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(54) Title: PHOTON DETECTION SYSTEM AND METHOD OF PHOTON DETECTION

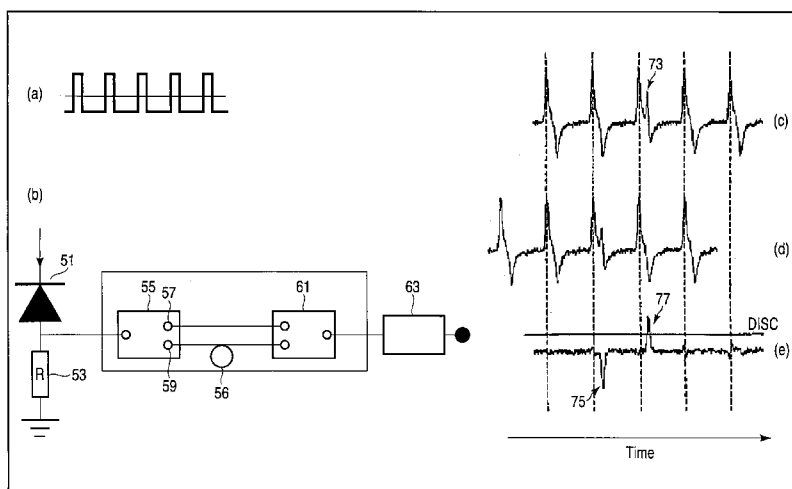


FIG. 3

(57) Abstract: A photon detection system configured to determine the number of detected photons, the detection system comprising an avalanche photodiode (51), means to apply a bias across the photodiode such that upon illumination the signal due to the avalanche (73, 75, 77) is less than the saturation value of the system and means to measure the size of the avalanche signal.

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# INTERNATIONAL SEARCH REPORT

International application No  
PCT/JP2009/050164

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. G01J1/44

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 H01L

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	YUAN Z. L. ET AL: "High speed single photon detection in the near infrared" APPLIED PHYSICS LETTERS, vol. 91, no. 4, 2007, pages 041114-1-041114-3, XP012100194 the whole document	1-11, 14-17, 19,20
X	NAMEKATA N ET AL: "800 MHz single-photon detection at 1550-nm using an InGaAs/InP avalanche photodiode operated with a sine wave gating" OPTICS EXPRESS, vol. 14, no. 21, 16 October 2006 (2006-10-16), pages 10043-10049, XP002525954 the whole document	1-7, 14-17, 19,20
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.	<input checked="" type="checkbox"/> See patent family annex.
* Special categories of cited documents :	
*A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *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  29 April 2009	Date of mailing of the international search report  11/08/2009
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Besser, Veronika

## INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2009/050164

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 218 657 B1 (BETHUNE DONALD S [US] ET AL) 17 April 2001 (2001-04-17) column 6, line 14 - column 10, line 7; figures 4,8,9	1-5, 15-17
P,X	WO 2008/104799 A (TOSHIBA KK [JP]; YUAN ZHILIANG [GB]; SHIELDS ANDREW JAMES [GB]) 4 September 2008 (2008-09-04) page 10, paragraph 3 - page 14; figures 4-7	1-11, 14-17, 19,20
A	COLDENSTRODT-RONGE, H. B. ET AL: "Avalanche photo-detection for high data rate applications" J. PHYS. B: ATOM, MOL. OPT. PHYS., vol. 40, 25 September 2007 (2007-09-25), pages 3909-3921, XP002525955 the whole document	1-11, 14-17, 19,20
A	TSUJINO, K. ET AL: "A charge-integration readout circuit with a linear-mode silicon avalanche photodiode for a photon-number resolving detector" OPTICS AND SPECTROSCOPY, vol. 103, no. 1, July 2007 (2007-07), pages 86-89, XP002525956 the whole document	1-11, 14-17, 19,20

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/JP2009/050164

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

see annex

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-11,14-17,19,20

Detection scheme where the time duration of the bias is less than the time required for the avalanche current to saturate.

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2. claims: 12,13,18

Detection scheme where the time duration of the bias is larger than the time required for the avalanche current to saturate and the readout occurs at an earlier time.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/JP2009/050164

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6218657	B1	17-04-2001	NONE
WO 2008104799	A	04-09-2008	GB 2447254 A
			10-09-2008