metres.

10. An infrared occupancy sensor comprising a segmented Fresnel lens (1) able to concentrate detection radiation on a sensitive element or optical sensor (10), with which control electronic circuitry is combined, **characterised in that** said segmented Fresnel lens (1) has characteristics according to any one of claims 1 to 9.

Patentansprüche

1. Eine segmentierte, kugelförmige Fresnel Linse, die eine Vielzahl von Fresnel-Linsen-Segmenten umfasst, welche in der Lage sind, entsprechende Strahlenbündel auf einen optischen Sensor (10) zu leiten, der im Fokalebereich (11) der Linse angeordnet ist, sowie eine Vielzahl von übereinander gelagerten äußeren Streifen (5, 6) von Kunststoffsegmenten (S), **dadurch gekennzeichnet, dass** die Anzahl von Kunststoffsegmenten (s) sich von der Anzahl der Fresnel-Linsen-Segmente unterscheidet, so dass keine direkte visuelle Übereinstimmung zwischen den genannten Kunststoffsegmenten

ten (S) und den genannten Fresnel-Linsen-Segmenten oder Strahlungssegmenten besteht.

2. Eine segmentierte Fresnel Linse gemäß Anspruch 1, **dadurch gekennzeichnet, dass** sie zwei Streifen (5, 6) von Kunststoffsegmenten (S) und vier Streifen (A, B, C, D) von Strahlungssegmenten umfasst.

3. Eine segmentierte Fresnel Linse gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** sie achtzehn Kunststoffsegmente (S) und siebzehn Strahlungssegmente umfasst.

4. Eine segmentierte Fresnel Linse gemäß Anspruch 3, **dadurch gekennzeichnet, dass** die genannten siebzehn Strahlungssegmente, welche die vier übereinander gelagerten Streifen einnehmen, von unten nach oben vorgehend wie folgt verteilt sind: drei im unteren Streifen (C), fünf im mittleren Streifen (B), sechs im mittleren Streifen (A) und drei im oberen Streifen (D).

5. Eine segmentierte Fresnel Linse gemäß einem beliebigen der vorausgegangenen Ansprüche, **dadurch gekennzeichnet, dass** die Winkelabdeckung der genannten Strahlungssegmente auf horizontaler Ebene etwa 112° entspricht.

6. Eine segmentierte Fresnel Linse gemäß einem beliebigen der vorausgegangenen Ansprüche, **dadurch gekennzeichnet, dass** die Winkelabdeckung der genannten Strahlungssegmente auf vertikaler Ebene etwa $36^\circ + 6^\circ$ über der Horizontalen und -30° unter der Horizontalen entspricht.

7. Eine segmentierte Fresnel Linse gemäß Anspruch 4, **dadurch gekennzeichnet, dass** das genannte Streifen (A) mit sechs Strahlungssegmenten im Verhältnis zur Horizontalen keine Neigung aufweist.

8. Eine segmentierte Fresnel Linse gemäß Anspruch 4, **dadurch gekennzeichnet, dass** das genannte untere Streifen (C) eine Abdeckung von etwa 1,5 m in Entfernung aufweist, während die übrigen drei Streifen (B, A, D) auf etwa 7,5 m eine Barriere bilden.

9. Eine Fresnel Linse gemäß einem beliebigen der vorausgegangenen Ansprüche, **dadurch gekennzeichnet, dass** sie einen kastenförmigen Körper (2) aufweist und mit dem genannten optischen Sensor (11) und der entsprechenden elektronischen Steuertechnik in einem in die Wand eingelassenen Kasten zusammen montiert ist, und zwar auf einer Höhe von 1,2 m.

10. Ein Infrarot-Belegungssensor, der eine segmentier-

te Fresnel Linse (1) umfasst, die in der Lage ist, die Erkennungsstrahlung auf ein empfindliches Element oder einen optischen Sensor (10) zu konzentrieren, an den ein elektronisches Steuersystem angeschlossen ist, **dadurch gekennzeichnet, dass** die genannte Fresnel Linse (1) Eigenschaften aufweist, die einem beliebigen der Ansprüche von 1 bis 9 entsprechen.

Revendications

1. Lentille de Fresnel segmentée à la forme sphérique, comprenant une pluralité de segments de lentilles de Fresnel en mesure de concentrer des faisceaux de radiation respectifs sur un capteur optique (10) placé dans la région focale (11) de la lentille, et une pluralité de bandes extérieures (5, 6) de segments plastiques (S), superposées (5, 6), **caractérisée en ce que** le nombre de segments plastiques (S) est différent du nombre de segments de lentilles de Fresnel de sorte qu'il n'existe pas de correspondance visuelle directe entre lesdits segments plastiques (S) et lesdits segments de lentilles de Fresnel ou segments de radiation. 5
2. Lentille de Fresnel segmentée selon la revendication 1, **caractérisée en ce qu'elle** comprend deux bandes (5, 6) de segments plastiques (S) et quatre bandes (A, B, C, D) de segments de radiation. 10
3. Lentille de Fresnel segmentée selon la revendication 1 ou 2, **caractérisée en ce qu'elle** comprend dix-huit segments plastiques (S) et dix-sept segments de radiation. 15
4. Lentille de Fresnel segmentée selon la revendication 3, **caractérisée en ce que** lesdits dix-sept segments de radiation occupant les quatre bandes superposées, en allant de bas en haut, sont ainsi répartis : trois dans la bande inférieure (C), cinq dans la bande intermédiaire (B), six dans la bande intermédiaire (A) et trois dans la bande supérieure (D). 20
5. Lentille de Fresnel segmentée selon une revendication quelconque parmi les revendications susmentionnées, **caractérisée en ce que** la couverture angulaire desdits segments de radiation, dans un plan horizontal, est de 112° environ. 25
6. Lentille de Fresnel segmentée selon une revendication quelconque parmi les revendications susmentionnées, **caractérisée en ce que** la couverture angulaire desdits segments de radiation, dans un plan vertical, est de 36°, +6° au-dessus de l'horizontal et -30° au-dessous de l'horizontal. 30
7. Lentille de Fresnel segmentée selon la revendication 4, **caractérisée en ce que** ladite bande (A) avec six segments de radiation a une inclinaison zéro par rapport à l'horizontal. 35
8. Lentille de Fresnel segmentée selon la revendication 4, **caractérisée en ce que** ladite bande inférieure (C) a une couverture en distance de 1,5 mètres environ, tandis que les trois bandes restantes (B, A, D) créent une barrière à 7,5 mètres environ. 40
9. Lentille de Fresnel selon une revendication quelconque parmi les revendications susmentionnées, **caractérisée en ce qu'elle** présente un corps en forme de boîte (2) et est montée avec ledit capteur optique (11) et l'électronique de commande correspondante dans une boîte à encastrement mural à une hauteur de 1,2 mètres environ. 45
10. Capteur de présence à infrarouge comprenant une lentille de Fresnel segmentée (1) en mesure de concentrer la radiation de détection sur un élément sensible ou un capteur optique (10), à laquelle une électronique de commande est associée, **caractérisé en ce que** ladite lentille de Fresnel segmentée (1) présente des caractéristiques selon une revendication quelconque parmi les revendications susmentionnées allant de 1 à 9. 50

