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(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, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
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MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
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TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,

[Continued on next page]

(54) Title: METHODS FOR SEPARATING MIXTURES

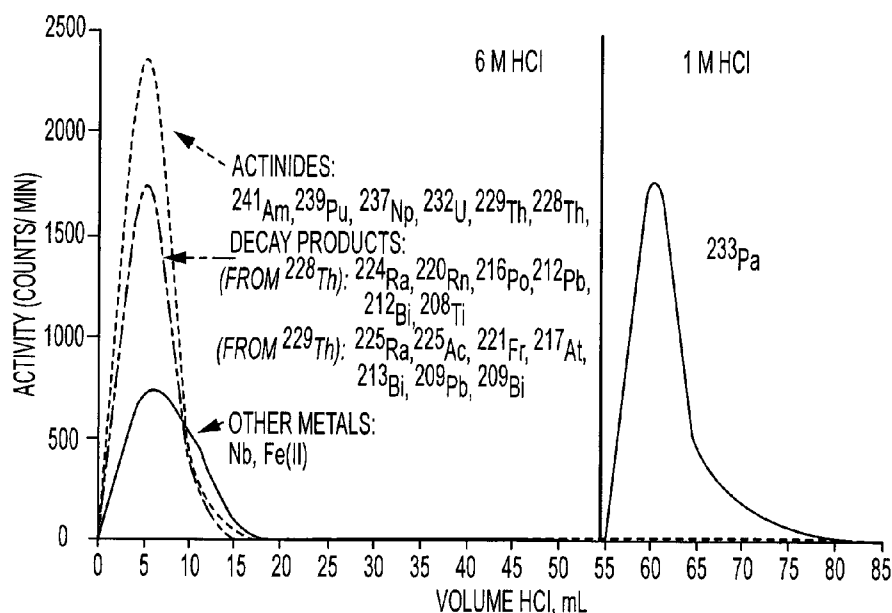


FIG. 1

(57) Abstract: This application discloses the method for separating element or isotopes such as protactinium and gallium and iso-
topes thereof from a corresponding mixture which method comprises contacting the mixture with a carbon-based separation material,
wherein the carbon- based separation material selectively associates with the element or isotope thereof.



DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT,
LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE,
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(88) Date of publication of the international search report:

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/42526

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C22B 60/02; C01G 15/00; G21F 9/12; B01D 15/08 (2015.01)

CPC - C01G 15/003; G21C 19/42; G21G 4/08; G21F 9/007; C22B 60/00

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) - C22B 60/02; C01G 15/00; G21F 9/12; B01D 15/08 (2015.01)

CPC - C01G 15/003; G21C 19/42; G21G 4/08; G21F 9/007; C22B 60/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Patents and non-patent literature (classification, keyword; search terms below)Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Scholar (NPL), Google Patents; search terms: separating protactinium, gallium, removing, carbon-based separation material, graphene, graphite, mesoporous carbon, sorbent, ordered structure, crystalline, CMK-3, 233Pa, 231Pa, 68Ga, surface, coating, hydroxyl, carboxyl, oxide

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	US 4865823 A (MINAGAWA et al.) 12 September 1989 (12.09.1989) col 1, ln 6-9; col 2, ln 15-32, 41-43, 47-48; col 3, ln 7-9, 26-30, 43-47	1, 6, 29, 38, 45-48 ----- 2-5, 12, 41-44, 51
X	CN 103301652 A (NORTHWEST INST NUCLEAR TECH) 18 September 2013 (18.09.2013) para [0002], [0004], [0006], [0045], [0050]; claim 1	29, 39
Y --- A	Chi et al. "Comprehensive study of mesoporous carbon functionalized with carboxylate groups and magnetic nanoparticles as a promising adsorbent" Journal of Colloid and Interface Science [online] March 2012 [retrieved on 16 October 2014]. Retrieved from the Internet: <URL: http://www.researchgate.net/publication/221739861_Comprehensive_study_of_mesoporous_carbon_functionalized_with_carboxylate_groups_and_magnetic_nanoparticles_as_a_promising_adsorbent > entire document	2-5, 12, 41-44, 51 ----- 30-37 and 40
A	Karakassides. "Synthesis and Characterization of Mesoporous Carbon Hybrids for Environmental Applications" [online] March 2011 [retrieved on 16 October 2015]. Retrieved from the Internet <URL: http://nanosystemy.upol.cz/upload/26/olomouc-23-3-2011.pdf > pg 4-5	2-5, 12, 41-44, 51
A	US 3808320 A (KAISER et al.) 30 April 1974 (30.04.1974) col 3, ln 7-8, 40-46	30-37 and 40
A	US 3110555 A (SHAFFER et al.) 12 November 1963 (12.11.1963) col 1, ln 11-16; col 3, ln 63-73; claim 1	30-37 and 40

☐ 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

"&" document member of the same patent family

Date of the actual completion of the international search

19 October 2015 (19.10.2015)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/42526

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.: 7-11, 13-28, 49-50
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:

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.:

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.