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(54) **Title**: LENS FOR A MOTION DETECTOR

(57) **Abstract**: An infra-red motion detector lens (50) is disclosed. The lens is configured to focus radiation on a 2 x 2 quad detector (10) that has a plurality of detector regions (11-14) capable of providing a first signal or a second signal. The lens comprises a series of lenslets, each of which can image respective regions (60, 70). The fields of view of the lenslets are partially overlapping in such a way that a source of radiation in a particular location can simultaneously project radiation onto two detector regions (11-14) through more than one respective lenslet. The detector regions (11-14) are diagonally opposite one another and are arranged to provide the same type of signal. A grid of overlapping lenslets can be constructed in this way so that two lenslets can increase the signal strength created at the detector by focusing radiation onto the same detector to create the same type of signal.

LENS FOR A MOTION DETECTOR

The present invention relates to a lens for a detector. In particular a detector that can detect motion of a human body using infra-red radiation.

Infra-red motion detectors are commonly used to detect the movement of a human or animal body, although they can also be used to detect radiation from any body that has a difference in temperature with respect to its environment. They can be used, for example, in intruder alarms or as the input to an automatic light switch so that a light can turn on automatically when a person enters a room.

Infra-red motion detectors typically include a lens and a pyroelectric infra-red detector, sometimes referred to as a “pyro”. The lens typically includes a number of lenslets, each of which focuses radiation onto the detector from a different region. Thus, the lens can image a large number of isolated tiles which together cover a large portion of a surface such as a floor.

An example of an infra-red motion detector is described in EP 2 246 828 A1. In this document a compound lens is described in which lenslets can detect radiation from separate detection areas on a floor. The detection areas are arranged to overlap so that the entire floor area is covered and there is no non-sensing area from which emitted infra-red rays cannot be detected.

Figure 1 shows a plan view of a conventional 4 element pyroelectric infra-red detector. In this arrangement the detector 10 includes first, second, third and fourth sensitive regions 11, 12, 13, 14 in a 2 x 2 array. The first and third regions 11, 13 are arranged to provide a positive voltage when they receive infra-red radiation and the second and fourth regions 12, 14 are arranged to provide a negative voltage when they receive infra-red radiation. The sensitive regions provide a single voltage output 16, cumulated from the different regions, which can be fed to an analyser 18.

The dimensions of the detector 10 can vary. A typical mounting height would be around 2.5 to 10m.

Figure 2 shows a perspective view of a lens 20. The lens comprises a plurality of lenslets 22. Each lenslet is arranged to focus infra-red radiation onto the detector 10 from a different direction. In this way the lenslets can create a tiled array of regions that cover a large portion of a room or street.

Each lenslet 22 has a field of view which defines a solid angle within which radiation can be imaged by the lenslet. By projecting this solid angle onto a surface such as a floor or a wall it is possible to define a zone or area that can be imaged by each lenslet.

Figure 3 shows the regions of a surface that would be imaged by the conventional lens shown in Figure 2 when used with the detector shown in Figure 1. As can be seen from Figure 3, each lenslet images radiation from a different region of the surface. Within each region there are four sensitive areas corresponding to each of the four regions in the detector. The lens creates a tiled array of regions in order to cover a large portion of the surface.

Looking specifically at Figure 3, a first region 30 is imaged by a first lenslet and a second region 40 is imaged by an adjacent lenslet. Within the first region 30 there are four sub-regions 31, 32, 33, 34 from which infra-red radiation will be focused onto sensitive detector areas. If a source of infra-red radiation such as a human body is present in any of these sub-regions then an appropriate voltage will be generated at the output 16. A two-dimensional movement of the source of infra-red radiation can be detected when the source moves from one sub-region 31, 32, 33, 34 into an adjacent sub-region. Specifically, a motion alarm can be triggered at the analyser 18 when the voltage of the output 16 changes by more than a threshold value, or if the polarity of the voltage changes. One object of the invention is to provide a lens that can improve the signal strength caused by the motion of a source from one sub-region to another.

The lens 20 images radiation when a source lies in a region of the floor corresponding to one of the sensitive regions 31, 32, 33, 34. As is clear from Figure 3 there are gaps between the sensitive regions in different tiles, and radiation would not be detected from a source in one of the gaps.

According to an aspect of the present invention there is provided an infra-red motion detector lens configured to focus radiation on a detector, wherein the lens comprises a plurality of lenslets, wherein each lenslet is arranged to focus radiation on the detector, wherein the field of view of a first lenslet is partially overlapping with the field of view of a second lenslet so that radiation from a first target region can be focused onto the detector by the first and second lenslets. The field of view of the first lenslet is partially overlapping with the field of view of a third lenslet so that radiation from a second target region is focused onto detector regions by the first and third lenslets. The detector regions that receive the radiation from the first target region are capable of providing the first signal, and the regions that receive the radiation from the second target region are capable of providing the second signal.
Each lenslet has a field of view which defines a solid angle of radiation that can be imaged by the lenslet. By projecting this solid angle onto a surface such as a floor or a wall it is possible to define a zone or area that can be imaged by the lenslet. By overlapping the fields of view of adjacent lenslets it is possible to create an overlap between the areas of the floor or wall that are imaged. This overlap may allow an increased area of coverage (or fill-factor) on the floor or wall.

The output from the detector may change when a source of radiation moves into the first target region. Specifically, the signal strength may increase when the source moves from a non-overlapping region to the first target region. This change in signal of the detector is enhanced due to the overlap between the first and second lenslets; it can be measured to indicate movement has occurred.

A very specific overlap is provided between lenslet fields of view in the invention. In particular, the field of view of a first lenslet is partially overlapping with the field of view of a second lenslet so that radiation from a first target region can be focused onto a detector region that provides a first signal. In addition, the field of view of the first lenslet is partially overlapping with the field of view of a third lenslet so that radiation from a second target region is focused onto a detector region that provides a second signal. In this way movement of a source of radiation from the first target region to the second target region can be detected by a change in the strength of the first signal relative to the second signal. This relative change in the strength of the two signals is enhanced because of the overlap between lenslets. This is achieved because the overlap between the lenslets means that the first signal includes contributions from the first target region, as focused onto the detector by the first lenslet and the second lenslet. Equally the second signal includes contributions from the second target region, as focused onto the detector by the first lenslet and the third lenslet. The first and second signals are therefore higher than they would otherwise be in the absence of any overlap between lenslets. The invention also allows for an increase in the fill factor on the wall or floor because the first lenslet has a field of view that overlaps with two of its neighbours.

The invention may allow lenslets to be provided with an increased field of view, in comparison to prior art lenslets. This increased field of view may create the partially overlapping fields of view between adjacent lenslets. If all of the lenslets are provided with an increased field of view then the overall field of view of the lens can be advantageously increased.

In another configuration the invention may increase the spatial resolution that can be achieved in comparison to a traditional lens. The invention may allow the centre of adjacent lenslets to be closer together than the traditional approach. This means that the number of lenlets over a given diameter can be increased. This gives more detection zones over a given area on the wall or floor.

The position of an infra-red source, within the field of view of a lenslet, may determine the detector regions that are illuminated. A movement of the source can, therefore, change the distribution of radiation on the detector. By creating areas of different sensitivity it is possible to measure this change in distribution of radiation and thereby to infer a movement of the source. By partially overlapping the fields of view of lenslets it is possible to increase the signal strength in a particular overlapping region.

The detector may comprise a plurality of separated regions, each of which can provide a first signal. In one arrangement the regions may be separated by areas of the detector that are not sensitive to infra-red radiation. Thus, a projection of the detector, through a lenslet, may create a plurality of separated zones on the floor. If a source of radiation is present in one of the zones then a first signal is generated by the detector. It may be possible to detect movement by detecting a variation in the strength of the first signal in time as a source of radiation moves through the separated zones on the floor. By overlapping the fields of view the signal strength can be advantageously increased in the area of overlap.

Preferably the first and second lenslets are configured to focus radiation onto different respective detector regions both of which are capable of providing the first signal. In one arrangement the two different regions are diagonally opposite one another in the detector. Preferably the detector comprises at least two regions that provide the first signal and at least two regions that provide the second signal.

Preferably the detector regions are capable of providing a first signal or a second signal, and the regions that receive the radiation from the first target region are capable of providing the first signal. In this way, the motion of a source of radiation into the first target region can cause a change in the first signal relative to the second signal. By partially overlapping the fields of view, the strength of the first signal is higher than it would be if there were only one lenslet focusing the radiation onto the detector from the first target region. The contributions of two lenslets advantageously increase the signal strength from the first target region. This improves the likelihood that movement of a source of radiation can be detected. Preferably the detector comprises at least two regions that provide the first signal and at least two regions that provide the second signal.

The invention may be considered counterintuitive as a partial overlap in the fields of view of lenslets could, in some circumstances, lead to a decrease in detector sensitivity. A decrease in detector sensitivity could be created if the overlap meant that a source in a target region generated signals of both the first and second type. This could be undesirable because it would be more difficult to detect a change in the strength of one type of signal relative to the other when the source moved into the target region. Cancelling effects can be avoided in an embodiment of the invention by providing a partial overlap so that radiation from the first target region contributes only to the first signal and not to the second signal.

Preferably the first and second signals are electrical signals with first and second respective voltages. The detector is preferably configured to provide a single signal output which is a voltage. The voltage preferably comprises components from each of the detector regions. Motion of a radiation emitter may be detected when the voltage changes through a threshold value because the position of the focused radiation moves from one detector region to another. Alternatively motion may be detected when the rate of change of the voltage increases above a threshold figure.

The first and second respective voltages may have an opposite polarity. Thus, motion of an infra-red source may be detected when the voltage changes polarity because the position of the focused radiation moves from one detector region to another. Of course, it will be appreciated that the detector could provide any two types of signal, other than positive or negative voltages so that an analyser can detect movement by measuring the strength of one signal relative to the other.

The field of view of the first lenslet may be partially overlapping, respectively, with the fields of view of second, third, fourth and fifth lenslets. In this way the field of view of a single lenslet can partially overlap with each of its four neighbours. Thus, if a detector has four sensitive regions each region can receive radiation from a respective target region, via two lenslets. This can create a grid array of lenslets, each of which has a field of view that is partially overlapping with one of its neighbours. Preferably the field of view of each lenslet also includes a portion that is not overlapping with any neighbours. The field of view of each lenslet includes a “corner” overlap of around 25% with each neighbour. The “corner” overlap is so named because the overlap extends across 50% of the field of view of the neighbouring lenslet in a first direction and across 50% of the field of view in a second, perpendicular direction.

The lens may comprise an optical surface on which the lenslets are arranged and a support for positioning the optical surface at a predetermined distance away from the detector. Preferably the predetermined distance corresponds to the focal length for each lenslet. . This means that collimated rays can be focused by the lens onto the detector. The field of view of a lenslet is preferably proportional to the diameter of the lenslet and inversely proportional to the focal length. Therefore, the length of the support may partly determine the field of view of the lenslets to ensure that the first and second lenslets have a field of view that is partially overlapping.

Each lenslet may be arranged to image an area on a surface and the plurality of lenslets may combine to image a tiled array of surface areas. Preferably the tiled array comprises a plurality of rows, and each row is offset from its neighbour. In this way it is possible to build an array of lenslets, each of which has a field of view that is partially overlapping with a neighbour. This arrangement can create a dense concentration of areas to optimise spatial resolution. Preferably each row is offset from its neighbour by approximately half the width of a tile. Thus, neighbouring rows may be considered to be out of phase by approximately 90 degrees. This can allow one sensitive region in a first tile to overlap with only one sensitive region in a second tile. . In one embodiment the rows may be arranged as concentric rings.
According to another aspect of the invention there is provided a mould configured to be used in the manufacture of the lens defined in claim 1. The mould preferably has a shape that is inverse to the shape of the lens. The mould may be made of metal or any other suitable material.

According to another aspect of the invention there is provided a method of manufacturing the lens defined in claim 1 using the mould defined above.

According to yet another aspect of the invention a device is provided comprising the lens defined in claim 1 and a detector comprising a plurality of regions that can provide a first or second signal. The lens is preferably arranged for use with a detector that has at least four detector regions. The respective detector regions that provide the first signal are preferably diagonally opposite one another. Equally, the respective detector regions that provide the second signal are preferably diagonally opposite one another. In this way radiation from a target region can be focused onto diagonally opposite regions in a detector, each of which provide the same type of signal.

The device may further comprise an analyser configured to receive the signal from the detector and detect movement of a source of radiation by determining a change in the strength of the first signal relative to the strength of the second signal.

According to another aspect of the present invention there is provided an infra-red motion detector lens configured to focus radiation on a detector, wherein the lens comprises a plurality of lenslets, wherein each lenslet is arranged to focus radiation on the detector, wherein the field of view of a first lenslet is partially overlapping with the field of view of a second lenslet so that radiation from a first target region can be focused onto the detector by the first and second lenslets.

Preferred features of the present invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a pyroelectric infra-red detector;

Figure 2 is a perspective view of a conventional lens;

Figure 3 is a view of a projection on a surface that would be formed when the lens shown in Figure 2 is used with the detector shown in Figure 1;

Figure 4 is a perspective view of a lens in an embodiment of the present invention;

Figure 5 is a view of a projection on a surface that would be formed when the lens shown in Figure 4 is used with the detector shown in Figure 1;

Figure 6 is an extract from Figure 5 showing the projections formed by two lenslets; and

Figure 7 is a plan view of another pyroelectric infra-red detector;

Figure 8 is a view of a projection on a surface that would be formed when a lens having lenslets with overlapping fields of view is used with the detector shown in Figure 7;

Figure 9 is a graph showing the voltage output of the detector shown in Figure 7 due to a movement of an infra-red source; and

Figure 10 is a perspective view of a mould in an embodiment of the invention.

Detailed description of an embodiment of the invention

Figure 4 shows a perspective view of a lens 50. The lens 50 comprises a plurality of lenslets 52. Each lenslet 52 has a field of view which defines a solid angle within which radiation can be imaged by the lenslet.

The lens 50 comprises an optical surface 56 on which the lenslets 52 are arranged. The lens 50 also comprises a cylindrical support 54 of height H and diameter D. The height of the support 54 determines the distance at which the lenslets 52 are supported above the detector 10 which can be positioned underneath. The optical surface 56 is made from a material that transmits infra-red radiation. The height H is generally arranged to be the focal length of the individual lenslets 52 which means that parallel rays can be focused onto the detector. In one arrangement the diameter D is around 13mm and the height H is around 11.6mm.

From a macroscopic perspective the lens 50 may appear similar to the conventional lens 20 shown in Figure 2. However, the optical performance of the lens 50 is different, especially when one considers the pattern created by the lenslets 52 on a detector 10.

Each lenslet 52 has a field of view which defines a solid angle of radiation that can be imaged by the lenslet. By projecting this solid angle onto a surface such as a floor or a wall it is possible to define a zone or area that can be imaged by each lenslet. Figure 5 shows the projection on a surface that would be formed when a lens 50 is used with the detector 10 shown in Figure 1. As can be seen from Figure 5, the lens creates an array of overlapping tiles whereby each tile is imaged by a different lenslet. The array of tiles is created in the present embodiment because each lenslet has a field of view that is partially overlapping with the field of view of an adjacent lenslet.

Figure 6 is a detailed view of two of the tiles shown in Figure 5. As is clear from Figure 6, a first region 60 is imaged by a first lenslet L1 and a second region 70 is imaged by a second lenslet L2. The second region 70 is partially overlapping with the first region 60. Within the first region 60 there are four sub-regions 61, 62, 63, 64 from which infra-red radiation will be focused onto sensitive detector areas. If a source of infra-red radiation is present in any of these sub-regions then an appropriate voltage will be generated at the detector output 16. The second region 70 also includes four sub-regions 71, 72, 73, 74. It will be noted that the second sub-region 62 of the first region 60 coincides with the fourth sub-region 74 of the second region 70. The second sub-region 62 of the first region 60 focuses radiation onto the second detector element 12 to generate a negative voltage. The fourth sub-region 74 of the second region 70 focuses radiation on the fourth detector element 14 which also generates a negative voltage. Thus, a source of radiation in the area of overlap between the first and second regions 60, 70 will project radiation onto diagonally adjacent portions of the detector, 12, 14 both of which generate a negative voltage. This is achieved because the fields of view of the relevant lenslets L1, L2 are partially overlapping.

By partially overlapping the fields of view of the first and second lenslets L1, L2 in this way it is possible to increase the magnitude of the negative voltage in comparison to a conventional lens where only one lenslet focuses radiation onto the detector. The contributions of two lenslets advantageously increase the signal strength from the first target region.

Movement can be detected by the analyser 18 when a source of infra-red radiation moves from one sub-region into an adjacent sub-region. Specifically, a motion alarm can be triggered at the analyser 18 when the magnitude of the voltage output changes above a threshold value.

As can be seen from Figure 5, the area imaged by each lenslet is partially overlapping with each of its four neighbours. This arrangement can create a dense concentration of overlapping regions covering a large portion of a floor surface. The only gaps between sensitive regions are those gaps that exist because of the physical separation of sensitive regions on the detector 10. Thus, the lens maximises the floor coverage that can be achieved for an individual detector.

The lens and a given detector combination has an increased total signal level in comparison to prior art lenses. This increased signal level is due to the larger detector that can be used due to the the facility for partially overlapping fields of view. Prior art detector size is limited to try to remove any overlap between regions on the floor, whilst keeping the size of the lens to a minimum.

The lens 50 is configured to create a tiled array of regions on the surface, where each region is imaged by a different lenslet. In the tiled array of Figure 5 there is a plurality of rows R1, R2, R3, and each row is offset from its adjacent rows. The offset between rows is such that the corner of one tile can overlap the corner of another tile. This arrangement can focus radiation onto diagonally opposite corners of the detector to increase the strength of a particular signal. In Figure 5 the rows R1, R2, R3 are shown in a rectangular grid; in an alternative arrangement the rows could be arranged as concentric rings, wherein each ring is offset from its neighbour.

The lens 50 has been described above in the context of the detector 10, which is a 2 x 2 (quad) array comprising elements that provide positive or negative voltages. Of course, a variety of other configurations would naturally occur to the skilled person for different arrangements of detector. For example, any scaled-up version of a 2 x 2 array would also be appropriate, such as a 4 x 4 array or 8 x 8 array.

In another arrangement, Figure 7 shows a 2 x 1 detector 80 comprising a first region 81 and a second region 82, both of which can provide positive voltage outputs to an analyser 18. A lens may be provided for the detector 80 so that lenslets have fields of view that are partially overlapping. Figure 8 shows the projection on a surface that would be formed when such a lens is used with the detector 80 shown in Figure 7. As can be seen the lens creates an array of overlapping tiles whereby each tile is imaged by a different lenslet. As is clear from Figure 8, a first region 90 is imaged by a first lenslet L1 and a second region 100 is imaged by a second lenslet L2. The second region 100 is partially overlapping with the first region 90. Within the first region 90 there are two sub-regions 91, 92 from which infra-red radiation will be focused onto sensitive detector areas. If a source of infra-red radiation is present in any of these sub-regions then an appropriate voltage will be generated at the detector output. The second region 100 also includes two sub-regions 101, 102. It will be noted that the second sub-region 92 of the first region 90 coincides with the first sub-region 101 of the second region 100. Thus, a source of radiation in the overlapping region will create increased signal strength at the detector.

Figure 8 includes a line 110 indicating a movement of an infra-red source along the relevant surface. Figure 9 shows a trace of the voltage that would be generated by the detector 80 due to the movement of the source. As can be seen, the voltage changes in time as the infra-red source moves through different zones on the floor. These changes in the voltage can be measured at the analyser 18 in order to detect movement.

Figure 7 shows a 2 x 1 detector array, but the skilled person would understand that the techniques could equally be applied to a detector array having a single sensitive region.

Figure 10 is a perspective view of a metal mould 200 in an embodiment of the invention. The mould 200 has a shape that is inverse to the shape of the lens 50. Thus, the mould can be used in a method of manufacturing the plastic lens 50.

Claims

1. An infra-red motion detector lens configured to focus radiation on a detector that has a plurality of detector regions capable of providing a first signal or a second signal, wherein the lens comprises

a plurality of lenslets, wherein each lenslet is arranged to focus radiation on the detector,

wherein the field of view of a first lenslet is partially overlapping with the field of view of a second lenslet so that radiation from a first target region can be focused onto the detector by the first and second lenslets, and wherein the field of view of the first lenslet is partially overlapping with the field of view of a third lenslet so that radiation from a second target region is focused onto the detector by the first and third lenslets, wherein the detector regions that receive the radiation from the first target region are capable of providing the first signal, and the detector regions that receive the radiation from the second target region are capable of providing the second signal.

2. The lens of claim 1 wherein the detector comprises a plurality of separated regions each of which can provide a first signal.

3. The lens of claim 2 wherein the first and second lenslets are configured to focus radiation onto different respective detector regions which are capable of providing the first signal.

4. The lens of any of the preceding claims wherein the first and second signals are electrical signals with first and second respective voltages.

5. The lens of claim 4 wherein the first and second respective voltages have an opposite polarity.

6. The lens of any of the preceding claims wherein the field of view of the first lenslet is partially overlapping, respectively, with the fields of view of second, third, fourth and fifth lenslets.

7. The lens of any of the preceding claims comprising an optical surface on which the lenslets are arranged and a support for positioning the optical surface at a predetermined distance away from the detector.

8. The lens of any of the preceding claims wherein each lenslet is arranged to image an area on a surface and wherein the plurality of lenslets combine to image a tiled array of partially overlapping surface areas, wherein the tiled array comprises a plurality of rows, and wherein each row is offset from its neighbour.

9. The lens of any of the preceding claims wherein the first and second lenslets are provided adjacent one another in the lens.

10. A mould configured to be used in the manufacture of the lens of any of the preceding claims.

11. A device comprising the lens of any of claims 1-9 and a detector that can provide a signal output when it receives radiation from the first target region.

12. The device of claim 11 wherein the detector comprises a plurality of separated regions that can provide a first signal.

13. The device of claim 12 wherein the plurality of separated regions can provide the first signal or a second signal.

14. The device of any of claims 11 to 13 further comprising an analyser configured to receive the signal output by the detector and detect movement of a source of radiation by determining a change in the signal.

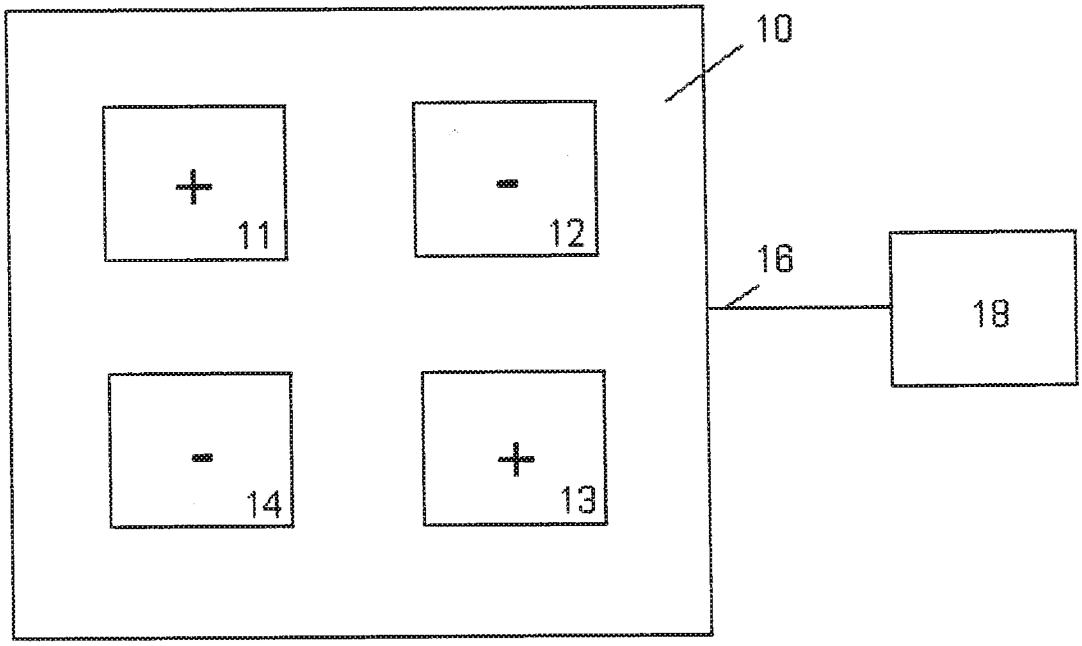

FIG. 1

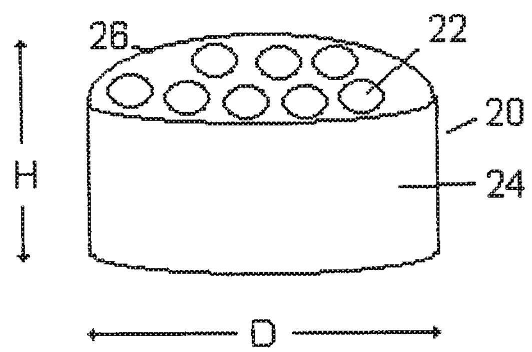

FIG. 2

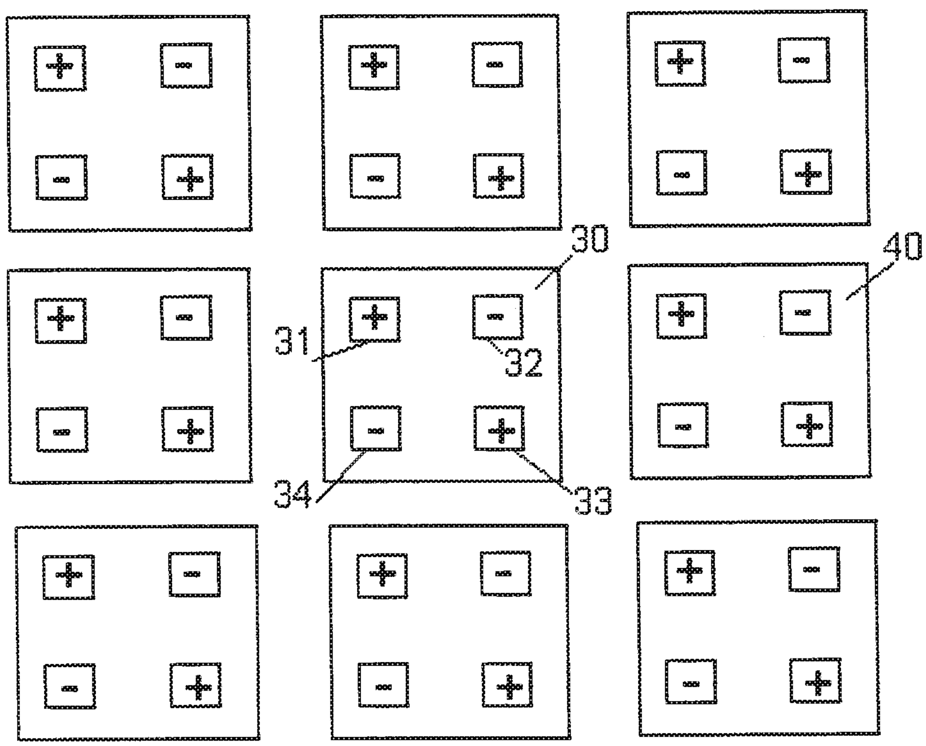

FIG. 3

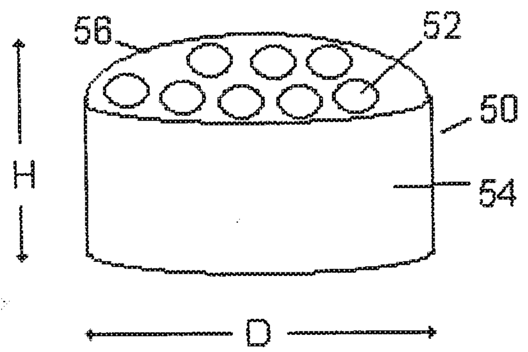

FIG. 4

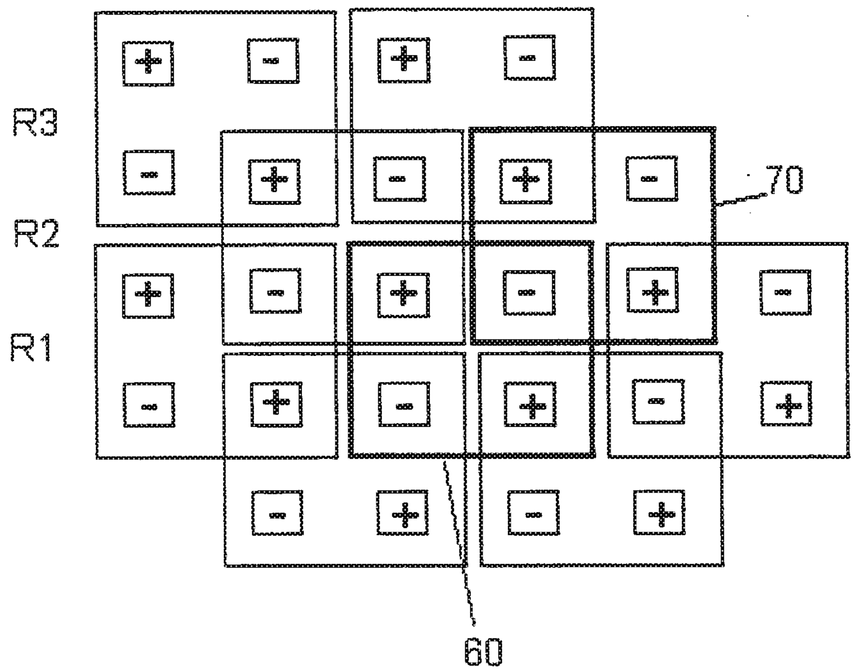

FIG. 5

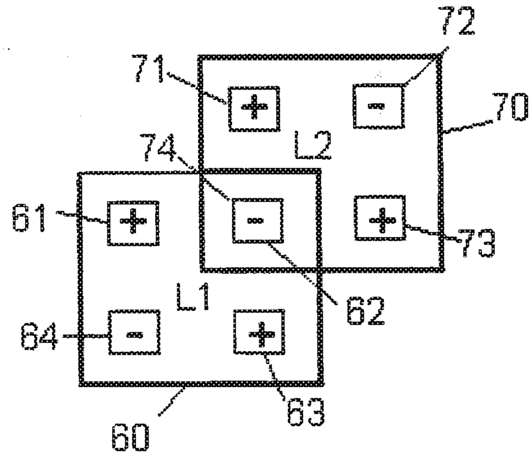

FIG. 6

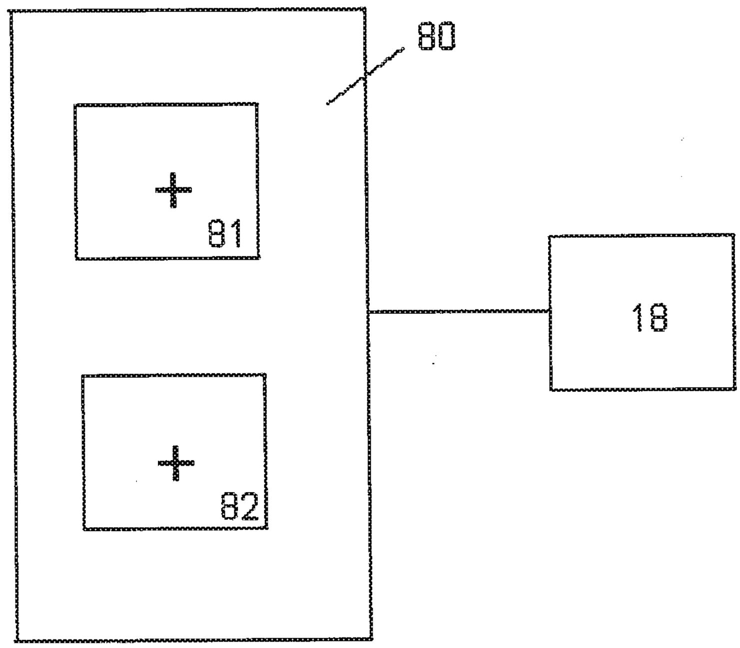

FIG. 7

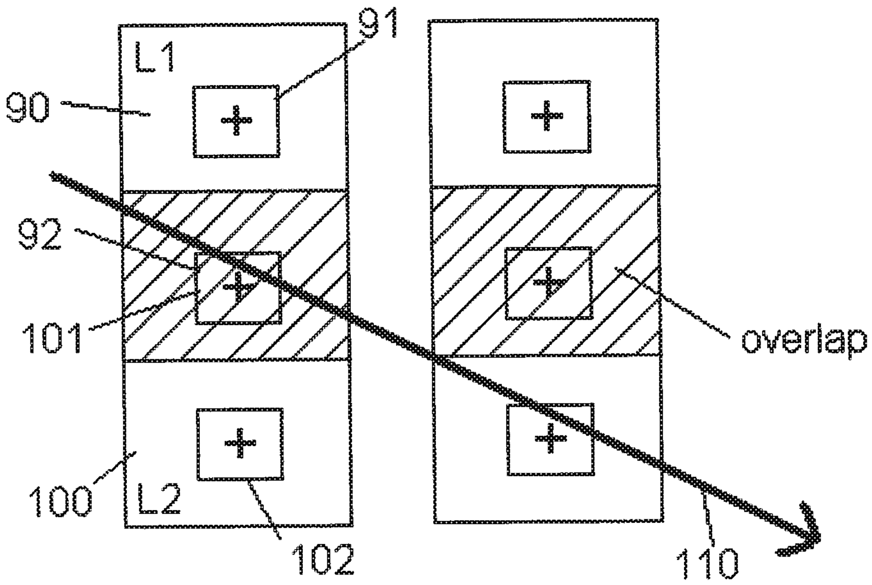

FIG. 8

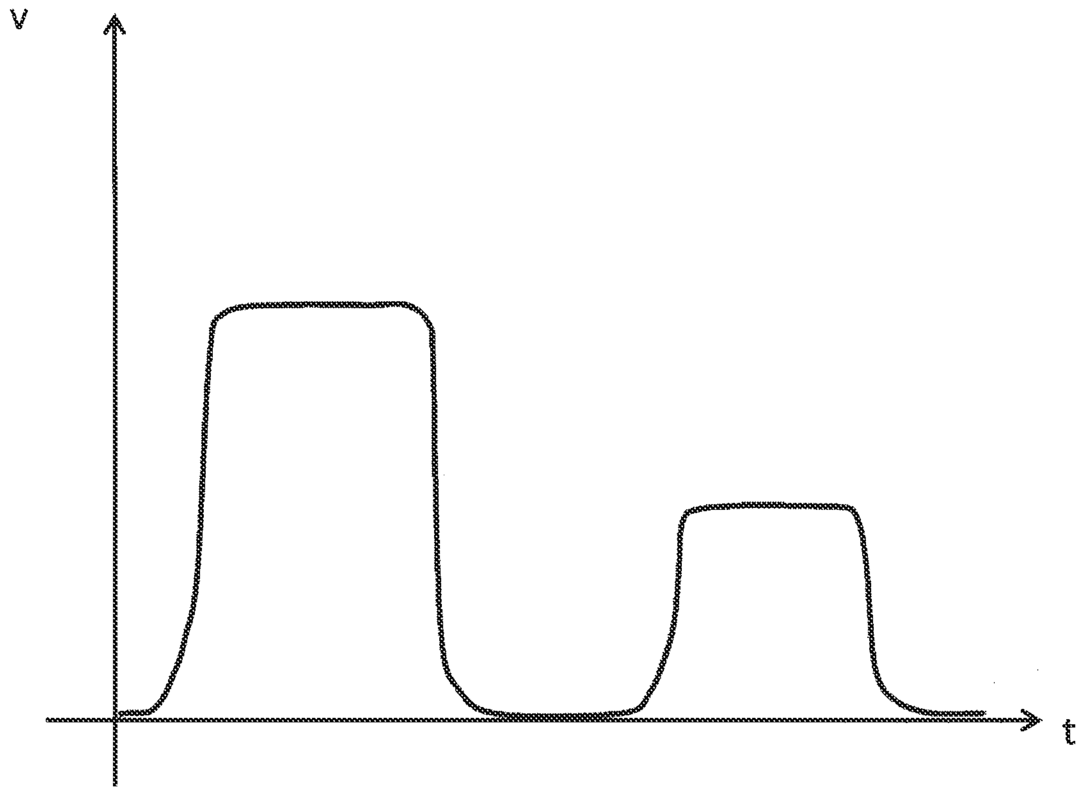

Fig. 9

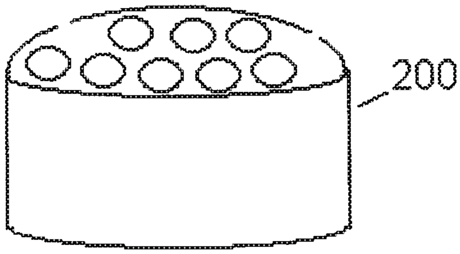

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2013/051742

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01J5/08 G01J5/00 G08B13/193 F21V23/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01J G08B F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 246 828 A1 (TOSHIBA LIGHTING & TECHNOLOGY [JP]) 3 November 2010 (2010-11-03) paragraphs [0038] - [0043]; figures 3,4,5	1-14
A	US 6 215 399 B1 (SHPATER PINHAS [CA]) 10 April 2001 (2001-04-10) column 3, line 48 - column 4, line 16; figures 2,8 column 5, line 64 - column 6, line 19	1-14
A	WO 2011/059830 A2 (SUREN SYSTEMS INC [CN]; MICKO ERIC SCOTT [US]) 19 May 2011 (2011-05-19) paragraph [0043]; figure 9	1-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August 2013	29/08/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hambach, Dirk

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2013/051742

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 2246828	A1	03-11-2010	EP	2246828	A1	03-11-2010
			JP	2010276598	A	09-12-2010
			US	2010270470	A1	28-10-2010
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			US	6215399	B1	10-04-2001
WO 2011059830	A2	19-05-2011	CN	102713544	A	03-10-2012
			EP	2494322	A2	05-09-2012
			US	2011210253	A1	01-09-2011
			WO	2011059830	A2	19-05-2011