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(71) **Applicant** (*for all designated States except US*): **GENERAL ELECTRIC COMPANY** [US/US]; 1 River Road, Schenectady, NY 12345 (US).

(72) **Inventors; and**

(75) **Inventors/Applicants** (*for US only*): **HOPKINS, Forrest, Frank** [US/US]; 414 Harmony Mills Lofts, Cohoes, NY 12047 (US). **LEE, Susanne, Madeline** [US/US]; 77 Fonda Road, Cohoes, NY 12047 (US). **EDIC, Peter, Michael** [US/US]; 55 Manning Boulevard, Albany, NY 12203 (US).

(74) **Agents:** **THOMAS, Jonathan, E.** et al.; General Electric Company, Global Patent Operation, P.O. Box 861, 2 Corporate Drive, Suite 648, Shelton, CT 06484 (US).

(81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Declarations under Rule 4.17:

 - *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
 - *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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Declarations under Rule 4.17:

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Published:

- with international search report (Art. 21(3))

[Continued on next page]

- (54) Title:** A MULTI-ENERGY IMAGING SYSTEM AND METHOD USING OPTIC DEVICES

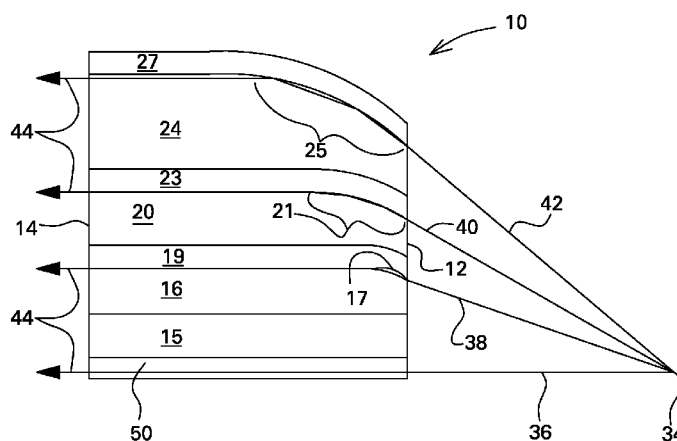


FIG. 3

- (57) Abstract:** A multi-energy imaging system and method for selectively generating high-energy X-rays and low-energy X-ray beams are described. A pair of optic devices are used, one optic device being formed to emit high X-ray energies and the other optic device being formed to emit low X-ray energies. A selective filtering mechanism is used to filter the high X-ray energies from the low X-ray energies. The optic devices have at least a first solid phase layer having a first index of refraction with a first photon transmission property and a second solid phase layer having a second index of refraction with a second photon transmission property. The first and second layers are conformal to each other.



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:
20 August 2009

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/085312

A. CLASSIFICATION OF SUBJECT MATTER

INV. G21K1/06 G21K1/10 H01J35/16

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)

G21K H01J H05G

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	WO 01/08162 A (UNIV CALIFORNIA [US]) 1 February 2001 (2001-02-01)	1,7,8, 11-13, 16,18, 23-26 2,17,27
Y	page 7, line 25 - page 8, line 24 page 9, line 9 - page 10, line 7 page 23, line 17 - page 24, line 15 page 25, lines 12-14 page 28, line 24 - page 29, line 4 page 30, lines 13-28 figures 1,2,6,10,12	
Y	US 4 684 565 A (ABELES BENJAMIN [US] ET AL) 4 August 1987 (1987-08-04) column 11, line 16 - column 12, line 11	2,17,27



Further documents are listed in the continuation of Box C.



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

8 April 2009

Date of mailing of the international search report

07/07/2009

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

Angloher, Godehard

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/085312

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.:
1, 2, 7, 8, 11-13, 16-18, 23-27

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, 2, 7, 8, 11 - 13, 16 - 18, 23 - 27

The subject-matter of independent claims 1, 7, 11, 12, 24, and of dependent claims 8, 13, 16, 18, 23, 25, 26 refers to an apparatus ("optic assembly", "array of optic devices", "multi energy imaging system") or to a method ("method for forming a low energy spectrum image", "method for manufacturing a multi-energy imaging system") for transmitting X-rays of a certain energy range and, as the case may be, filtering / redirecting certain energies of the transmitted X-rays.

In particular, transmission of the X-rays through a corresponding optic component is obtained through at least one of total internal reflection, diffraction, and refraction. This optic component comprises at least three conformal solid phase layers, wherein interfaces between these layers are gapless and wherein these layers include at least one X-ray redirection region.

A corresponding filter component may be external to the optic component or integral to the optic component. Also the filter component may comprise at least three conformal and gapless solid phase layers that layers include at least one X-ray redirection region.

The apparatus / method may also include a target that is configured to form X-rays upon being struck by electrons from a source of electrons, as e.g. within an evacuated X-ray tube.

additional subject-matter of dependent claims 2, 17, 27:
the filter component comprises at least one roughened interface surface;

2. claims: 3, 19, 28

apparatus / method according to independent / dependent claims 1, 12 / 18, 24 / 25;
additional subject-matter of dependent claims 3, 19, 28:
the filter component comprises a filter wheel;

3. claims: 4, 20, 29

apparatus / method according to independent / dependent claims 1, 12 / 18, 24 / 25

additional subject-matter of dependent claims 4, 20, 29:
the filter component comprises a dopant;

4. claims: 5, 21, 30

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

apparatus / method according to independent / dependent
claims 1, 12 / 18, 24 / 25

additional subject-matter of dependent claims 5, 21, 30:
the filter component comprises a vapor deposited or
chemically plated material on an input or an output face of
the optic component;

5. claims: 6, 22, 31

apparatus / method according to independent / dependent
claims 1, 12 / 18, 24 / 25

additional subject-matter of dependent claims 6, 22, 31:
the filter component comprises a choice of different
materials in said optic component that determine the
critical angle for total internal reflection, wherein the
critical angle determines the highest X-ray energies
transmitted by said optic component;

6. claim: 9

apparatus according to independent claim 7;

additional subject-matter of dependent claim 9:
the optic component and the filter component comprise
opposing halves of a single optic device;

7. claims: 10,15

apparatus according to independent / dependent claims 7, 12
/ 13;

additional subject-matter common to dependent claims 10 and
15:
the optic component is configured to pass high X-ray
energies and the filter component is configured to pass low
X-ray energies;

8. claim: 14

apparatus according to independent / dependent claim 12 /
13;

additional subject-matter of dependent claim 14:
multiple accelerating voltages between the source of
electrons and the target enhance a separation between high
and low X-ray energy spectra;

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2008/085312

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
WO 0108162	A	01-02-2001	AU	7328700 A		13-02-2001
			US	6278764 B1		21-08-2001
US 4684565	A	04-08-1987	CA	1252664 A1		18-04-1989
			EP	0183471 A2		04-06-1986
			JP	61128199 A		16-06-1986