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

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(54) Title: NUCLEAR RADIATION SHIELDS, SHIELDING SYSTEMS AND ASSOCIATED METHODS

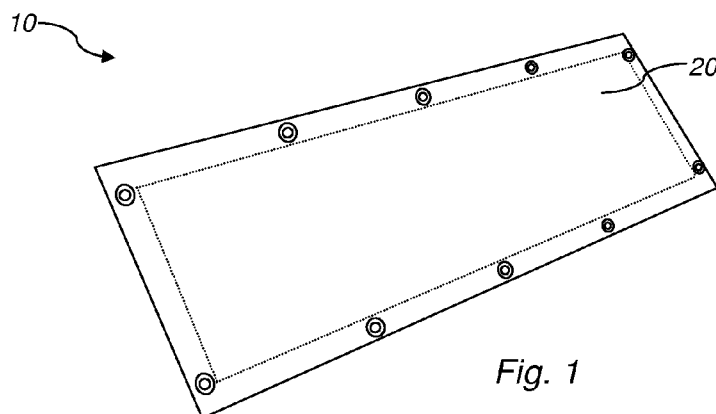


Fig. 1

(57) Abstract: A radiation shield, which may attenuate nuclear radiation or ionizing particles, may include a non-toxic, radioactivity-attenuating material based on an element or an elemental species having an atomic number, of 56 or more. Examples of such materials include barium sulfate and bismuth oxide. A radiation shield may include two or more different radioactivity-attenuating materials, which may attenuate different types of nuclear radiation or ionizing particles, or attenuate different energy ranges of nuclear radiation or ionizing particles. Different radioactivity-attenuating materials may be carried by different layers of the radiation shield. Radiation shields with at least partially superimposed layers are also disclosed.



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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/067333

**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 extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying 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.:  
1-10

**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.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/067333

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G21F 5/00 (2014.01)

USPC - 252/584

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) - G21C 11/00; G21F 5/00, 06 (2014.01)

USPC - 250/507.1, 515.1, 519.1; 252/582, 584

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

CPC - G21C 11/00; G21F 5/00, 06 (2014.02)

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

PatBase, Google Patents, Google

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| X         | US 2009/0198007 A1 (WANG) 06 August 2009 (06.08.2009) entire document              | 1, 6-10               |
| Y         |  | 2-5                   |
| Y         | US 2008/0296541 A1 (HAMILTON et al.) 04 December 2008 (04.12.2008) entire document | 2-5                   |
| A         | US 2004/0124374 A1 (JOSEPH) 01 July 2004 (01.07.2004) entire document              | 1-10                  |
| A         | US 6,232,383 B1 (JOSEPH) 15 May 2001 (15.05.2001) entire document                  | 1-10                  |
| A         | US 8,067,758 B2 (POPA-SIMIL et al) 29 November 2011 (29.11.2011) entire document   | 1-10                  |

☐ 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

"E" earlier application or patent 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

"&amp;" document member of the same patent family

Date of the actual completion of the international search

11 August 2014

Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/067333

Continuation of Box III.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-10, drawn to a shell; a radioactivity limiting element including: at least one non-toxic, radioactivity attenuating material based on an element having an atomic number of 56 or greater; a polymer holding the particles together.

Group II, claims 11-20, drawn to a plurality of layers that are at least partially superimposed relative to one another and are enabled to move longitudinally relative to one another.

Group III, claims 21-27, 34-36, drawn to a first radioactivity attenuating material; and a second radioactivity attenuating material.

Group IV, claims 28-32, drawn to a pliable component.

Group V, claims 33, drawn to a flowable component to be applied to coat a substrate.

The inventions listed as Groups I, II, III, IV and V do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a shell; a radioactivity limiting element including: at least one non-toxic, radioactivity attenuating material based on an element having an atomic number of 56 or greater; a polymer holding the particles together as claimed therein is not present in the invention of Groups II, III, IV or V. The special technical feature of the Group II invention: a plurality of layers that are at least partially superimposed relative to one another and are enabled to move longitudinally relative to one another as claimed therein is not present in the invention of Groups I, III, IV or V. The special technical feature of the Group III invention: a first radioactivity attenuating material; and a second radioactivity attenuating material as claimed therein is not present in the invention of Groups I, II, IV or V. The special technical feature of the Group IV invention: a first radioactivity attenuating material; and a second radioactivity attenuating material.

Group IV, claims 28-32, drawn to a pliable component as claimed therein is not present in the invention of Groups I, II, III or V. The special technical feature of the Group V invention: a flowable component to be applied to coat a substrate as claimed therein is not present in the invention of Groups I, II, III or IV.

Groups I, II, III, IV and V lack unity of invention because even though the inventions of these groups require the technical feature of a shield for attenuating nuclear radiation or ionizing particles having a radioactivity attenuating material, this technical feature is not a special technical feature as it does not make a contribution over the prior art. Specifically, US 8,067,758 B2 (POPA-SIMIL et al) 29 November 2011 (29.11.2011) abstract, figures 4, 10-11, 20, column 1, lines 34-40, column 5, lines 27-42.

Since none of the special technical features of the Group I, II, III, IV or V inventions are found in more than one of the inventions, unity of invention is lacking.