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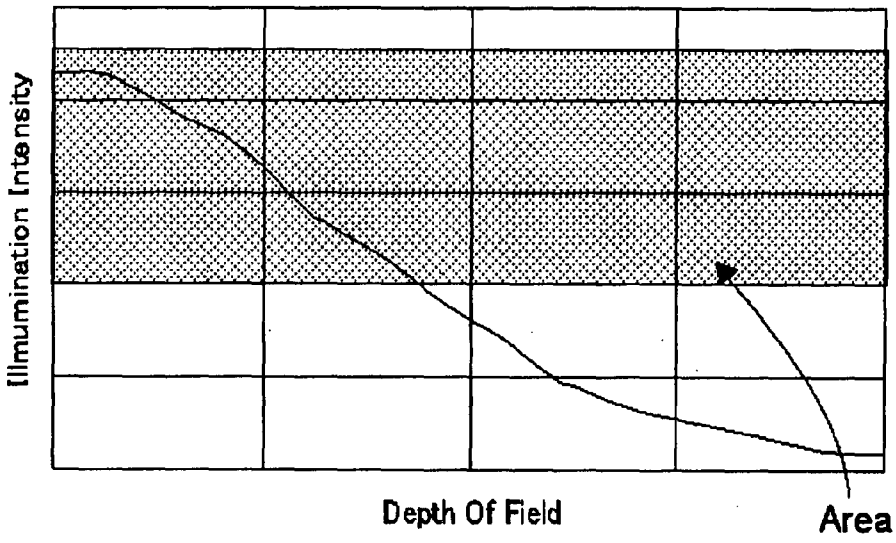
(54) **Title:** OPTIMIZED ILLUMINATION FOR AN OMNISCANNER

FIG. 1



(57) **Abstract:** An imaging device preferably for use in a 2-D CCD or CMOS sensor is disclosed. The illumination means uses a plurality of illumination sources, some of which are coupled to lenses in an offset manner to promote far field illumination, and some of which are not so coupled and are arranged to provide near field illumination.

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OPTIMIZED ILLUMINATION FOR AN OMNISCANNER

TECHNICAL FIELD

This invention relates to imaging devices, and more specifically, to an optimized illumination system having particular application in 2-D imaging systems.

BACKGROUND OF THE INVENTION

2-D imaging systems typically involve an illumination means and an imaging array, such as Complimentary Metal on Silicon ("CMOS") or a Charge Coupled Device ("CCD"). Such systems use LEDs or other means to illuminate the object to be captured, and the light reflected from such object is then incident upon the imaging matrix. One problem associated with such devices is that the depth of field over which the illumination of the object can be kept constant is relatively narrow. For example, FIG. 1 shows how the intensity of illumination falls off drastically as a function of distance from the source.

In the prior art, solutions to this problem typically involve installing an additional one or more LEDs or other illumination means, which is directed to the area close to the device. One such arrangement is disclosed in U.S. Published Application No. 2006-0219792. In the '792 publication, two modes of operation are used, each of which has its own associated set of LEDs. Depending upon whether it is desired to capture images in the near field or far field, a different mode of operation is selected, which results in a different set of LEDs being illuminated. However, the position of the various LEDs, renders this arrangement somewhat less than optimal.

Another prior art arrangement with a separate set of LEDs to illuminate an area close to the imaging array is disclosed in U.S. Published Application No. 2006-0118627. In the '627 publication, a separate set of LEDs is disposed vertically to the remaining circuit board in the device, and light is directed from these LEDs to illuminate the close in field of view. This is perhaps best shown in FIG. 9 of the '627 publication.

These and other prior art arrangements are all suboptimal in that they require arrangements that are either too large in size, too expensive to manufacture, or which are cumbersome to use. Many involve positioning the source of secondary illumination in a manner that increases the manufacturing cost of the device.

Some such prior art arrangements are also less than optimal because the illumination means are positioned in a manner that may shine into a user's eyes. Thus, there exists a need in the art for an improved device that can provide for uniform illumination over a wide range of distances from the imaging array.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the intensity of light over field of view as distance from the imaging array varies, using a prior art system;

FIG. 2 shows one exemplary prior art arrangement for attempting to uniformally illuminate objects at a closing field of view;

FIG. 3 shows a side view from an exemplary embodiment of the present invention;

FIG. 4 is a front view of an exemplary embodiment of the present invention;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The above and other problems with the prior art are overcome in accordance with the present invention which relates to the technique of providing both near field and far field illumination while at the same time avoiding many of the drawbacks of the prior art. Specifically, a plurality of illumination sources such as LEDs are utilized, where each is positioned behind a lens in an offset manner. Because the LED is offset with respect to the lens in front thereof, the illumination can be directed to the far or near fields of view.

FIG. 3 depicts a conceptual side view of an imaging device utilizing the illumination technique of the present invention. The arrangement includes a masking device 306 which partially shields the illimination means 301 and 304 as shown, thereby avoiding the illumination being projected into a user's eyes. An inner portion of the mask is designated 307. The mask is preferably continuous, as shown in FIG. 4, and includes an opening surrounding the LED to provide an output path for the light.

As shown best in FIG. 3, an illumination means 304 is placed behind a lens 305 in an offset manner so that the lens 305 acts to direct the illumination to a far field of view. A similar arrangement is employed and depicted as illumination means 301 with lens 310. The illumination means 301 and 304 act in concert to provide illumination for the far field of

view, also as depicted in FIG. 3. Further, the illumination means 302 acts to provide illumination for the near field of view.

Although the arrangement provides for a substantially uniform illumination from a near field of view to a far field of view, it is nonetheless still contemplated that a user can select between the near and far field of view, and activate the appropriate illumination means (e.g., LEDs). Or, both can simply be activated when the device is activated for capturing an image.

For example, and with reference to FIG. 4, a user may select LEDs 301 and 304 to be illuminated, which would illuminate a far field of view, or a user may select LEDs 302 to illuminate when an object is within the near field of view. It is also possible that such selection can occur automatically, and to illuminate the appropriate LEDs, such as by a laser based distance measuring apparatus known in the art.

The LEDs 301 and 304 may be mounted on a circuit board 340, and other electronics may be on circuit board 350 as well.

Note examplary LED 304 is aligned with a side of a lens 305 that itself is aligned with an outer mask portion 306. By placing the LED 304 near to the outer side mask, the beam is directed correctly as shown, and the outer side mask shields the user from having to view the light being emitted by the illumination means 301 and 304.

From FIG. 4, it can be seen that there is an opening 408 in the masking 306, 307 that allows the light from the LEDs to properly illuminate the target. Note that a review of openings 407 – 410 shows that there are plural openings, and that the LED within the openings is closest to a different corner of the opening for each of the four sets of two openings. Specifically, the LED within opening 409 is closest to a part of the opening that would form an angle of 315 degrees with respect to the horizontal, if the opening represented a Cartesian plane. Within opening 410, that angle would be 215 degrees. Within opening 407, that angle would be 135 degrees. Within opening 408, that angle would be 45 degrees.

The foregoing positioning of the LEDs within the openings results in the illumination of the proper field of view for objects located relatively far from the device. For near field objects, the illuminations means 302 is used, as shown in FIGs. 3 and 4. These LEDs 302 are optionally not surrounded by mask portions 306 and 307, but their light is nonetheless advantageously blocked from the user's view by mask portions 306 and 307. Of course, the

entire device may be disposed within a suitable housing, shown only conceptually as 380 for purposes of explanation.

While the foregoing describes the preferred embodiments of the present invention, other variations are possible as well. The imaging array may be comprised of any suitable technology other than CMOS or CCD. The lenses shown may be LED mask lenses, or other types of lenses, and the illumination may be derived from sources other than LEDs. These and other embodiments are intended to be within the scope of the appended claims.

CLAIMS:

1. An imaging device comprising a first illumination means and a second illumination means, said first illumination means being arranged to illuminate a field of view at a first distance from said device, said second illumination means being arranged to illuminate a field of view at a second and further distance from said device, at least one of said illumination means including a source of light and a lens having a center, the source of light being offset from said center of said lens, said device further comprising an imaging array to capture light reflected from a target object.

2. The imaging device of claim 1 wherein at least one of the illumination means comprises plural Light Emitting Diodes (LEDs).

3. The imaging device of claim 2 wherein said first illumination means comprises an LED with a mask portion on one side thereof.

4. The imaging device of claim 3 wherein said second illumination means includes at least one LED with a mask portion on both sides thereof.

5. The imaging device of claim 3 further comprising a user selectable switch that activates one or the other of said illumination means.

6. An imaging device comprising an imaging array disposed within a housing, a plurality of first illumination sources for illuminating a target to be imaged, said first illumination sources being surrounded by a masking portion with an opening therein to allow light to be emitted, and a plurality of second illumination sources which are not surrounded by said masking portion, said first and second illumination sources being arranged to illuminate an object at different distances from said imaging device.

7. The imaging device of claim 6 wherein the first illumination sources include LEDs.

8. The imaging device of claim 6 wherein the first illumination sources includes a plurality of LEDs and wherein the LEDS are disposed within openings of a mask, and wherein the LED within at least one of the openings is positioned differently with respect to the opening from the LEDs in the other openings of the mask.

9. The imaging device of claim 6 wherein there are plural pairs of illumination sources, and wherein within each pair of illumination sources, the sources are positioned similarly with respect to the openings in the mask, but wherein the positioning of the LEDs within the openings is different among the different pairs of illumination sources.

10. The imaging device of claim 9 having a lens and wherein the first illumination sources are disposed symmetrically with respect to the lens and wherein the second illumination sources are disposed asymmetrically with respect to the lens.

11. The imaging device of claim 10 further comprising a distance measuring means to automatically illuminate either the first or second illumination sources, depending upon a distance between the device and a target to be imaged.

12. The imaging device of claim 10 wherein all of said illumination sources are installed in a common plane.

13. The imaging device of claim 10 wherein the imaging sources are installed on plural circuit boards.

FIG. 1

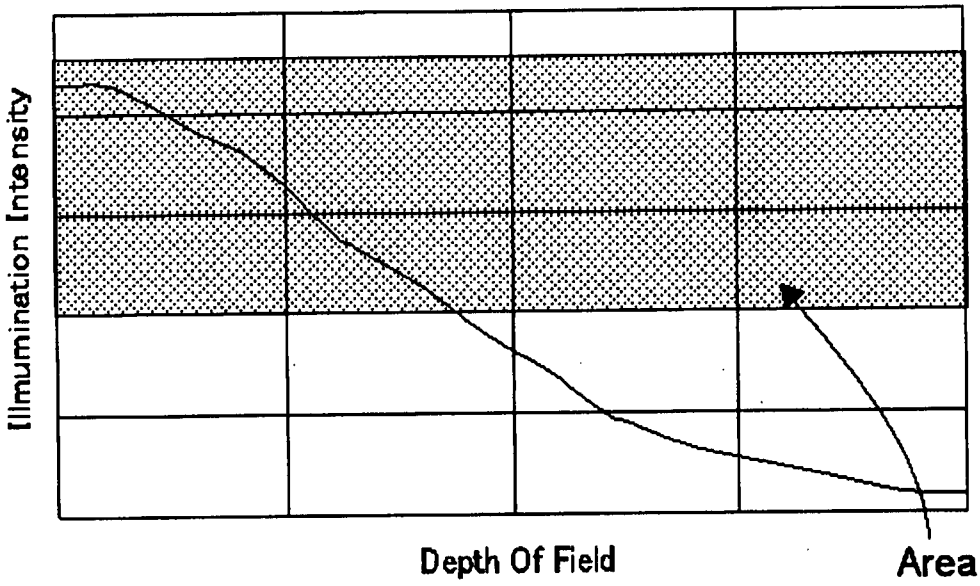
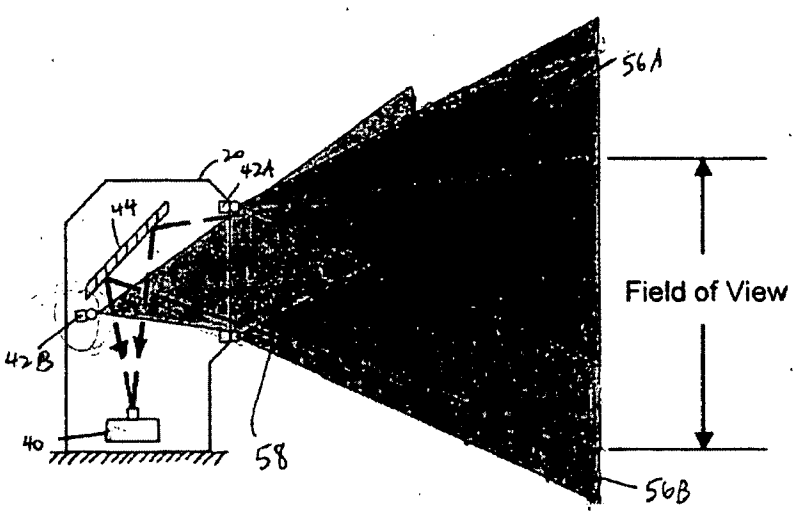


FIG. 2



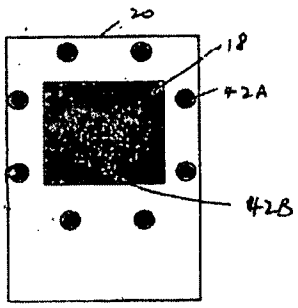


FIG 3

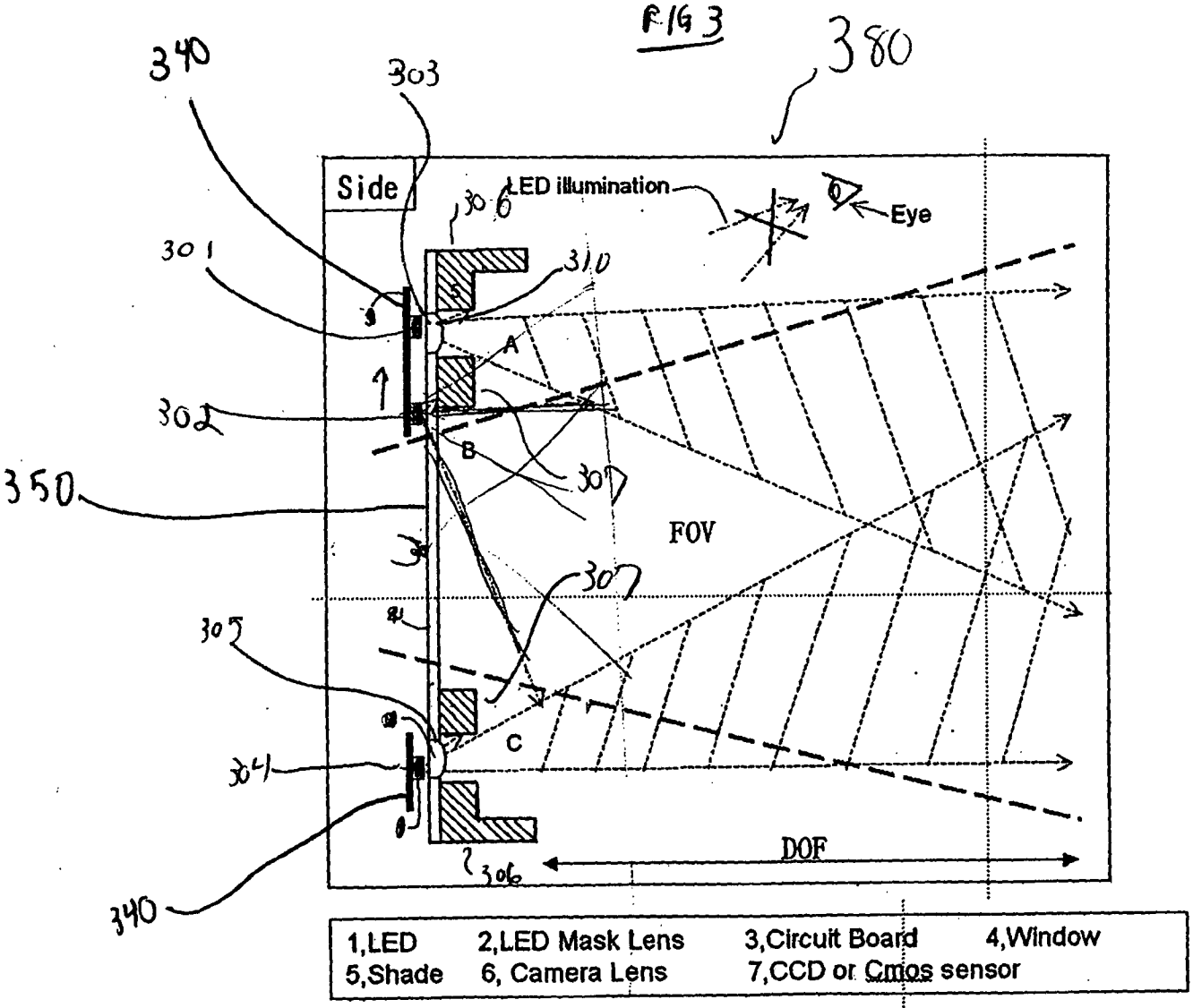
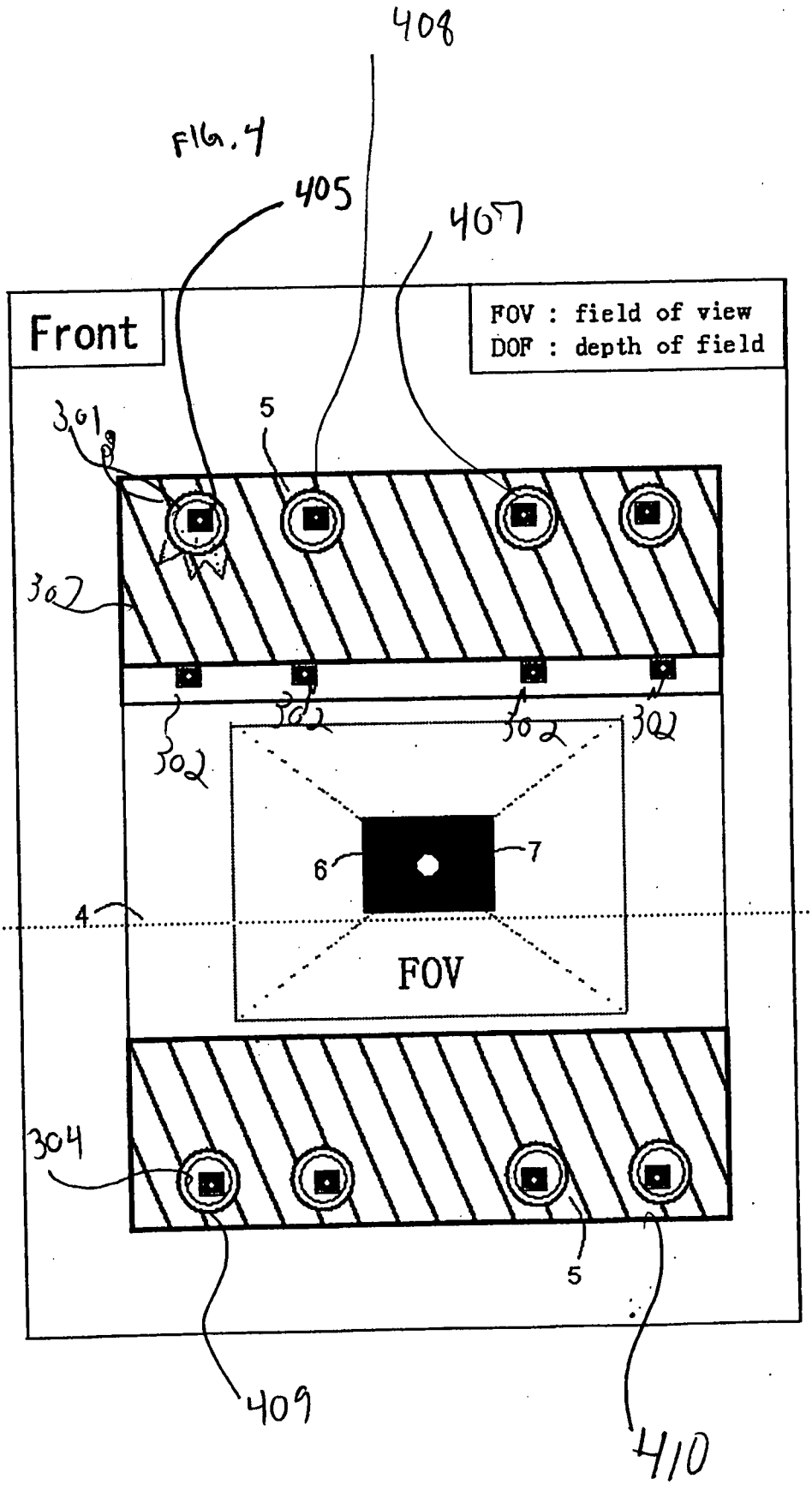

340
303
380
Side
LED illumination
Eye
306
301
310
A
302
B
350
307
FOV
305
C
304
DOF
306
340
1,LED
2,LED Mask Lens
3,Circuit Board
4,Window
5,Shade
6, Camera Lens
7,CCD or Cmos sensor

FIG. 4


408
405
407
Front
FOV : field of view
DOF : depth of field
301
5
302
302
302
302
6
7
4
FOV
304
5
409
410

INTERNATIONAL SEARCH REPORT

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PCT/US07/75851

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06K 7/10 (2007.10)
USPC - 235/472
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)
IPC(8) - G06K 7/10 (2007.10)
USPC - 235/472

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)
PUBWest

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,783,811 A (FENG et al) 21 July 1998 (21.07.1998) entire document.	1-13
Y	Applicant's Admited Prior Art (APA) in the PCT Application, pages 2-3.	1-13
Y	US 6,832,725 B2 (GARDINER et al) 21 December 2004 (21.12.2004) entire document.	1-13
A	US 4,711,567 A (TANIMOTO et al) 08 December 1987 (08.12.1987) entire documetnt.	1-13

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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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
04 January 2008	06 MAR 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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