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(54) **Title**: BIOMETRIC SENSOR

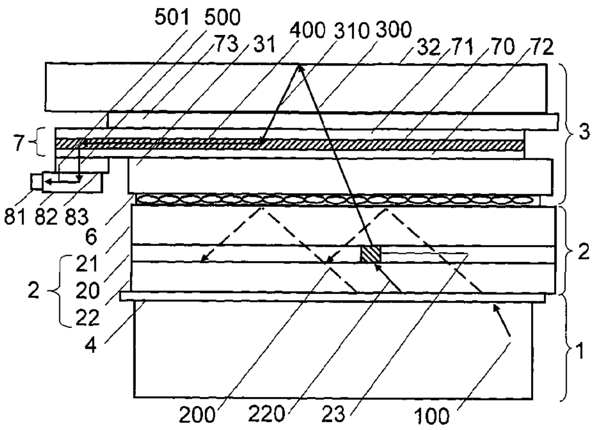


FIG.1

(57) **Abstract**: A biometric sensor comprises: an illumination means; an SBG device further comprising transparent substrates sandwiching an array of selectively switchable SBG elements, the substrates and SBG array together providing a fust TIR light guide; means for coupling illumination light into the light guide; and an optical wave guiding structure sandwiched between a first cladding layer facing the SBG device and a second cladding layer, the cladding layers providing a second TIR light guide. An SBG element in a diffracting state diffracts incident light into the second TIR light guide to provide second TIR light. The sensor further comprises means for coupling the second TIR light into the wave- guiding structure; a means for coupling light out of the wave-guiding structure onto a detector element. External pressure at a point on the outer side of the second cladding layer causes the propagation of the second TIR light to be frustrated.

WO 2011/110821 A1

BIOMETRIC SENSOR

BACKGROUND OF THE INVENTION

The present invention relates to a biometric sensor, and more particularly to a finger print sensing device using electrically switchable Bragg gratings.

Fingerprints are a unique marker for a person, even an identical twin, allowing trained personel or software to detect differences between individuals. Fingerprinting using the traditional method of inking a finger and applying the inked finger to paper can be extremely time-consuming. Digital technology has advanced the art of fingerprinting by allowing images to be scanned and the image digitized and recorded in a manner that can be searched by computer. Problems can arise due to the quality of inked images. For example, applying too much or too little ink may result in blurred or vague images. Further, the process of scanning an inked image can be time- consuming. A better approach is to use "live scanning" in which the fingerprint is scanned directly from the subject's finger. More specifically, live scans are those procedures which capture fingerprint ridge detail in a manner which allows for the immediate processing of the fingerprint image with a computer. Examples of such fingerprinting systems are disclosed in Fishbine et al. (U.S. Pat. Nos. 4,811,414 and 4,933,976); Becker (U.S. Pat. No. 3,482,498); McMahon (U.S. Pat. No. 3,975,711); and Schiller (U.S. Pat. Nos. 4,544,267 and 4,322,163).

While the fingerprinting systems disclosed in the foregoing patents are capable of providing optical or optical and mechanical fingerprint images, such systems are only suitable for use at a central location such as a police station. Such a system is clearly not ideal for law enforcement and security applications where there is the need to perform an immediate identity and background check on an individual while in the field. A live scanner must be able to capture an image at a resolution of 500 dots per inch (dpi) or greater and have generally uniform gray shading across a platen scanning area. The term "platen" refers to a component that includes an imaging surface upon which at least one finger, for example, is placed during a live scan.

Thus there exists a need for a portable, high resolution, lightweight fingerprint sensor that can optically generate fingerprint images in the field.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a portable, high resolution, lightweight fingerprint sensor thatcan optically generate fingerprint images in the field.

In a first embodiment of the invention a finger print sensor according to the principles of the invention comprises: an illumination means; an SBG device further comprising first and second transparent substrates sandwiching an array of selectively switchable SBG elements in which the substrates and SBG array together providing a first TIR light guide; a means for coupling light from the illumination means into the first TIR light guide to provide first TIR light; an optical wave guiding structure sandwiched between a first cladding layer facing the SBG device and a second cladding layer exposed to air, the cladding layers provide a second TIR light guide. Each SBG element has a diffracting state and a non diffracting state. An SBG element in a diffracting state diffracts incident first TIR light into the second TIR light guide to provide second TIR light. The finger print sensor further comprises a means for coupling the second TIR light into the wave-guiding structure; a means for coupling light out of the wave-guiding structure into an output optical path; and a detector element disposed at the end of the output optical path. The second cladding layer provides a finger print platen layer. External pressure applied at a point on the outer side of the second cladding layer causes the propagation of the second TIR light to be frustrated. The external pressure is provided by the friction ridges of a finger.

In one embodiment of the invention the illumination means comprises a multiplicity of laser illumination channels, each said channel comprising a laser and collimating lens system. The illumination means provides a multiplicity of collimated, abutting beams of rectangular cross section.

In one embodiment of the invention the illumination means comprises a laser and a collimator lens. The said illumination means provides a collimated beam of rectangular cross section.

In one embodiment of the invention the optical wave guiding structure comprises a multiplicity of parallel strip cores separated by cladding material.

In one embodiment of the invention the optical wave guiding structure comprises a single layer core.

In one embodiment of the invention the SBG elements are strips aligned normal to the propagation direction of the TIR light.

In one embodiment of the invention the SBG elements are switched sequentially across the SBG array and only one SBG element is in its diffracting state at any time.

In one embodiment of the invention the finger print sensor further comprises a microlens array disposed between the SBG device and the first cladding layer.

In one embodiment of the invention the means for coupling light from the illumination means into the first TIR light guide is a grating device.

In one embodiment of the invention the means for coupling light from the illumination means into the first TIR light guide is a prismatic element.

In one embodiment of the invention the means for coupling the second TIR light into the wave-guiding structure is a grating.

In one embodiment of the invention the means for coupling light out of the wave-guiding structure is a grating device.

A more complete understanding of the invention can be obtained by considering the following detailed description in conjunction with the accompanying drawings wherein like index numerals indicate like parts. For purposes of clarity, details relating to technical material that is known in the technical fields related to the invention have not been described in detail.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a schematic side elevation view of a finger print sensor in a first embodiment of the invention.

FIG.2 is a schematic plan view of a first operational state of an SBG device used in a first embodiment of the invention.

FIG.3 is a schematic plan view of a second operational state of an SBG device used in a first embodiment of the invention.

FIG.4A is a schematic side elevation view of one embodiment of the invention.

FIG.4B is a schematic plan view of an illuminination means used in one embodiment of the invention.

FIG.5 is a schematic plan view of a wave-guiding structure and detector module used in one embodiment of the invention.

FIG.6 is a schematic plan view of a wave-guiding structure and detector module used in one embodiment of the invention.

FIG.7 is a schematic plan view of a wave-guiding structure and detector module used in one embodiment of the invention.

FIG.8 is a schematic plan view of an illumination means in one embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

It will be apparent to those skilled in the art that the present invention may be practiced with some or all of the present invention as disclosed in the following description. For the purposes of explaining the invention well-known features of optical technology known to those skilled in the art of optical design and visual displays have been omitted or simplified in order not to obscure the basic principles of the invention.

Unless otherwise stated the term “on-axis” in relation to a ray or a beam direction refers to propagation parallel to an axis normal to the surfaces of the optical components described in relation to the invention. In the following description the terms light, ray, beam and direction may be used interchangeably and in association with each other to indicate the direction of propagation of light energy along rectilinear trajectories.

Parts of the following description will be presented using terminology commonly employed by those skilled in the art of optical design.

It should also be noted that in the following description of the invention repeated usage of the phrase “in one embodiment” does not necessarily refer to the same embodiment.

In the following description the term "grating" will refer to a Bragg grating. The term "switchable grating" will refer to a Bragg grating that can be electrically switched between an active or diffracting state and an inactive or non-diffractive state. In the embodiments to be described below the preferred switchable grating will be a Switchable Bragg Grating (SBG) recorded in a Holographic Polymer Dispersed Liquid Crystal (HPDLC) material. The principles of SBGs will be described in more detail below. For the purposes of the invention an non switchable grating may be based on any material or process currently used for fabricating Bragg gratings. For example the grating may be recorded in a holographic photopolymer material.

An SBG comprises a HPDLC grating layer sandwiched between a pair of transparent substrates to which transparent electrode coatings have been applied. The first and second beam deflectors essentially comprise planar fringe Bragg gratings. Each beam deflector diffracts incident planar light waves through an angle determined by the Bragg equation to provide planar diffracted light waves.

An (SBG) is formed by recording a volume phase grating, or hologram, in a polymer dispersed liquid crystal (PDLC) mixture. Typically, SBG devices are fabricated by first placing a thin film of a mixture of photopolymerizable monomers and liquid crystal material between parallel glass plates. Techniques for making and filling glass cells are well known in the liquid crystal display industry. One or both glass plates support electrodes, typically transparent indium tin oxide films, for applying an electric field across the PDLC layer. A volume phase grating is then recorded by illuminating the liquid material with two mutually coherent laser beams, which interfere to form the desired grating structure. During the recording process, the monomers polymerize and the HPDLC mixture undergoes a phase separation, creating regions densely populated by liquid crystal micro-droplets, interspersed with regions of clear polymer.

The alternating liquid crystal-rich and liquid crystal-depleted regions form the fringe planes of the grating. The resulting volume phase grating can exhibit very high diffraction efficiency, which may be controlled by the magnitude of the electric field applied across the PDLC layer. When an electric field is applied to the hologram via transparent electrodes, the natural orientation of the LC droplets is changed causing the refractive index modulation of the fringes to reduce and the hologram diffraction efficiency to drop to very low levels. Note that the diffraction efficiency of the device can be adjusted, by means of the applied voltage, over a continuous range from near 100% efficiency with no voltage applied to essentially zero efficiency with a sufficiently high voltage applied. U.S. Patent 5,942,157 and U.S. Patent 5,751,452 describe monomer and liquid crystal material combinations suitable for fabricating SBG devices.

To simplify the description of the invention the electrodes and the circuits and drive electronics required to perform switching of the SBG elements are not illustrated in the Figures. Methods for fabricated patterned electrodes suitable for use in the present invention are disclosed in PCT/US2006/043938 entitled METHOD AND APPARATUS FOR PROVIDING A TRANSPARENT DISPLAY by Waldern et al filed on 13 November 2006. Other methods for fabricating electrodes and schemes for switching SBG devices are to be found in the literature. The present invention does not rely on any particular method for fabricating transparent switching electrodes or any particular scheme for switching arrays of SBGs.

A finger print sensor according to a first embodiment of the invention is illustrated in the schematic side elevation view of FIG.1. The apparatus comprises: an illumination means generally indicated by 1; an SBG device generally indicated by 2; and a wave guiding structure and finger print platen generally indicated by 3. The SBG device further comprises first and second transparent substrates 21,22 sandwiching an array of selectively switchable SBG elements 20 such as the element 23 in which the substrates and SBG array together provide a first TIR light guide. In functional terms the SBG device comprises an array of strips aligned normal to the propagation direction of the TIR light. The SBG is recorded as single continuous rectangular SBG element. Transparent electrodes are applied to the opposing surfaces of the substrates 21,22 with at least one electrode being patterned to define the stripes of SBG elements. As explained above, each SBG element has a diffracting state and a non diffracting state. The fingerprint sensor further comprises a means 4 for coupling light from said illumination means into the first TIR light guide to provide first TIR light; an optical wave guiding structure 7 sandwiched between a first cladding layer 31 facing the SBG device and a second cladding layer 32 exposed to air, the cladding layers 31,32 providing a second TIR light guide. The wave-guiding structure comprises at least one core region 70 surrounding by cladding indicated by 71,72. An SBG element in a diffracting state diffracts incident first TIR light into the second TIR light guide to provide second TIR light. Both the first and second TIR light execute TIR in planes parallel to the projection section of FIG.1. The finger print sensor further comprises a means 73 for coupling said second TIR light into the wave-guiding structure; a means 81 for coupling light out of the wave-guiding structure into an output optical path indicated by 82; and a detector element 83 disposed at the end of the output optical path 82. The output optical path 82 typically comprises a further wave guiding structure. The second cladding layer 32 provides a finger print platen. External pressure applied at a point on the outer side of the second cladding layer causes the propagation of the second TIR light to be frustrated. The external pressure is provided by the friction ridges of a finger. Typically, the waveguide core 70 will have a refractive index higher than that of the cladding material 71,72. Although in FIG.1

the waveguide cladding is distinguished from the cladding layers 31,32, it should be noted that the waveguide cladding and cladding layers may be fabricated from one material allowing the number of layers to be reduced from four to two. In some cases it may be advantageous to have more than one cladding material in order to provide better control of the guide wave mode structure.

In one embodiment of the invention the finger print sensor further comprises a microlens array 6 disposed between the SBG device and the first cladding layer. Each lens element in the micro lens array images a portion of the active SB G element typically around 40x40um section down to a small spot of around 30x30um overlapping the cross section of one waveguide of the wave guiding structure. The microlens elements are typically fabricated from polymer of refractive index 1.49. The microlens array 6 is not required in all applications of the invention. The need for the microlens array will depend on the quality of collimation provided by the illumination means and other factors such as the dimensions of the waveguide cavities in the wave guiding structure 7. The microlens array may comprise diffractive optical elements.

In one embodiment of the invention the optical wave guiding structure comprises a multiplicity of parallel strip cores separated by cladding material of an identical refractive index to the index of the cladding layers 31,32.

In one embodiment of the invention the optical wave guiding structure comprises a single layer core. The invention does not assume any particular waveguide geometry or material for fabricating the waveguide. It will be recognized that there is a large number of core/cladding combinations that can be used to practice the invention. Many possible design solutions will be known to those skilled in the art of integrated optics.

The SBG elements are switched sequentially across the SBG array with only one SBG element being in its diffracting state at any time. The disposition of the SBG elements is illustrated in FIGS.2-3 which provides schematic plan views of the SBG device 20 at two consecutive switching states. In the first state illustrated in FIG.1 the SBG element indicated by 23 is in its diffracting state and all other SBG elements are in their non diffracting states allowing TIR light to be transmitted through the arrays without substantial transmission loss or path deviation. In the second state illustrated in FIG.3 the SBG element 23 is switched to its non-diffracting stated while the adjacent element 24 is switched to its diffracting state .

We next consider the propagation of light through the finger print sensor turning again to FIG.1. Incident light generally indicated by 100 from the illumination means is coupled into the first TIR light guide by the coupling means 4 to provide the first TIR light 200. The portion of the light incident on the diffracting element 23 which is in its diffracting state is indicated by 220. The light 220 is diffracted into the path 300 entering the second TIR light guide. The light 300 is totally internally reflected as light 310 towards the waveguide structure 7. The light 310 is coupled into the waveguide by the coupling means 73 and propagates within the waveguide as the guided beam 400. A portion of the guided beam indicated by 500 is coupled out of the waveguide by the coupling means 81 into the output optical path 82 as light 501. The light 501 strikes the detector element 83 disposed at the end of the output optical path 82. The output signal from the detector element is transmitted to a processor which is not illustrated

In one embodiment of the invention the means 73 for coupling the second TIR light into the wave-guiding structure is a grating device. In one embodiment of the invention the means 83 for coupling light out of the wave-guiding structure is a grating device. Advantageously the grating device is a Bragg grating as such gratings provide high efficiency and angular selectivity. The key factor that determines the efficiency of a Bragg grating is the coupling strength, which characterises the strength of interaction of the incident light with the grating. In more precise terms, the coupling strength depends on the overlap between the refractive index distribution (ie the Bragg fringes) and the incident light beam. In a waveguide the coupling strength depends on the spatial overlap between the index distribution and the modal field (ie the light wave electric field distribution in the waveguide and cladding). Typically, waveguides are a few microns in thickness making the grating cross section smaller than that of a free space grating. In practice the grating tends to act mainly on the evanescent field where the electric field is small. The very low index modulation dictates that longer interaction lengths (ie around 5 mm.) are needed to achieve high coupling efficiencies. In certain applications of the invention in which the waveguides have large cross sectional dimensions the coupling and propagation of incident light in the waveguides may be described in simpler geometrical terms. The integrated optics literature discloses many grating techniques for coupling light into waveguides that are relevant to the present invention. It should also be apparent to those skilled in the art that grating devices suitable for use with the invention may be based on transmission or reflection.

The SBG elements are switched sequentially across the SBG array and only one SBG element is in its diffracting state at any time. When a finger print ridge contacts a point on the air side of the cladding layer 32 the total internal reflection is frustrated. The precise location of the finger print ridge may be determined by the SBG array location of the last SBG element that was in a diffracting state just prior to the interruption of total internal reflection together with the ray path from the SBG element to the platen surface. The ray path may be computed using the diffraction angle and the thicknesses and refractive indices of the optical layers between the SBG element and the platen surface.

FIG.4 illustrates the finger print sensor in more detail. FIG.4A is a schematic side elevation view showing the illumination means and the SBG device in one embodiment of the invention. FIG.4B provides a side elevation view of the same embodiment of the invention. The wave guiding structure is not illustrated in FIG.4A. The illumination means comprises a multiplicity of lasers indicated by 13A-13D providing separate parallel illumination modules, each module comprising a pair of crossed cylindrical lenses such as 46A,46B. Referring to the module shown in FIG.4A, the lenses collimate the laser beam 101A from the laser die in the orthogonal beams 102A,103A to provide a fully collimated rectangular cross section beam 104A. Each laser provides an identical beam, the beams abutting to form a continuous rectangular beam extending over an area substantially the same as the SBG array in plan view. The beams are guided by the element 47 which comprises a transparent slab with a planar input surface orthogonal to the beam direction and a reflecting surface 44 at an angle to the beam direction. The surface 44 reflects the beam 104A into the orthogonal direction 105A. The illumination means further comprises a substrate 43 stacked on top of the slab 77 and a further layer on top of the substrate 43 comprising the slabs indicated by42 and 49. Although the slab portion 42 and 49 are illustrated as being air separated they may abut. The slab 42 has a tilted reflecting surface 48 fro directing light 106A into the SBG device 2. The slab 42 has an identical refractive index to the substrates 21,22 sandwiching the SBG array 20. The slab 49 essentially performs the function of a spacer. The slab 43 also acts as spacer but is coated with a polarisation selective coating in the region illuminated by the light 106A. The refractive index of the slab 49 is chosen to ensure TIR within the first light guide formed by the SBG device. It will be apparent to those skilled in the art of lens design that other lens configurations equivalent to the crossed cylindrical lenses of FIG.4 may be used to provide the above described beam geometry.

Typically, the SBG array has an average refractive index of 1.55 in its non diffractive state and 1.62 when in a diffracting state. The substrates 21,22 have refractive indices of 1.55. The slab 42 has an index of 1.52 to match the SBG substrates. The slab 49 is advantageously a polymer material of refractive index 1.49. the lens array adjacent the substrate 21 is also a polymer material of index 1.49. The resulting critical angle in the first TIR light guide formed by the SBGH device is therefore approximate 74 degrees. Advantageously, the slab 47 is also a polymer allowing the lens elements to be cut out of a block of polymer material using laser machining or an equivalent cutting process. The SBG elements diffract light such that the incidence angle at the platen surface is around 40 degrees. The cladding layers 31,32 are fabricated from glass of index 1.55. The wave-guiding structure may use a polymer waveguide core of index 1.60 with cladding index 1.50. The illumination means may further comprise optical stops to eliminate stray light and scatter.

FIGS.5-7 provide schematic plan views of wave guiding structures and detector configurations for use with the present invention. In each case the wave-guiding structure 7 comprises parallel strip waveguides with the waveguide core element 70 of one of the waveguides being indicated in each Figure. The ray paths from the active SBG element 23 to the waveguide are indicated by 300,310,400 using the numerals of FIG.1. In the embodiment of FIG.5 the detector array comprises linear array of elements such as 83A each detector element being disposed at the termination of a waveguide. In the embodiment of FIG.6 the output light indicated by 502 from the waveguides is converged onto a smaller area detector array using the convergent path waveguide routing element 84A to converge output light onto detector elements such as 83B. In the embodiment of FIG.7 the output light indicated by 503 from the waveguides is converged onto a single element detector 83C using the convergent path waveguide routing element 84B. It should be apparent to those skilled in the art of integrated optics that other configurations of waveguides, detectors and coupling elements equivalent to the ones illustrated in FIGS.5-7 may be used. It should also be apparent that additional optical elements of the type commonly used in integrated optics may be used to facilitate efficient coupling of the wave guided light to the detectors.

In one embodiment of the invention illustrated in the schematic plan view of FIG. 8 the illumination means comprises a single laser 13e and a collimator lens system comprising the crossed cylindrical lenses 46a,46b. The said illumination means provides a single collimated beam of rectangular cross section 104E.

The invention may be used to perform any type of "live scan" or more precisely any scan of any print ridge pattern made by a print scanner. A live scan can include, but is not limited to, a scan of a finger, a finger roll, a flat finger, a slap print of four fingers, a thumb print, a palm print, or a combination of fingers, such as, sets of fingers and/or thumbs from one or more hands or one or more palms disposed on a platen. In a live scan, for example, one or more fingers or palms from either a left hand or a right hand or both hands are placed on a platen of a scanner. Different types of print images are detected depending upon a particular application. A flat print consists of a fingerprint image of a digit (finger or thumb) pressed flat against the platen. A roll print consists of an image of a digit (finger or thumb) made while the digit (finger or thumb) is rolled from one side of the digit to another side of the digit over the surface of the platen. A slap print consists of an image of four flat fingers pressed flat against the platen. A palm print involves pressing all or part of a palm upon the platen. A platen can be movable or stationary depending upon the particular type of scanner and the type of print being captured by the scanner.

The invention may be used in a portable fingerprint system which has the capability for the wireless transmission of fingerprint images captured in the field to a central facility for identity verification using an automated fingerprint identification system.

It should be clear from the above discussion that the invention may be used in any application in which a surface relief structure similar to a finger print is detected using the prinicple of frustratated total internal reflection from a platen surface in contact with the surface relief structure. The invention may also be used to sense contact prints arsing from the friction ridges of hands or other parts of the body. Other applications of the invention may occur in the fields of medicne, industrial sensors, robotics and security.

It should be emphasized that the drawings are exemplary and that the dimensions have been exaggerated.

Although the invention has been described in relation to what are presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not limited to the disclosed arrangements, but rather is intended to cover various modifications and equivalent constructions included within the spirit and scope of the invention.

CLAIMS

What is claimed is:

1. A sensor comprising:

an illumination means (1);

an SBG device (2) further comprising first (22) and second (21) transparent substrates sandwiching an array of selectively switchable SBG elements (20), said substrates and said SBG array together providing a first TIR light guide;

a means (4) for coupling light from said illumination means into said first TIR light guide to provide first TIR light;

an optical wave guiding structure sandwiched between a first cladding layer (31) facing said SBG device and a second cladding layer (32) exposed to air, wherein said cladding layers provide a second TIR light guide,

wherein each said SBG element has a diffracting state and a non diffracting state, wherein an SBG element in a diffracting state diffracts incident first TIR light into said second TIR light guide to provide second TIR light;

a means (73) for coupling said second TIR light into said waveguide;

a means (81) for coupling light out of said waveguide into an output optical path (82); and

a detector element 83) disposed at the end of said output optical path,

wherein external pressure applied at a point on the outer surface of said second cladding layer causes said second TIR to be frustrated.

2. The sensor of claim 1 wherein said second cladding layer provides a finger print platen layer.

3. The sensor of claim 1 wherein said external pressure is provided by the friction ridges of a finger.

4. The sensor of claim 1 wherein said illumination means comprises a multiplicity of laser illumination channels each said channel comprising a laser and collimating lens system, said illumination means providing a multiplicity of collimated, abutting beams of rectangular cross section.

5. The sensor of claim 1 wherein said illumination means comprises a laser, a collimator lens said illumination means providing a collimated beam of rectangular cross section.

6. The sensor of claim 1 wherein said optical wave guiding structure comprises a multiplicity of parallel strip cores separated by cladding material.

7. The sensor of claim 1 wherein said optical wave guiding structure comprises a single layer core.

8. The illumination device of claim 1 wherein said SBG elements are strips aligned normal to the propagation directions of said TIR light.

9. The sensor of claim 1 wherein said SBG elements are switched sequentially across said array and only one SBG element is in its diffracting state at any time.

10. The sensor of claim 1 further comprising a microlens array disposed between said SBG device and side first cladding layer.

11. The sensor of claim 1 wherein said means for coupling light from said illumination means into said first TIR light guide is a grating.

12. The sensor of claim 1 wherein said means for coupling light from said illumination means into said first TIR light guide is a prismatic element.

13. The sensor device of claim 1 wherein said means for coupling said second TIR light into said waveguide is a grating device.

14. The sensor of claim 1 wherein said means for coupling light out of said waveguide is a grating device.

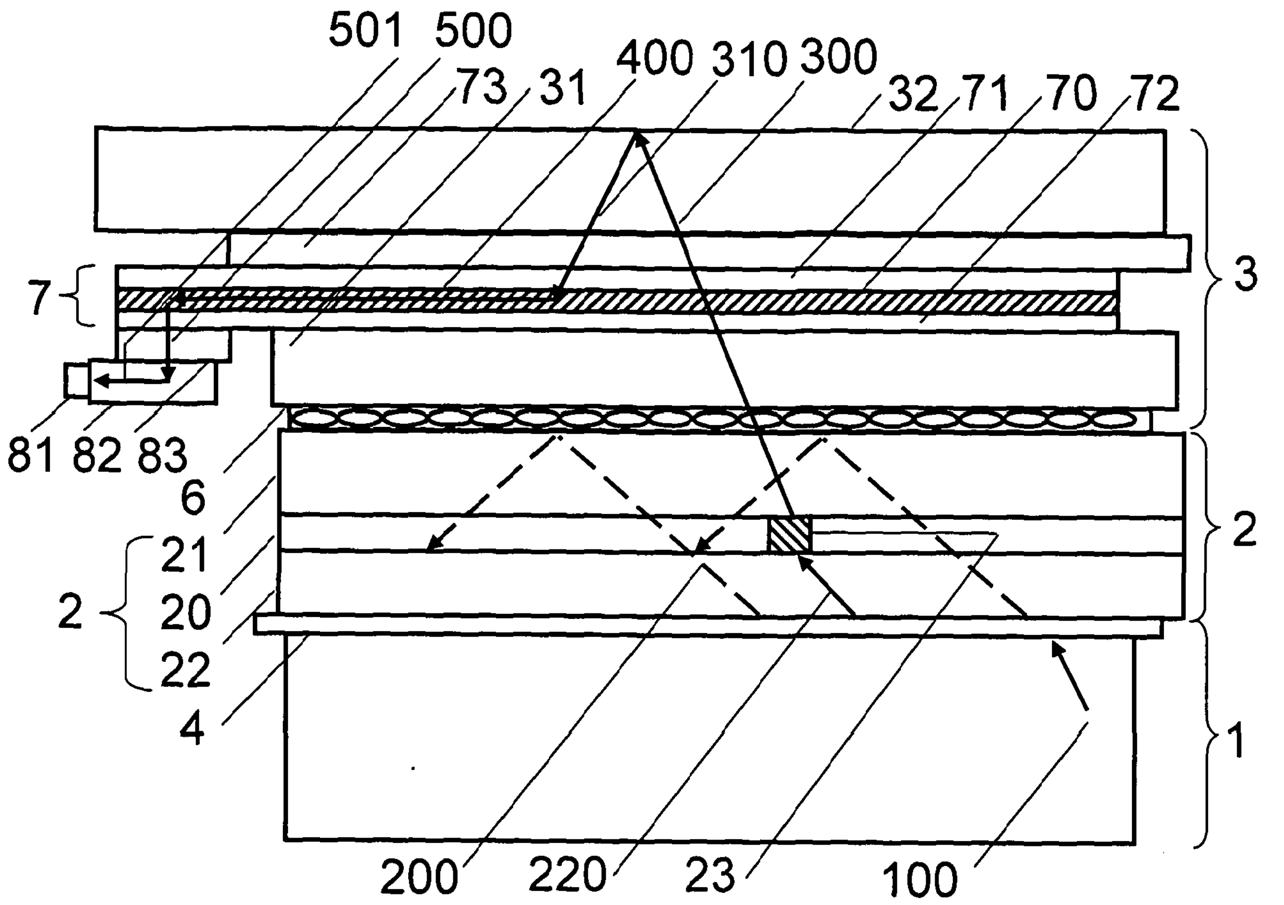


FIG.1

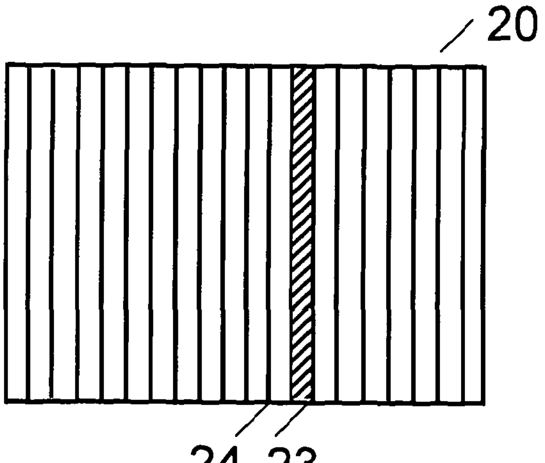


FIG.2

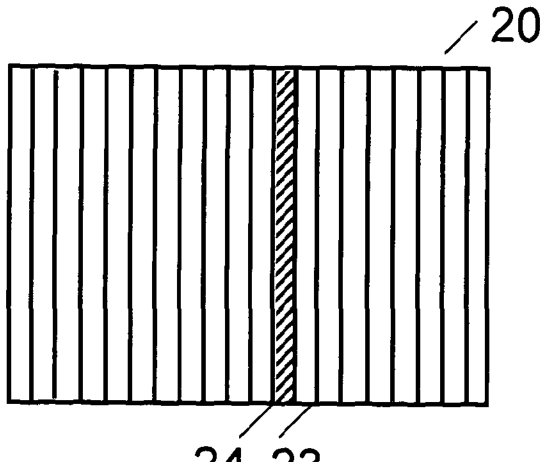
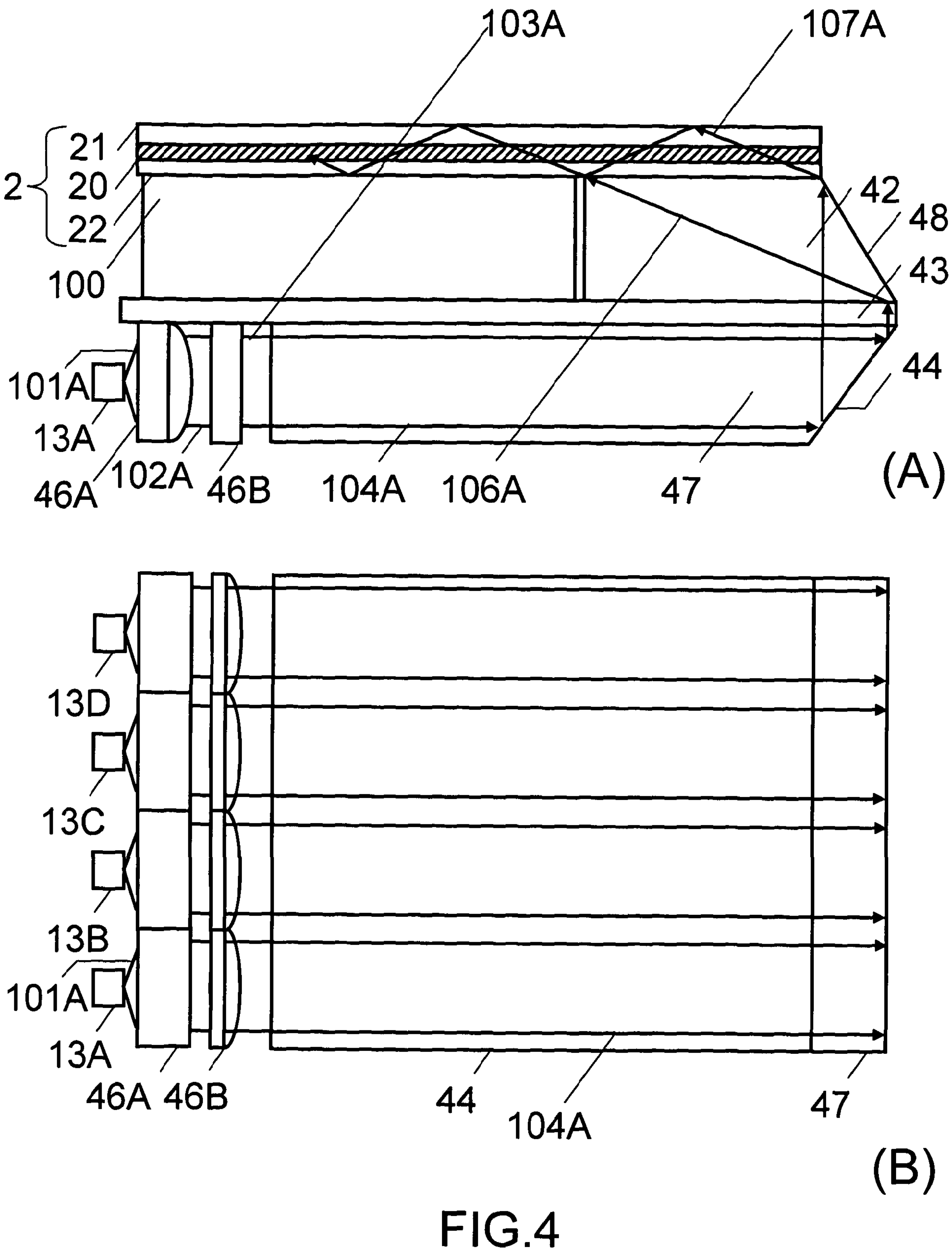


FIG.3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104A
47
(B)

FIG.4

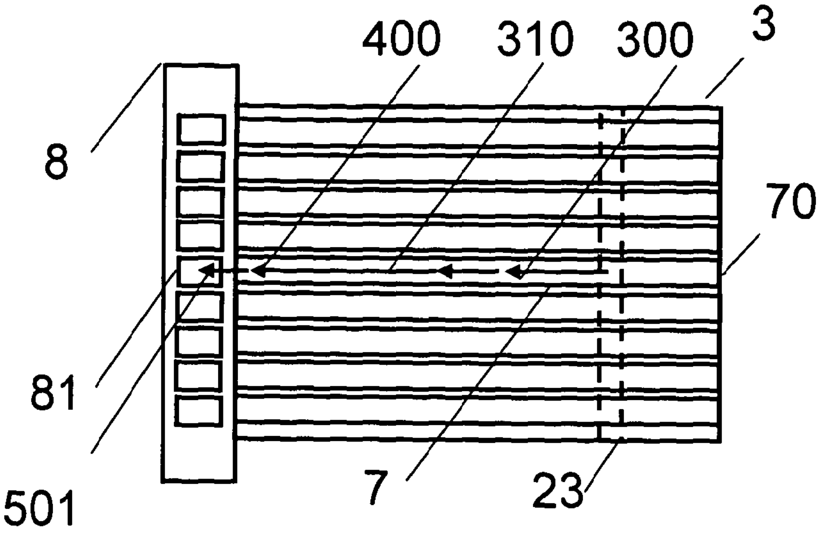

FIG.5

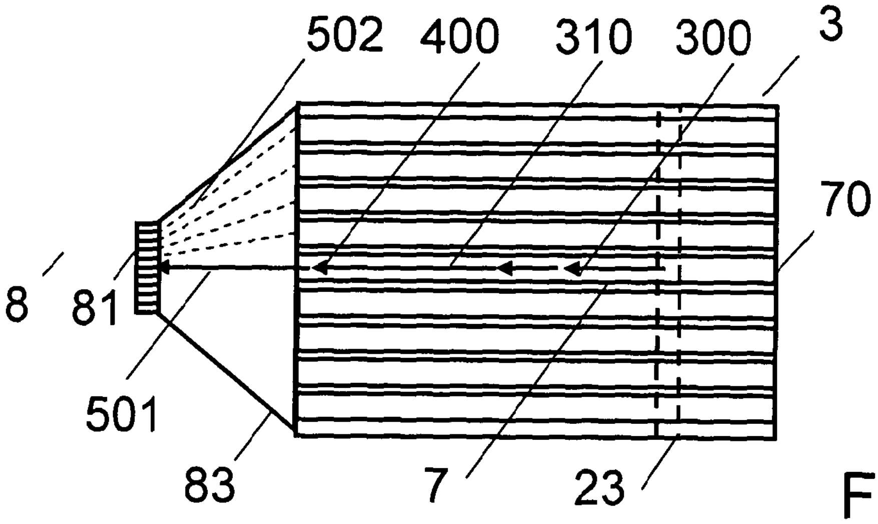

FIG.6

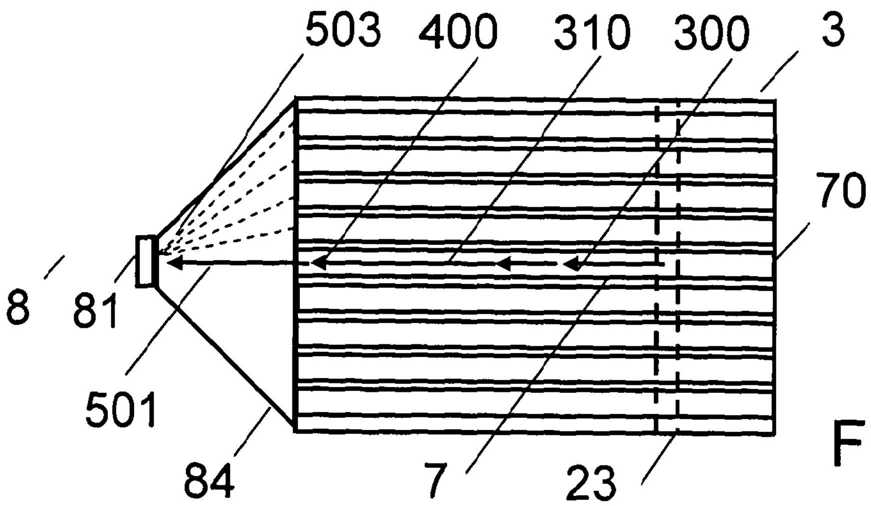

FIG.7

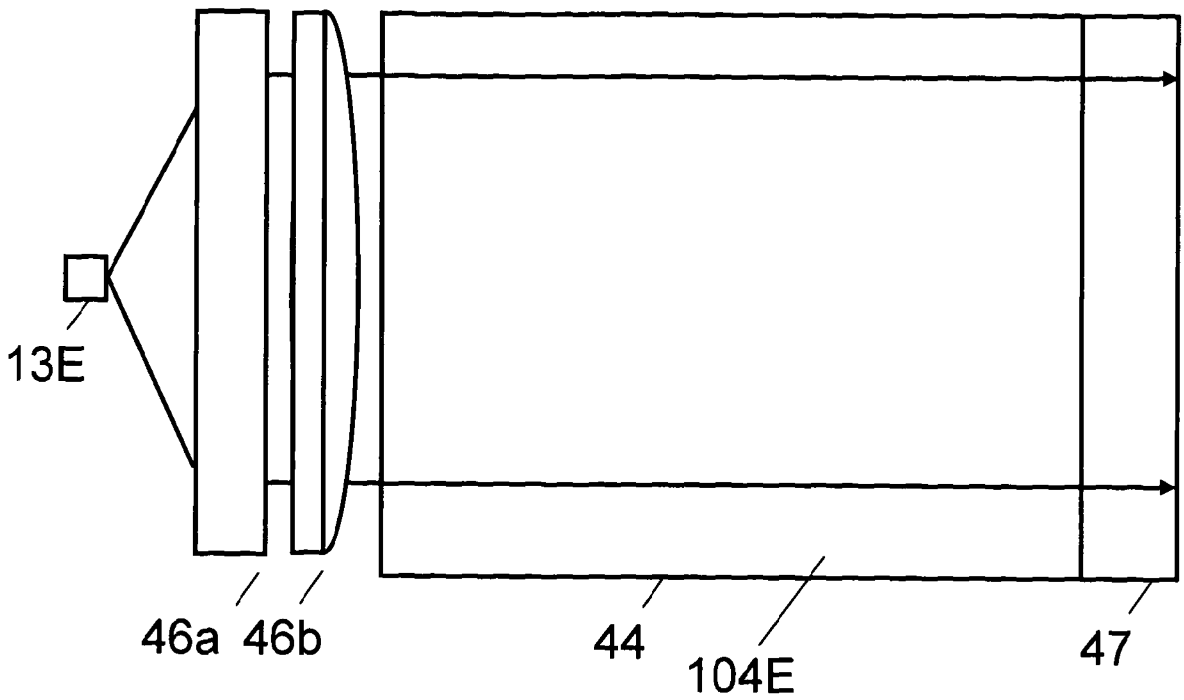

FIG.8

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2011/000349

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06K9/00
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)
G06K

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 practical, search terms used)

EPO-Internal, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 2011/032005 A2 (IDENTIX CORP [US]; HAMRE JOHN D [US]; MAASE DANIEL F [US]) 17 March 2011 (2011-03-17) the whole document -----	1-14
E	US 2011/063604 A1 (HAMRE JOHN D [US] ET AL) 17 March 2011 (2011-03-17) the whole document -----	1-14
A	US 6 061 463 A (METZ MICHAEL [US] ET AL) 9 May 2000 (2000-05-09) the whole document -----	1-14
A	US 5 892 599 A (BAHUGUNA RAMENDRA D [US]) 6 April 1999 (1999-04-06) the whole document -----	1-14
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means
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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
17 August 2011	25/08/2011

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	Deltorn, Jean-Marc

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2006/119837 A1 (RAGUIN DANIEL H [US] ET AL) 8 June 2006 (2006-06-08) the whole document -----	1-14
A	WO 2005/001753 A1 (APRILIS INC [US]; WALDMAN DAVID [US]; FEDELE VINCENT [US]; INGWALL RIC) 6 January 2005 (2005-01-06) the whole document -----	1-14

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2011/000349

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 2011032005	A2	17-03-2011	US 2011063604	A1	17-03-2011
US 2011063604	A1	17-03-2011	WO 2011032005	A2	17-03-2011
US 6061463	A	09-05-2000	NONE		
US 5892599	A	06-04-1999	AU 6542596	A	10-02-1997
			WO 9703412	A1	30-01-1997
			US 5629764	A	13-05-1997
			US 6038043	A	14-03-2000
US 2006119837	A1	08-06-2006	NONE		
WO 2005001753	A1	06-01-2005	CA 2529033	A1	06-01-2005
			CA 2529147	A1	06-01-2005
			EP 1636734	A2	22-03-2006
			EP 1636735	A1	22-03-2006
			JP 2007524906	A	30-08-2007
			JP 2007526542	A	13-09-2007
			US 2009226052	A1	10-09-2009
			WO 2005001752	A2	06-01-2005