Placeholder Sheet for Supplemental Content

Application Number: 18680605 Document Date: 05/31/2024

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Form Revision Date: March 1, 2024

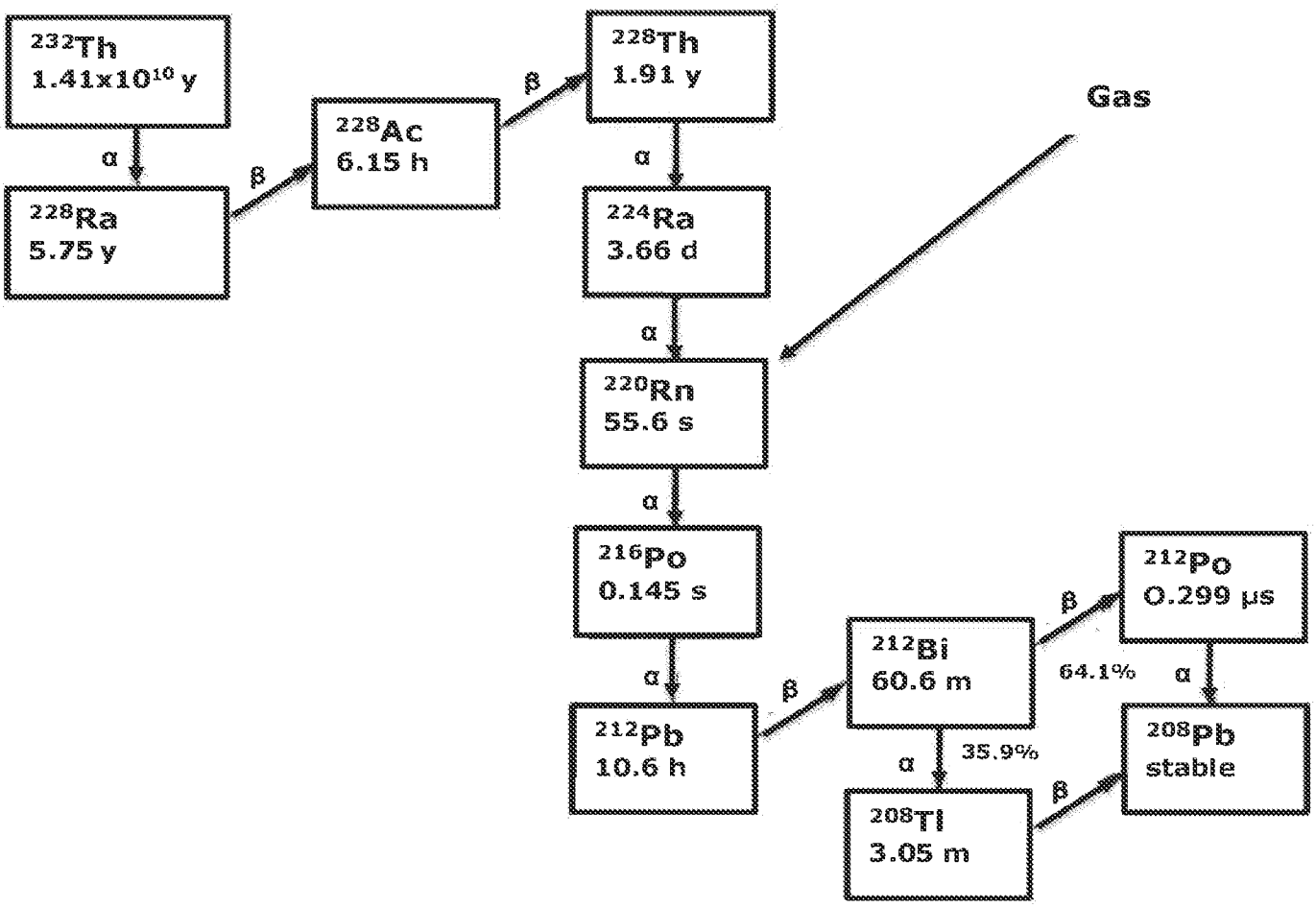

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212Pb
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212Bi
60.6 m
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Fig. 1

Figure 2A

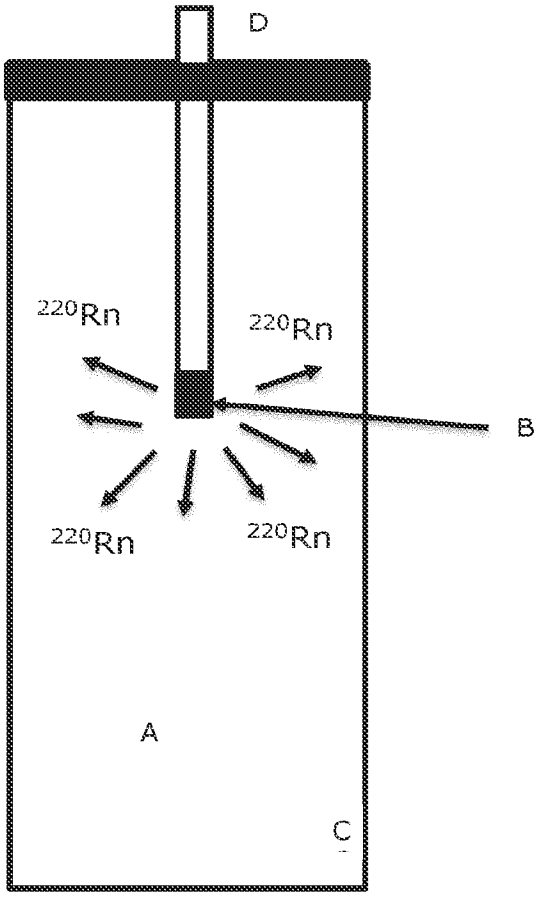


Figure 2B

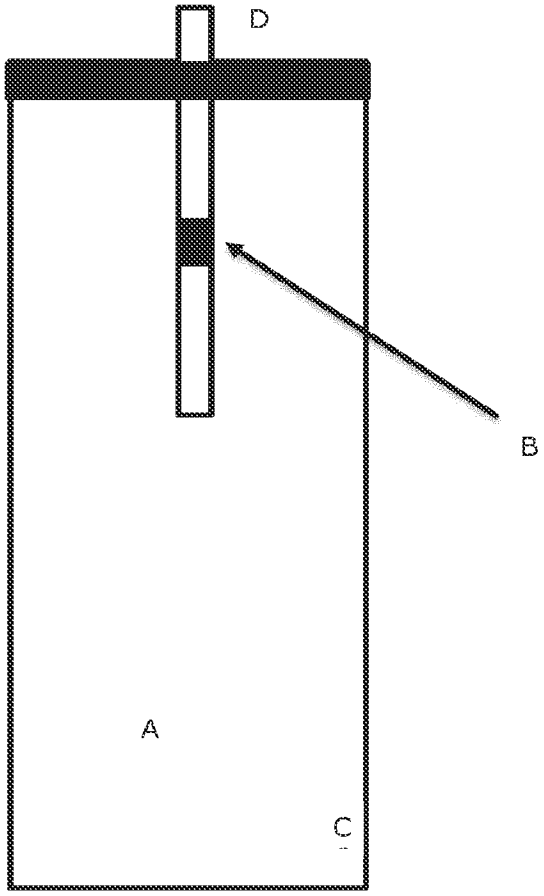


Fig 2

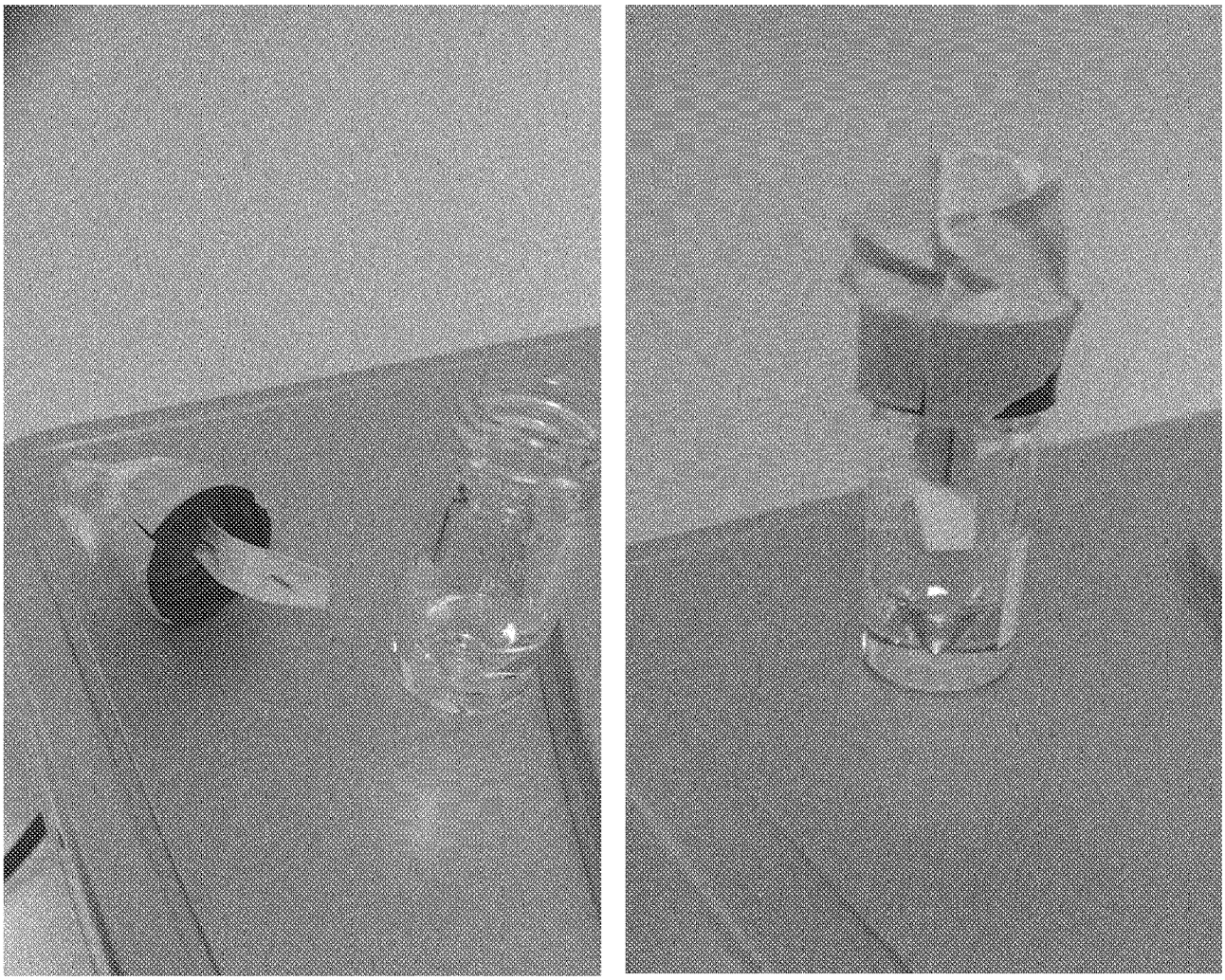


Fig 3

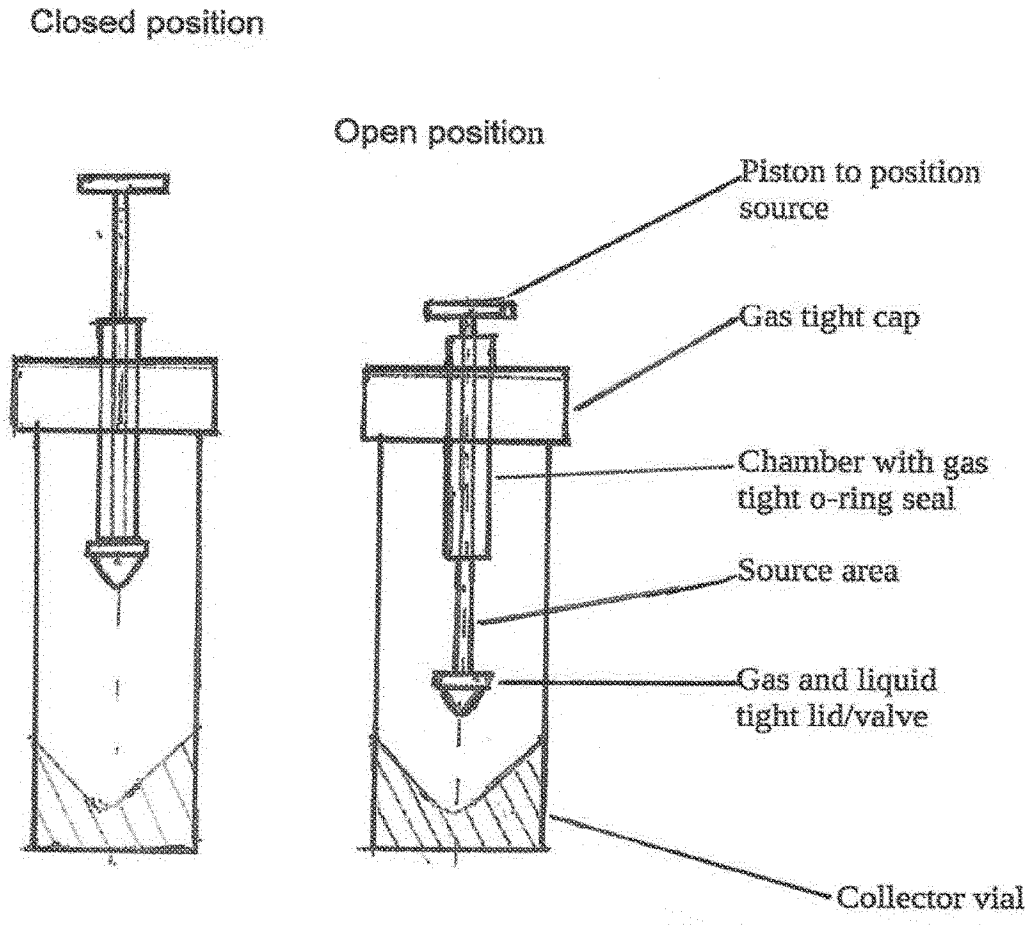

Closed position
Open position
Piston to position source
Gas tight cap
Chamber with gas tight o-ring seal
Source area
Gas and liquid tight lid/valve
Collector vial

Fig 4



Fig 5

FORM PTO-1449/A and B (modified PTO/SB/08)	APPLICATION NO.: Not Yet Assigned	ATTY. DOCKET NO.: A1389.70001US02
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	FILING DATE: Concurrently Herewith	CONFIRMATION NO.: Not Yet Assigned
	FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet 1 of 1	GROUP ART UNIT: Not Yet Assigned	EXAMINER: Not Yet Assigned

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		Number	Kind Code		
		3,453,196		Sporek	07-01-1969
		7,476,370	B2	Mitsugashira et al.	01-13-2009
		2006-0022127	A1	Zyuzin	02-02-2006
		2015-0170776	A1	Torgue et al.	06-18-2015
		2018-0047474	A1	O'Hara	02-15-2018

FOREIGN PATENT DOCUMENTS

Examiner's Initials #	Cite No.	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)
		Office/ Country	Number	Kind Code			
	*	EP	0 466 290	A1	Brunswick Corporation	01-15-1992	

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
	*	International Search Report for PCT Application No. PCT/EP2020/084701 dated February 17, 2021.	

[NOTE – No copies of U.S. patents, published U.S. patent applications, or pending, unpublished patent applications stored in the USPTO's Image File Wrapper (IFW) system, are included. See 37 CFR § 1.98 and 1287OG163. Copies of all other patent(s), publication(s), unpublished, pending U.S. patent applications, or other information listed are provided as required by 37 CFR § 1.98 unless 1) such copies were provided in an IDS in an earlier application that complies with 37 CFR § 1.98, and 2) the earlier application is relied upon for an earlier filing date under 35 U.S.C. § 120.]

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

*a copy of this reference is not provided as it was previously cited by or submitted to the office in a prior application, Serial No. 17/756,802, filed June 2, 2022, and relied upon for an earlier filing date under 35 U.S.C. 120 (continuation, continuation-in-part, and divisional applications).

DOCKET NO.: A1389.70001US02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	Not Yet Assigned
Confirmation No.:	Not Yet Assigned
Filed:	Concurrently Herewith
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	Not Yet Assigned
Art Unit:	Not Yet Assigned

MAIL STOP AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATEMENT FILED PURSUANT TO THE DUTY OF DISCLOSURE UNDER 37 C.F.R. §§ 1.56, 1.97 AND 1.98

Commissioner:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the undersigned requests consideration of this Information Disclosure Statement.

PART I: Compliance with 37 C.F.R. § 1.97

This Information Disclosure Statement has been filed within three months of the filing date of a national application other than a continued prosecution application under 37 C.F.R. § 1.53(d).

No fee or certification is required.

PART II: Information Cited

The undersigned hereby makes of record in the above-identified application the information listed on the attached form PTO-1449 (modified PTO/SB/08). The order of presentation of the references should not be construed as an indication of the importance of the references.

The undersigned hereby makes the following additional information of record in the above-identified application.

The undersigned would like to bring to the Examiner's attention the enclosed search report or other communication from a corresponding or related International or Foreign National Application:

Serial No.	Date of Mailing	Type(s) of Communication	Docket No.
PCT/EP2020/084701	**02-17-2021**	***International Search Report and Written Opinion**	**n/a**

*a copy of this reference is not provided as it was previously cited by or submitted to the office in a prior application, Serial No. 17/756,802, filed June 2, 2022, and relied upon for an earlier filing date under 35 U.S.C. 120 (continuation, continuation-in-part, and divisional applications).

PART III: Remarks

Documents cited anywhere in the Information Disclosure Statement are enclosed unless otherwise indicated. It is respectfully requested that:

1. The Examiner consider completely the cited information, along with any other information, in reaching a determination concerning the patentability of the present claims;

2. The enclosed form PTO-1449 (modified PTO/SB/08) be signed by the Examiner to evidence that the cited information has been fully considered by the United States Patent and Trademark Office during the examination of this application;

3. The citations for the information be printed on any patent which issues from this application.

By submitting this Information Disclosure Statement, the undersigned makes no representation that a search has been performed, of the extent of any search performed, or that more relevant information does not exist.

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, material to patentability as defined in 37 C.F.R. § 1.56(b).

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, in fact, prior art as defined by 35 U.S.C. § 102, or an admission by Applicant as prior art.

Notwithstanding any statements by the undersigned, the Examiner is urged to form his or her own conclusion regarding the relevance of the cited information.

An early and favorable action is hereby requested.

The Director is hereby authorized to charge any deficiency or credit any overpayment in the fees occasioned by the filing of this Information Disclosure Statement to our Deposit Account No. 23/2825 under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Respectfully submitted,

Electronic signature: /Jeffrey C. Harrigan/
Jeffrey C. Harrigan
Registration No.: 79,725
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
617.646.8000

Docket No.: A1389.70001US02
Date: May 31, 2024

Application Data Sheet

Inventor Information

Inventor Number::	1
Given Name::	Roy
Middle Name::	H.
Family Name::	Larsen
City of Residence::	Oslo
Country of Residence::	Norway
Street of mailing address::	Sørbråtveien 12
City of mailing address::	Oslo
Country of mailing address::	Norway
Postal or Zip Code of mailing address::	0891

Correspondence Information

Correspondence Customer Number::	23628

Application Information

Application Type::	Nonprovisional
Subject Matter::	Utility
CD-ROM or CD-R?::	None
Sequence submission?::	None
Computer Readable Form (CRF)?::	No
Title::	PRODUCTION OF HIGHLY PURIFIED 212PB

Attorney Docket Number::	A1389.70001US02
Request for Early Publication?::	No
Request for Non-Publication?::	No
Total Drawing Sheets::	5
Small Entity?::	Yes
Petition included?::	No
Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2::	No

Representative Information

Representative Customer Number::	23628

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::	Prior Appl Status::
This Application	Continuation of	17/756802	06/02/22	Pending
17/756802	a 371 of international	PCT/EP2020/084701	12/04/20	

Foreign Priority Information

Country::	Application number::	Filing Date::	Priority Claimed::	DAS Access::
EP	20172038.0	04/29/20	Yes	
EP	19213759.4	12/05/19	Yes	

Applicant Information

Applicant Number::	1
Applicant Type::	Assignee
Organization Name::	Sciencons AS
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City of mailing address::	Oslo
Country of mailing address::	Norway
Postal or Zip Code of mailing address::	NO-0484

Assignee Information Including Non-Applicant Assignee Information

Assignee Number::	1
Organization Name::	Sciencons AS
Street of mailing address::	Gullhaugveien 7
City of mailing address::	Oslo
Country of mailing address::	Norway
Postal or Zip Code of mailing address::	NO-0484

Authorization or Opt-Out of Authorization to Permit Access

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Jeffrey C. Harrigan/	Date (YYYY-MM-DD)	2024-05-31
Name	Jeffrey C. Harrigan	Registration Number	79,725

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**05/31/2024 04:32:12 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Christine Doyle
PATENT CENTER #	65758161	FILING DATE	-
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jeffrey Harrigan

Documents

TOTAL DOCUMENTS: 15

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
A138970001US02-TRN-JCH.pdf	1	Transmittal of New Application	33 KB
A138970001US02-FEE1-JCH.pdf	1	Fee Worksheet (SB06)	32 KB
A138970001US02-FEE2-JCH.pdf	1	Fee Worksheet (SB06)	27 KB
A138970001US02-TRK1-JCH.pdf	1	Track One Request	34 KB
A138970001US02-ADS-JCH.pdf	5	Application Data Sheet	62 KB

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A138970001US02-UTLAPL-JCH.pdf		31	-	4924 KB
A138970001US02-UTLAPL-JCH-SPEC.pdf	(1-25)	25	Specification	4876 KB
A138970001US02-UTLAPL-JCH-CLM.pdf	(26-30)	5	Claims	38 KB
A138970001US02-UTLAPL-JCH-ABST.pdf	(31-31)	1	Abstract	8 KB
A138970001US02-DRW-JCH.pdf		5	Drawings-other than black and white line drawings	1692 KB
A138970001US02-PAMN-JCH.pdf		3	-	24 KB
A138970001US02-PAMN-JCH-A.PE.pdf	(1-1)	1	Preliminary Amendment	16 KB
A138970001US02-PAMN-JCH-SPEC.pdf	(2-2)	1	Specification	18 KB
A138970001US02-PAMN-JCH-REM.pdf	(3-3)	1	Applicant Arguments/Remarks Made in an Amendment	18 KB
A138970001US02-INVDEC-JCH.pdf		2	Oath or Declaration filed	3530 KB
A138970001US02-IDSBODY-JCH.pdf		3	Transmittal Letter	26 KB
A138970001US02-IDS1449-JCH.pdf		1	Information Disclosure Statement (IDS) Form (SB08)	24 KB

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Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
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A138970001US02-UTLAPL-JCH-ABST.pdf	473730F54B49414B5A39F54908DC88FFC08FAD165D2511289C4C618C3A13E01ABD240EAAA0AD0F4BB3E7F4B167516345B1A9C5C414937C210F91DF09B7A2B992
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A138970001US02-PAMN-JCH-A.PE.pdf	12157FD5F3304B4A08F9113D6C8E1D04BA8C06F08DB40403924D15D60142894A87C36CD4651B42A23DBF7F0100D9D2F98A953092F63EB25F2FFCEA7095A75079
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/17i (11-23)
Approved for use through 05/31/2024. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number

PROCESSING FEE Under 37 CFR 1.17(i) TRANSMITTAL

(Fees are subject to annual revision)

Send completed form to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Application Number	Not Yet Assigned
Filing Date	Concurrently Herewith
First Named Inventor	Roy H. Larsen
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Practitioner Docket No.	A1389.70001US02

Enclosed is a paper filed under 37 CFR § 1.102(e) that requires a processing fee (37 CFR 1.17(i)(1) or (2)).
Payment of $ 56.00 is enclosed.

This form should be included with the above-mentioned paper and faxed or mailed to the Office using the appropriate Mail Stop, if applicable. For transmittal of petition fees under 37 CFR 1.17(f), (g) or (h), see form PTO/SB/17p or PTO/AIA/17p, as applicable.

[x] Applicant asserts small entity status. See 37 CFR 1.27.

[ ] Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

Payment of Fees

[x] The Commissioner is hereby authorized to charge the following fees to Deposit Account No. 23/2825 :

[x] processing fee under 37 CFR 1.17(i)(1) [ ] processing fee under 37 CFR 1.17(i)(2) [x] any deficiency of fees and credit of any overpayments

[ ] Check in the amount of $ _____ is enclosed. [x] Payment via USPTO's patent electronic filing system.

[x] Payment by credit card ~~(Form PTO-2038 or equivalent is enclosed)~~. Do not provide credit card information on this form.

Processing Fees Under 37 CFR 1.17(i)(1):

Undiscounted Fee $140 (Fee Code 1053) Small Entity Fee $56 (Fee Code 2053) Micro Entity Fee $28 (Fee Code 3053)

For papers filed under:
§ 1.28(c)(3) - for processing a non-itemized fee deficiency based on an error in small entity status.
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§ 1.71(g)(2) - for processing a belated amendment under § 1.71(g).
§ 1.102(e) - for requesting prioritized examination of an application.
§ 1.103(b) - for requesting limited suspension of action, continued prosecution application for a design patent (§ 1.53(d)).
§ 1.103(c) - for requesting limited suspension of action, request for continued examination (§ 1.114).
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Processing Fees Under 37 CFR 1.17(i)(2):

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SUBMITTED BY					
Signature	/Jeffrey C. Harrigan/	Registration No. (Attorney/Agent)	79,725	Telephone	617.646.8000
Name (Print/Type)	Jeffrey C. Harrigan			Date	May 31, 2024

Docket No.: A1389.70001US02
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	Not Yet Assigned
Confirmation No.:	Not Yet Assigned
Filed:	Concurrently Herewith
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	Not Yet Assigned
Art Unit:	Not Yet Assigned

FIRST PRELIMINARY AMENDMENT UNDER 37 C.F.R. § 1.115

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

INTRODUCTORY COMMENTS

Prior to examination on the merits, please amend the above-identified U.S. patent application as follows:

Amendments to the Specification begin on page 2 of this amendment.

Remarks/Arguments begin on page 3 of this amendment.

AMENDMENTS TO THE SPECIFICATION

Please insert the following heading and paragraph on page 1, directly after the title and before the FIELD section:

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation of U.S. Application Serial No. 17/756,802, filed June 2, 2022, which is a national stage filing under 35 U.S.C. § 371 of International Patent Application Serial No. PCT/EP2020/084701, filed December 4, 2020. Foreign priority benefits are claimed under 35 U.S.C. § 119(a)-(d) or 35 U.S.C. § 365(b) of European application number 20172038.0, filed April 29, 2020 and European application number 19213759.4, filed December 5, 2019. The entire contents of these applications are incorporated herein by reference in their entirety.

REMARKS

The Specification has been amended to update the priority claim.

The pending application is believed to be in condition for substantive examination.

Dated: May 31, 2024

Respectfully submitted,

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Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (11-23)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Roy H. Larsen	Nonprovisional Application Number (if known):	Not Yet Assigned
Title of Invention:	PRODUCTION OF HIGHLY PURIFIED 212PB		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.
2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.
3. The applicable box is checked below:

I. [x] **Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)**

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via USPTO patent electronic filing system.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. [ ] **Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)**

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via USPTO patent electronic filing system.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature	/Jeffrey C. Harrigan/	Date	May 31, 2024
Name (Print/Typed)	Jeffrey C. Harrigan	Practitioner Registration Number	79,725

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required. **

[ ] *Total of 1 forms are submitted.

Production of highly purified ^{212}Pb

FIELD

The present invention relates to a single chamber diffusion generator (assembly), assemblies and method for obtaining a container comprising ^{212}Pb on the walls obtained from a ^{212}Pb precursor isotope source. The invention provides an improved system and method for producing ^{212}Pb in high purity without the need for processing, with high yields, and which safely and efficiently can be transported to the locations where it is to be used.

BACKGROUND

Assemblies for preparing or producing ^{212}Pb have previously been described and based on ^{228}Th bound to stearate in a chamber with another chamber for collecting the ^{212}Pb after ^{220}Rn has diffused from the first chamber (source chamber) to the second chamber (collector chamber).

In another system the $^{228}Th/^{224}Ra$ was extracted from one vessel with a pump generated airflow and $^{220}Rn/^{212}Pb$ collected in another vessel. The system consisted of an "air loop" for transportation of ^{220}Rn and a "fluid loop" for ^{212}Pb rinsing and after rinse collection. This is a quite complex system which is not suitable for shipment and handling, and the potential for leakage or inappropriate use in for example a hospital is significant.

In another system an emanator source is placed inside one chamber and a gas flow passes through and carry ^{220}Rn to another chamber where $^{220}Rn/^{212}Pb$ is collected. After some time, the carrier gas valve is closed, and the collection unit is added a liquid through a top valve and the liquid is collected through a bottom valve. This system is as well relatively complex. Both of these systems need significant work effort of skilled workers and relatively advanced lab equipment and space to operate.

Also, generator systems for ^{212}Pb not relying on ^{220}Rn emanation and diffusion has been presented previously. In one existing generator system ^{224}Ra is bound to ion exchange material and the ^{212}Pb extracted by elution with acid which must be evaporated before it can be used for radiolabeling in another existing system the ^{212}Pb in a solution with ^{224}Ra is used for labelling following the removal of ^{224}Ra by size exclusion purification. Both these methods are working but requires extra time for processing, more so for the first method than the second.

^{212}Pb has a half-life of only 10.6 h. This half-life makes the radioisotope idea for medical applications such as anti-cancer treatment because it acts on its target and without prolonged side effects from a long half-life. However, this feature also makes is difficult to use in a commercial setting involving centralized production and long-distance shipment to end users simply because it decays fast which gives lower yields over time.

Thus a challenge for the current emanation and diffusion systems is transport distances which can reduce efficiency significantly due to decay of ^{220}Rn before reaching the collection vessels. For example, one system reported a total yield from a 3 days operation of 2.01 MBq ^{212}Pb collected compared from a ^{228}Th source of 7.05 MBq, *i.e.* less than 30% yield. Increasing the operation time did not increase the amount collected and the system was sensitive to the air flow rate.

There is a need for alpha-emitter therapeutics for biomedical applications. Lead-212 (^{212}Pb) is a beta-emitter that decays to short lived progenies producing alpha particles and can thus act as an alpha emitter generator *in vivo* useful in alpha emitter therapeutics.

This industry therefore needs an improved system and method for producing ^{212}Pb in high purity without the need for processing, with high yields, and which safely and efficiently can be transported to the locations where it is to be used.

SUMMARY

An object of the present invention relates to a method for obtaining a container comprising ^{212}Pb on the walls comprising the steps of providing an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, connecting the first part and the second part such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container and such that a single chamber container assembly is provided, allowing the ^{212}Pb precursor isotope source sufficient time to decay to progenies ^{220}Rn, ^{216}Po, or ^{212}Pb, and sufficient time for ^{220}Rn, ^{216}Po and/or ^{212}Pb to settle onto the inner walls of the single chamber container assembly, removing or isolating the remaining ^{212}Pb precursor isotope from the single chamber assembly without having the ^{212}Pb precursor isotope source come into contact with an inner wall of the single chamber container assembly, and obtaining a container comprising ^{212}Pb on an inner wall of the container and substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. The described system may be termed a single chamber diffusion generator for ^{212}Pb.

In the following, precursor isotope is defined as a mother nuclide, grandmother nuclide, great grandmother nuclide etc. for ^{212}Pb i.e., ^{216}Po, ^{220}Rn, ^{224}Ra etc.

A further object of the present invention relates to an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container, and such that a single chamber container assembly is provided.

Yet another object of the present invention relates to a single chamber container assembly comprising a first part and a second part, wherein the first part comprises a container and the

second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container.

In one or more embodiments of the invention the single chamber container assembly is gas tight.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is selected from the group consisting of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and/or ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{228}Th and ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th.The ^{212}Pb activity may vary from typically 0% to 114% of the ^{224}Ra precursor activity in the generator depending on the ingrowth status. The ^{212}Pb activity can be at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % of the ^{224}Ra precursor activity.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{228}Th measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{224}Ra measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the total amount of radioactivity in the single chamber container assembly is 1 kBq – 100 GBq.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in the form of an inorganic or organic salt, such as $RaCl_2$.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is bound to a non-radioactive material, such as particles or a holding material.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a dry form or in a liquid solution, such as an aqueous solution or a dispersion.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a liquid solution that is at acidic, neutral or basic pH.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere that is made of a material suitable for application of a liquid.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers, cellulose.

In one or more embodiments of the invention a strip or sphere is attached to the second part, which comprises means for holding the strip or sphere, such as a rod.

In one or more embodiments of the invention the second part comprises a syringe, or wherein the rod is the syringe.

In one or more embodiments of the invention the syringe tip has been pushed through a rubber cap.

In one or more embodiments of the invention the second part comprises a rod that is attached to the means for opening and closing the container.

In one or more embodiments of the invention the means for opening and closing the container is a cap, cover or a lid.

In one or more embodiments of the invention the cap, cover or a lid is made of a material selected from the group consisting of rubber, glass, paper, plastic, metal, ceramic, and natural or synthetic fibers.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is placed on or in a sphere, suitable for holding the source but allowing radon diffusion.

In one or more embodiments of the invention the container comprises a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the gas permeable barrier impervious to the ^{212}Pb precursor isotope source is in contact with the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the container does not comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the volume of the container is 1 µl to 10 liters, such as 1 µl to 1 liter, such as 100 µl to 10 ml, such as 100 µl to 100 ml.

In one or more embodiments of the invention the substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container is less defined as less than 3 % ^{224}Ra of the ^{212}Pb

precursor isotope source, such as less than 1 %, such as less than 0,5 %, as measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the inner walls of the container are coated. The coating may be a film of salt or other suitable material on the inner walls.

In one or more embodiments of the invention the inner walls of the container are coated with a compound that comprises a chelator which can complex with ^{212}Pb.

In one or more embodiments of the invention the inner walls of the container are coated with a chelator which is TCMC or a variant hereof.

In one or more embodiments of the invention the container comprises an aqueous or an oil solution.

DETAILED DESCRIPTION

The present inventors have in response to the need for a simpler, safer system with less size and transport distances to handle the short half-life of ^{220}Rn and ^{212}Pb, designed an assembly whereby the radon producing source is placed inside the collector chamber or container. Instead of using ^{228}Th only as a source is the present invention flexible and can able to use pure ^{224}Ra or a combination of ^{228}Th or ^{224}Ra as source, or even their precursor isotopes (Figure 1).

The assembly of the present inventions can be made very compact and very simple, allowing for a shippable and disposable ^{212}Pb-generator unit. In the present context is assembly, diffusion generator and system are used interchangeably. The described assembly or system may therefore be termed a single chamber diffusion generator for ^{212}Pb.

Thus, an object of the present invention relates to a method for obtaining a container comprising ^{212}Pb on the inner walls comprising the steps of providing an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, connecting the first part and the second part such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container and such that a single chamber container assembly is provided, allowing the ^{212}Pb precursor isotope source sufficient time to decay to progenies ^{220}Rn, ^{216}Po, and/or ^{212}Pb, and sufficient time for ^{220}Rn, ^{216}Po and/or ^{212}Pb to settle onto the inner walls of the single chamber container assembly, removing or isolating the remaining ^{212}Pb precursor isotope from the single chamber assembly without having the ^{212}Pb precursor isotope source come into contact with an inner wall of the single chamber container assembly, and obtaining a container comprising ^{212}Pb on an inner wall of the container and substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. Examples of such containers or assemblies are described in the examples of the present disclosure and can also be seen in figures 2-5.

An aspect of the invention relates to a method of obtaining a ^{212}Pb solution comprising obtaining the above container comprising ^{212}Pb on the walls and collect the ^{212}Pb in a solution. The ^{212}Pb can be collected in a solution that is in the container before the ^{212}Pb is generated or using a solution that is introduced to the container after the ^{212}Pb has been generated, and then collected. The collection can be done for example using a syringe.

A further object of the present invention relates to an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container, and such that a single chamber container assembly is provided.

Yet another object of the present invention relates to a single chamber container assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container.

A huge advantage with the described assembly (or also defined herein as a container, system or a generator) is the ability to supply ^{212}Pb without the activity level is dictated by the short (10.6 h) half-life of ^{212}Pb. With the described system it is possible to produce a diffusion generator in a centralized production facility and ship it to the end user. A portable disposable generator could be made and shipped to *e.g.* a hospital from one end or the world to the other. For such a disposable unit, a pure ^{224}Ra (without ^{228}Th) is preferable as this would become inactive after 40-50 days approximately avoiding generation of long-lived radioactive waste. Such a diffusion source will steadily produce ^{220}Rn/^{212}Pb in a fashion dictated by the half-life of ^{224}Ra (Table 1 and Figure 1). The container, comprising the ^{212}Pb precursor isotope source, will produce ^{212}Pb due to the nature of decaying isotopes. The amount of ^{212}Pb deposited on will depend on several factors including the choice of ^{212}Pb precursor isotope source and time. The time is an important factor. An object of the invention relates to a method for preparing a substantially pure ^{212}Pb solution, the method comprising obtaining the assemblies and containers described herein, wherein the ^{212}Pb precursor isotope source is kept in the sealed assemblies and containers for a given time, the ^{212}Pb precursor isotope source is isolated or removed without coming into contact, and the ^{212}Pb on the walls are then collected by adding a solution that is suitable for collecting the ^{212}Pb. The time that the ^{212}Pb precursor isotope source is kept in the assemblies and containers of the present invention can be from minutes, to hours, to days, to years, depending on the choice of ^{212}Pb precursor isotope source and the amount of ^{212}Pb needed. The time can be at least one day. The time can be at least one day. The time can be at least two days. The time can be at least four

days. The time can be at least a week. The time can be at least two weeks. The time can be at least two weeks. The time can be at least a month. The time can be at least a year.

^{212}Pb is a member of the thorium natural radionuclide series and can be found in materials containing ^{232}Th ($t_{1/2}$=1.4x10^{10} years). The ^{212}Pb precursor can therefore be chosen based on the intended use. A precursor with longer half-life can be chosen to generate an assembly or system that that will act as a ^{212}Pb generator for continuous production over a longer period of time. Alternatively, an isotope with a shorter half-life be used is the intended use for example is at a hospital or similar where generation of long-lived radioactive waste can be problematic. Naturally a mix of different precursors will therefore also be relevant and also where specific assemblies are needed for the generation of a specific amount of ^{212}Pb over a specific period of time.

Thus, in one or more embodiments of the invention the ^{212}Pb precursor isotope source is selected from the group consisting of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and/or ^{224}Ra. Thus, in the following ^{212}Pb precursor isotope is defined as a mother nuclide, grandmother nuclide, great grandmother nuclide etc. for ^{212}Pb, *i.e.* ^{216}Po, ^{220}Rn, ^{224}Ra ^{228}Th, ^{228}Ac, ^{228}Ra, ^{232}Th.

The decay of these radioisotopes can be seen in figure 1 which clearly indicate the possibility of creating a ^{212}Pb precursor isotope source with different decay profiles and different combinations of precursor isotopes will be able to generate ^{212}Pb at different rates over different periods of time.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{228}Th and ^{224}Ra. The source can also be each of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra individually, but due to the decay will a mixture naturally over time occur because ^{232}Th will decay to ^{228}Ra and so on. The key is that the gaseous ^{220}Rn is produced because it will diffuse from the source and later settle on the inner walls of the container as ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{228}Th measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th. The ^{212}Pb activity may vary from typically 0% to 114% of the ^{224}Ra precursor activity in the generator depending on the ingrowth status. The ^{212}Pb activity can be at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 20 % of the ^{224}Ra

precursor activity. The ^{212}Pb activity can be at least at least 30 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 40 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 50 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 60 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 70 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 80 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 90 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 100 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 110 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 20 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 30 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 40 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 50 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 60 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 70 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 80 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 90 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 100 % of the ^{224}Ra precursor activity.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{224}Ra measured as % radioactivity relative to ^{212}Pb.

The assembly working as a ^{212}Pb generator unit can be mass produced in a centralized production facility and shipped to end users for application in production of radiopharmaceuticals. It can also be adapted and used for large scale centralized production of ^{212}Pb. Thus, the amount of radioactivity in the assembly can adjusted according to its intended use. In one or more embodiments of the invention will the total amount of radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 kBq – 100 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 kBq – 10 MBq. The total amount of radioactivity in the single chamber container assembly can be 100 kBq – 10 MBq. The total amount of radioactivity in the single chamber container assembly can be 1 MBq – 1 GBq. The total amount of radioactivity in the single chamber container assembly can be 10 MBq – 10 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 MBq – 1 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 GBq – 100 GBq.

In one or more embodiments of the invention will the amount of ^{212}Pb radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as

100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq. In one or more embodiments of the invention will the amount of ^{212}Pb precursor isotope source radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq.

The ^{212}Pb precursor isotope source can be in different forms, sizes and shapes depending on the application type. Thus, in one or more embodiments of the invention the ^{212}Pb precursor isotope source is in the form of an inorganic or organic salt, such as $RaCl_2$. The ^{212}Pb precursor isotope source can also be in a dry form or in a liquid solution, such as an aqueous solution or a dispersion. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a liquid solution that is at acidic, neutral or basic pH. The pH can be 1-14, such as pH 1-6, pH 2-6, pH 2-8, pH 4-8, pH 5-7, pH 6-8, pH 7-8, pH 7,2, pH 8-10, pH 8-12, or pH 10-14.

The solution can be an aqueous solution. The solution can be a 0,1M aqueous HCl solution. This solution can also be used to dissolve the ^{212}Pb on the walls of the assembly.

The assembly working as a generator system may be used for preparing single patient dosing or for multiple patient dosing, or even for industrial use. The amount of radioisotope can therefore be adjusted depending on the application of the assembly.

The ^{212}Pb precursor isotope source can be placed on the rod, either directly or on a strip attached to the rod, typically in a very small liquid volume. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere that is made of a material suitable for application of a liquid. Such liquid can be in the amount of 1 µl to 1 ml, such as 1 µl to 10 µl, such as 1 µl to 100 µl.

When the container, which can be a vial, can be empty or contain a small volume of liquid in the bottom, that is not touching the source. In one or more embodiments of the invention the container comprises an aqueous or an oil solution.

It is important that the source does not drip or chip of in a fashion that causes cross contamination of the inner surfaces of the collector unit (container) with source material and that the source and source holder can be removed and or withdrawn from the collector without causing cross contamination by contact.

In one or embodiments the source is surrounded by a grid or encapsulated in a porous material to reduce risk of cross-contamination. This encapsulation can be a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

Thus, in one or more embodiments of the invention the container does or does not comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is placed on or in a sphere, suitable for holding the source but allowing radon diffusion. The container may comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source, and the gas permeable barrier impervious to the ^{212}Pb precursor isotope source can be in contact with the ^{212}Pb precursor isotope source. In one or more embodiments of the invention the single chamber container assembly is gas tight.

Figure 2 shows an example of the single chamber container assembly where the container (the first part) is connected with a cap and a rod attached to the cap is used to hold the ^{212}Pb precursor isotope source (the second part) without having this source touch an inner wall of the container during the entire process.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source can therefore be bound to a non-radioactive material, such as particles or a holding material. These can ensure that the source does not contaminate the container. The ^{212}Pb precursor isotope source can be deposited on a strip, sphere or a rod which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers. The strip or sphere can be attached to the second part or be contained or comprised in the second parts, which comprises means for holding the strip or sphere. Such means can for example be a rod.

In one or more embodiments of the invention the second part comprises, optionally, a rod that is attached to the means for opening and closing the container. The means for opening and closing the container can be a cap, cover or a lid which can be made of a material selected from the group consisting of rubber, glass, paper, plastic, metal, ceramic, and natural or synthetic fibers, cellulose ion exchange resin, natural mineral, polymer. Alternatively, the source is attached to a material placed onto the cap with or without being adhered to the cap. If the cap is placed on the bottom, the source material can be simply placed onto the interior of the cap without touching the ^{212}Pb collector part and kept in place by gravitation. In such case the generator unit should be stored and handled in position whereby cap with the source is always kept at the bottom.

The means for opening and closing the container can comprise the ^{212}Pb precursor isotope source. The ^{212}Pb precursor isotope source can be placed on a sponge, a wool or another substance that is capable of keeping the ^{212}Pb precursor isotope source in the means for opening and closing the container. The wool can be a quartz wool. The wool can also be a mineral wool. The wool can also be a glass wool. The substance that is capable of keeping the ^{212}Pb precursor isotope source in the means for opening and closing the container can be attached by glue, double-sided mounting tape or other means for attachment.

In one or more embodiments of the invention the second part comprises a syringe, or wherein the rod is the syringe. The means for holding can be deposited on a strip or sphere which is made of

material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers cellulose ion exchange resin, natural mineral, polymer.

In one or more embodiments of the invention the syringe tip has been pushed through a rubber cap. An alternative design is where the second part is a rubber cap, or septum of another material permeable, and preferential self-sealing, with a syringe tip, with means for holding the ^{212}Pb precursor isotope source attached to the cap or to the inner walls of the container. In this case will user of the assembly be able to dissolve the ^{212}Pb from the inner walls of the container in an aqueous solution though a syringe that is pushed through the cap. The resulting ^{212}Pb in aqueous solution can afterwards be collected by the same syringe which will generate the option of working in a GMP environment which can be directly applied for patient use. Thus, in one embodiment the ^{212}Pb precursor isotope source be withdrawn into a capsule or similar allowing the container to be washed e.g., by using a solution transferred via a syringe through a rubber septum, without having to disassemble the two units. In another embodiment the assembly can be autoclaved, and the solution be of a physiological acceptable composition containing a chelator for disease targeting allowing withdrawal into a syringe and direct infusion with or without the use of a sterile syringe filter. In one embodiment the assembly including all subunits is autoclavable and with a syringe permeable zone on the cap allowing aseptic extraction of ^{212}Pb from the assembly.

After a few hours or days of operation the assembly with the ^{212}Pb precursor isotope source can be used for producing ^{212}Pb by retracting the ^{212}Pb precursor isotope source, e.g., by changing the cap with the attached ^{212}Pb precursor isotope source to a new cap without radioactivity and washing the inner surface with a suitable solution to dissolve surface deposited ^{212}Pb and progenies. Since the ^{212}Pb solution is free from long lived predecessor radionuclides it can be used directly without further chemical processing to label carrier molecules for e.g. cancer therapy.

The ^{212}Pb precursor isotope source can associated with a needle, rod or a strip of a material of which ^{212}Pb precursor isotope source is attached to allow diffusion of ^{220}Rn. The source may or may not contain a holder for the radioactive part and a grid or ring or similar surrounding the source to prevent cross contamination when the ^{212}Pb precursor isotope source is withdrawn from the container. In one embodiment it may be attached to a screw cap that can be used to close the container. The ^{212}Pb precursor isotope source can be isolated from the container by withdrawing the source into a cover. This will ensure that the source does not cross contaminate the inner walls of the container while the ^{212}Pb is extracted, and also limit risk of exposure to the user of the assembly. It is important that after a period of decay the ^{212}Pb precursor isotope source and the ^{212}Pb adsorbed onto the vial inner surfaces can be separated by withdrawing the ^{212}Pb precursor isotope source form the container, e.g. by replacing the screw cap of which the source is attached by a rod or similar with a standard gas tight screw cap. Thus, In one special embodiment is the ^{212}Pb precursor isotope source equipped with a retractable radioactive source that is withdrawn

into the cap similar to a "click pen system" or similar for isolating the source from the generator units interior surfaces and thus not require the disassembling and replacement of the cap (e.g. Figures 2 and 4). Thus, the second part of the assembly can comprise a piston that can be in open and closed positions. The second part of the assembly can also comprise a chamber with a gas tight o-ring seal. In one or more further embodiments the assembly comprises a gas and liquid tight lid or valve in the second part.

The second part of the assembly can, optionally, comprise a needle, rod or strip which may be supplied with a small ball of a material that can absorb radium or thorium including glass wool, quartz wool, mineral wool, metal, paper, cotton, stearate or another fatty acid, metal, cellulose, natural mineral, polymer, ion exchange resin, or other fibrous material. The composition of the holder of the precursor isotope should be chosen with care according to the known affinity of radon for various materials. A material that ^{228}Th and or ^{224}Ra has a good adsorption or absorption to and ^{220}Rn has a low affinity for would be suitable. The container can be made of a glass (including quartz), polymer and or metal, such as a glass vial, with a screw cap or similar, whereby the source is attached to the screw cap. The container (or assembly) can be a glass flask placed up-side down and with for example quartz wool with ^{224}Ra or ^{228}Th placed in the center of the inside of the cap. ^{212}Pb can be produced by unscrewing the flask standing up-side down from the cap with the source, and thereafter washing the interior of the flask with a solution to dissolve ^{212}Pb. The container can have a volume of 1 µl to 10 liters, such as 1 µl to 1 liter, such as 100 µl to 10 ml, such as 100 µl to 100 ml. The volume will depend on the use, where single use generally will be smaller and industrial batch containers will be larger.

Minimizing risk of cross contamination is important and the assembly has to be designed so that the ^{212}Pb precursor isotope source does not come into contact with the inner walls of the container. Thus, in one or more embodiments of the invention the container is substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. The definition of substantially free depends on use of the ^{212}Pb produced in the assembly. In one or more embodiments of the invention is "substantially free" defined as less than 3 % ^{224}Ra of the ^{212}Pb precursor isotope source, such as less than 1 %, such as less than 0,5 %, as measured as % radioactivity relative to ^{212}Pb. In one or more embodiments of the invention, the substantially free refers to the purity of ^{212}Pb vs ^{224}Ra in a solution from the walls of the container. This purity can be better than 95 %. This purity can be better than 98 %. This purity can be better than 99 %. This purity can be better than 99,5 %. This purity can be better than 99,8 %.

The container is surrounding, but not touching, the ^{212}Pb precursor isotope source. This should be made of an appropriate material, for example glass, plexiglass, metal, ceramics, polymer including polypropylene and Teflon or other materials suitable for allowing deposition of ^{220}Rn and/or ^{212}Pb on its inner walls and allowing ^{212}Pb to be dissolved when washed with a suitable solution for

further use in radiolabeling. A solution can be used to wash the inner walls of the container to extract radionuclides, mainly ^{212}Pb and progenies. It may be present during the ^{212}Pb production period in the assembly or be applied after the ^{212}Pb precursor isotope source has been removed or withdrawn. In one embodiment the solution and an acidic or alkaline solution that can be transferred and neutralized before use for administration to a patient. In one embodiment the solution may be water of a suitable purity for pharmaceutical use. Solution volume of 1 ul to 1 liter for single dosing, e.g. 100 ul to 10 ml, and 1 ul to 10 liter or higher for multiple dosing may be used.

The container may or may not contain a surface film on the inner surfaces or some liquid to assist in collecting the diffusion product. This surface film can for example be a coating. Size and volume may be in microliter to ml for single dosing units and in microliters to tens of liters or higher for multiple dosing. The inner walls of the container can be coated. This coating can ensure that ^{212}Pb settles in an optimal way. In one or more embodiments of the invention the inner walls of the container are coated with a compound that comprises a chelator which can complex with ^{212}Pb. It is also possible that the inner walls are coated with one or more compounds where a complex with ^{212}Pb is needed. In one or more embodiments of the invention the inner walls of the container are coated with a chelator capable of chelating ^{212}Pb. This chelator can be TCMC or a variant hereof. The coating may be a film of salt or other suitable material on the inner walls.

In a special embodiment the container is washed directly with the reaction solution containing the complexing agent to yield a radiolabeling solution which after a suitable reaction time can be used directly for therapeutic purposes. In one embodiment the final product solution is autoclaved and or sterile filtered before administration to a subject in need thereof.

In one embodiment the assembly can be attached to a flushing and filtering circuit whereby when the source is retraced from the chamber a reservoir of a solution is connected and an outlet with a sterile filter and a syringe or vacuum pump is attached to flush the chamber and collect the flushing solution, *e.g.*, in similar fashion as for ^{99m}Tc-generators.

In general, surface ratios between precursor source holder and the collector chamber inner surfaces should be optimized so that as much as possible of the generated ^{212}Pb settles on the collector chamber surfaces. The surfaces may be smooth, or porous or may contain structures to increase surface area relative to the diffusion subunit, container or assembly.

The production can be a production period of 5 hours, 10, hours, 20 hours or more. Afterwards the source may be withdrawn from the chamber into a tube-shaped holder or similar with a gas and liquid tight lid in the bottom that closes when the source is completely withdrawn. This allows for addition of a washing solution, *e.g.*, by a syringe, or activation of a flushing and collecting circuit *e.g.* similar to that of a ^{99m}Tc generator.

In a special embodiment the single chamber diffusion unit has its ^{212}Pb precursor isotope source as a film on the inside surfaces of the assembly and has the ^{212}Pb collector unit (container) inserted into the source covered surfaces without touching these, *i.e.* a reverse configuration compared to what is shown in figure 2.

In another embodiment the diffusion generator is subject to temperature manipulation, either elevated or reduced temperature vs 20 °C.

The use of the invention for includes in the production of radiopharmaceuticals, medical devices and or standardization sources for ^{212}Pb. The assembly of the present invention can be used to generate a ^{212}Pb standard for calibrations.

In one or more embodiments of the invention is the assembly of the present invention comprised in kit with the ^{212}Pb precursor isotope source, and a solution containing a chelator, and a compound that for use in therapy. Such compound can be a nano- or microparticle. In one embodiment such a kit will contain a ^{212}Pb precursor isotope source, a solution for washing the inner walls of the container and a solution or dry form of a carrier compound, for example a chelator, micro- or nanoparticles.

Tables

Table 1. Main radiation properties of the ^{224}Ra series.

Radionuclide (half-life)	Alphas and betas (mean energy in MeV)	X-rays and gammas Energy and % abundance
^{224}Ra (3.6 days)	α 5.6	241 keV, 4.1%
^{220}Rn (55.6 s)	α 6.3	
^{216}Po (145 ms)	α 6.8	
^{212}Pb (10.6 h)	β 0.1	75 keV, 10.3% 77 keV, 17.1% 87 keV, 6.0% 90 keV, 1.5% 239 keV, 43.6% 300 keV, 3.3%
^{212}Bi (1 h)	α 6.1 × 0.36 (2.2 MeV effective[1]) β 0.7 × 0.64 (0.4 MeV effective)	727 keV, 6.7% (4.3% effective)
^{212}Po (299 ns) (64% branch)	α 8.8 (5.6 effective)	
^{208}Tl (3.1 min) (36% branch)	β 0.6 (0.2 MeV effective)	75 keV, 3.4% (1.2% effective) 511 keV, 22.6% (8.1% effective) 583 keV, 85.0% (30.6% effective) 860 keV, 12.5% (4.5% effective) 2615 keV, 99.8% (35.9% effective)

[1]Average per ^{224}Ra transformation due to branching. Only X-rays or gammas above 1% effective abundance accounted for. Adds up to a total effective energy of approximately 26.5 MeV of alpha of 0.7 MeV of beta per complete decay of a ^{224}Ra atom via progenies to a stable ^{208}Pb atom.

Table 2. A pure ^{212}Pb source with initial 100 MBq ^{212}Pb kept sealed and emptied for ^{212}Pb only once.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	23.1	4.4	0.92	0.192

Table 3. Lead-212 production from a source with initial 100 MBq ^{224}Ra kept sealed and emptied for ^{212}Pb only once.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	70.3	72.9	63.4	53.1
70% extraction recovery (MBq ^{212}Pb) in final product	49.2	51.0	44.4	37.2

Table 4. Lead-212 production from a source with initial 100 MBq ^{224}Ra source emptied for ^{212}Pb every 24 h.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	70.3	58.2	48.1	39.8
70% extraction recovery (MBq ^{212}Pb) in final product	49.2	40.7	33.7	27.9

The following figures and examples are provided below to illustrate the present invention. They are intended to be illustrative and are not to be construed as limiting in any way.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows the decay of ^{232}Th to its progenies. The decay type (alpha or beta) is indicated and so is the half-lives. These half-lives are important because they dictate the decay rate and are therefore also key in deciding the optimal mix of isotopes as ^{212}Pb precursor isotope source for the production of ^{212}Pb.

Figure 2A shows a figure of the single chamber container assembly with the container (A), the a ^{212}Pb precursor isotope source (B) that generates the ^{220}Rn gas which is released into the single chamber container assembly and after decay settled as ^{212}Pb onto the inner walls of the container (C). The upper part of the single chamber container assembly (D) is the second part which comprises the ^{212}Pb precursor isotope source and in this case a cover/cap with a rod attached pointing towards the centre of the container thus enabling ^{212}Pb precursor isotope source release of ^{220}Rn into the container. Figure 2B shows a situation where the ^{212}Pb precursor isotope source (B) has been withdrawn into a gas tight seal that ensures that no ^{220}Rn is released into the container. The ^{212}Pb precursor isotope source can also be removed entirely from the assembly.

Figure 3 shows picture of a crude version of the generator system based on a 3 ml v-vial with an membrane inserted open top screw cap penetrated by a syringe tip (with position fixed by tape on top of screw cap) and with a strip of laboratory bench paper attached to the syringe tip (left picture shows the ^{212}Pb precursor isotope source and container). The ^{212}Pb precursor isotope source is placed onto the strip by a pipette before the screwcap with the source is carefully attached to the vial (right picture). It is very important that the source is not touching the vial when assembling and disassembling the unit to avoid cross-contamination.

Figure 4. An example of a single chamber diffusion generator for ^{212}Pb with a retractable source simplifying washout of ^{212}Pb from the inner surfaces by having syringe permeable zones on the lid supplied with septum, a syringe could be used for washing of the interior surfaces without radionuclide cross contamination when the unit is put in closed position.

Figure 5. Top picture shows a 100, 50 and 10 ml generator unit for ^{212}Pb production. Bottom pictures shows the cap with quartz wool in the center of the inner surface. The ^{212}Pb precursor nuclide solution can be placed onto the quartz wool and the flask mounted for up-side-down

storage to produce ^{212}Pb deposited on the flask' inner surface generated via ^{220}Rn diffusion from the precursor source material.

EXAMPLES

Example 1 - Calculation of the relative ^{212}Pb daughter nuclide level at various time points

Background. The development and use of pure ^{212}Pb in therapeutic radiopharmaceuticals is hampered by the short half-life (10.6 h) of the radionuclide making it almost impossible to produce a product in a centralized fashion and shipped to the end user. If ^{224}Ra is used as a short-term generator for ^{212}Pb the level of ^{212}Pb activity can be maintained essentially according to the half-life of ^{224}Ra, which is 3.6 days. The variation in ^{212}Pb level in a sealed source of pure ^{224}Ra is shown.

Method: The ingrowth of ^{212}Pb from a pure ^{224}Ra source were calculated using a universal activity calculator.

Results: Table 2 shows the amount of ^{212}Pb at various time points after the production of a pure (^{224}Ra-free) pharmaceutical solution and storage in a gas tight container. As can be seen the pure ^{212}Pb source rapidly decays and lose more than 75% per 24 h. Table 3 shows the amount of ^{212}Pb present in a sealed source of ^{224}Ra at the same time points. As can be seen the ^{212}Pb activity is maintained at a high level (> 50%) at least up to 96 h.

Table 4 shows the effect of "milking" a ^{224}Ra precursor-based generator for ^{212}Pb several times during a 96-h period.

The data also shows that significant amount of daughter nuclide is present within a relatively short time frame when starting with pure ^{224}Ra. It is noteworthy though that the ratio of ^{212}Pb to ^{224}Ra in the solution reaches 1 after 36 hours and thereafter gradually increases to about 1.1 of which is kept for the rest of the time until complete decay. In conclusion, using ^{224}Ra as a source for ^{212}Pb makes the logistic of centralized production and shipment to end users possible providing an easy way to extract the ^{212}Pb from ^{224}Ra exist.

Example 2 - Preparation of radionuclides and counting of radioactive samples

In the following, all work with the concentrated radioactive preparations including evaporation of solvent etc was performed in a glove-box. A source of ^{228}Th in 1 M HNO3 was acquired from a commercial supplier. Ac-resin was obtained from Eichrom Technologies LLC (Lisle, IL, USA) in the form of a pre-packed cartridge.

Radium-224 was made from ^{228}Th bound to Actinide resin (Eichrom Technologies, LLC) by eluting a column containing actinide resin with immobilized ^{228}Th with 1 M HCl. The eluate was purified on

a second Ac-resin column and the eluate evaporated to dryness using an evaporation vial with a cap with gas inlet and outlet placed in a heater block at approximately 110 ◦C and a gentle stream of nitrogen gas to evaporate of the solvent. When the evaporation vial was empty from solvent it was added 0.1 M HCl to dissolve the residue, typically 200-400 µl. Typically, more than 70% of the ^{224}Ra present in the ^{228}Th source could be extracted and purified using the described methods.

Radioactive samples were counted on a Cobra II Autogamma counter (Packard Instruments, Downer Grove, IL, USA). During extraction of ^{224}Ra from the ^{228}Th source, a CRC-25R dose calibrator (Capintec Inc., Ramsey, NJ, USA) was used.

Example 3 - Determining net count rate for ^{212}Pb in a $^{212}Pb/^{224}Ra$ mixture before radioactive equilibrium has been reached

After more than 3 days, i.e., "equilibrium" a sample kept gas tight will for practical purposes have 1.1 times ^{212}Pb vs ^{224}Ra.

In a gas tight unit regardless of whether ^{212}Pb is at or lower than equilibrium it can be assumed that this is reached after 3 days since surplus ^{212}Pb is reduced by 99% and the ingrowth of ^{212}Pb from ^{224}Ra is practically complete vs. "equilibrium".

Using the Cobra II Autogamma counter with a counting window setting from 70-80 KeV gives mainly the ^{212}Pb with very little contribution from other radionuclides in the ^{224}Ra series. Radium-224 must be indirectly counted when the initial ^{212}Pb has vanished and equilibrium between ^{224}Ra and ^{212}Pb has been reached (after approximately 3 days). This indirect counting requires the sample to be stored in a relatively gas tight containers as otherwise the ^{220}Rn may escape preventing the radionuclide equilibrium of 1.1 between ^{212}Pb and ^{224}Ra to be reached.

Since sampling and counting may be separated by some time, the net count rate for ^{212}Pb can be adjusted for decay to determine the net ^{212}Pb count rate at the time of sampling. By storing ^{212}Pb samples for a week or longer and remeasure, the amount of ^{224}Ra contaminant can be determined as activity after about 110 hours of storage would not be ^{212}Pb but must be from longer lived precursor isotope.

Example 4 - A simplified single chamber (diffusion chamber generator) assembly for ^{212}Pb production (Figure 3).

A 3 ml v-vial with an open top cap. The open top cap was supplied with a membrane permeable by a syringe tip. A syringe tip was pushed through the membrane and fixed with tape on top to lock the position of the tip with regard to the open top cap. On the syringe tip vas placed a strip of

absorbent paper about 0.5 X 3 cm by inserting the syringe tip in two holes in the strip. The paper strip was added 2-40 ul ^{224}Ra solution. Thereafter the cap was placed carefully onto the v-vial while the syringe tip and radioactive strip were not to touch the inside of the v-vial. Thereafter the assembly was standing for various time to produce ^{212}Pb via ^{220}Rn diffusion from the strip to the space surrounding the strip. The ^{212}Pb tended to settle on the inner surfaces of the v-vial. Depending on the liquid volumes used for applying the ^{224}Ra source onto the strip, there may be some condensation of liquid due to evaporation/condensation of the liquid applied. Alternatively, the source could be dried before assembling the unit to avoid any solvent condensation on the v-vial inner surfaces.

Example 5A: Production of ^{212}Pb with the ^{212}Pb precursor isotope source absorbed on a paper strip.

Methods: The assembly was assembled with ^{224}Ra placed on the strip of the diffusion subunit inserted in a v-vial according to Figure 3, and was standing for 17.5 h or more to produce ^{220}Rn and ^{212}Pb. Production of ^{212}Pb evaluation of radiochemical purity of product. At the end of the production period the whole unit was measured on a Capintec dose calibrator. The product was evaluated by separating the source from the container and cap the latter with a gas tight screw cap and measure immediately in the Capintec dose calibrator. The purity of the product was determined by measuring the collector subunit again after a few days when all the ^{212}Pb had decayed but the presence of longer-lived predecessor nuclides ^{224}Ra and ^{228}Th would have been measurable. Results: Highly purified ^{212}Pb was collected in the collector subunit with a relevant yield of 65.6% (range 62.7-69.9% n=4) and with no measurable longer-lived precursor nuclides present (< 0.5%). In conclusion: The assembly was effective in producing and collecting purified ^{212}Pb in an easy manner without need for further purification.

Example 5B: Production of ^{212}Pb with the ^{212}Pb precursor isotope source absorbed on a parafilm strip. The experiment from 5A was repeated except that a parafilm strip was used instead of paper a strip to carry the precursor isotope source.

Results: The yield of ^{212}Pb on the inner surfaces of the collector subunit (vial or container) was found to be only 19.3%. In contrast a unit with paper strip run in parallel with exact same configuration and emanation period gave a yield of 63.9%. In conclusion, the material used for absorbing and holding the ^{212}Pb precursor isotope source could greatly affect the yield of ^{212}Pb on the collector subunit or container.

Example 6: Dissolving of ^{212}Pb from the container using a solution.

Methods: The collector vial was added 0.3-0.5 ml 0.1 M HCl which was gently swirled to contact the inner surfaces with the liquid and counted in the Capintec dose calibrator. Thereafter the liquid was transferred to an Eppendorf tube and measured in the Capitec dose calibrator. The extraction yield was 74.0 % (range 70.0-76.9%, n=3) when the collector subunit (3 ml v-vial), was washed one single time with 0.3 ml 0.1 M HCl. In conclusion, ^{212}Pb absorbed onto the surfaces of the container was rapidly and with good yield dissolved by a solution useful for radiopharmaceutical processing.

Example 7: Thin layer chromatography analyses

Thin layer chromatography (TLC) was performed using chromatography strips (model # 150-772, Biodex Medical Systems Inc, Shirley, NY, USA). A small beaker with about 0.5 ml of 0.9% NaCl was used to place strips with a sample spot in. To the strip was typically added 1-4 µl of sample at approximately 10% above the bottom of the strip. After the solvent front had moved to about 20% from the top of the strip, the strip was cut in half and each half was placed in a 5 ml test tube for counting. In this system radiolabeled antibody and free radionuclide does not migrate from the bottom half while radionuclide complexed with EDTA migrates to the upper half. A formulation buffer (FB) consisting of 7.5% human serum albumin and 1 mM EDTA in DPBS and adjusted to approximately pH 7 with NaOH was mixed with the radioconjugates in ratio 2:1 for at least 5 minutes before application to the strips to determine free radionuclide. It was verified that in a test solution with free ^{212}Pb was the radionuclide was completely (> 99%) complexed by the EDTA, when mixed with FB, and would travel to the upper half of the TLC strip.

Example 8: In situ chelation of ^{212}Pb in solutions.

Background: The labeling properties of the ^{212}Pb extracted with 0.1 M HCl from the containers was evaluated. Methods: A 10:1 ratio of ^{212}Pb in 0.1 M HCl and 5 M ammonium acetate was used before addition of the chelators, resulting in a pH range of 5 – 6 for the reactions. Reaction times of 15-30 minutes at 37 °C, were tested. For PSMA-617 solutions of 5 µg per 100 µl was labeled with good yield of 96.6% as determined by TLC. Also, TCMC-conjugated Herceptin antibody solution of approximately 1.0 mg/ml was labeled with pure ^{212}Pb with a good yield of 98.9%. In conclusion: Lead-212 produced with the assembly was readily complexed with small molecular and large

molecular conjugates indicating suitability for use in production of ^{212}Pb based radiopharmaceuticals.

Example 9 - Production of ^{212}Pb from the ^{224}Ra source when unit is kept sealed and emptied only at one time point

Table 3, lower row, shows the example of an output from a diffusion generator emptied after various time points after insertion of the source of 100 MBq of ^{224}Ra into the unit. As shown the generator gives a relatively stable output of ^{212}Pb for up to 96 h.

Example 10 - Production of ^{212}Pb from the ^{224}Ra source when unit is emptied once a day for four days e.g. if used for fractionated radionuclide therapy etc.

Table 4 shows the output when the assembly is "milked" once every 24 h. The combined output is a total of 151.5 MBq of ^{212}Pb when starting with a 100 MBq source. In conclusion, the one chamber assembly is suitable for single dose as well as fractionated dose production.

Example 11 - Example of an assembly with a retractable source (Figure 2 and Figure 4)

The materials used may be of glass (including quartz), polymer, metal, ceramic or other suitable materials for pharmaceutical containers. The rod in figure 2 (piston in figure 4) slides in a tube with o rings or similar at the top to secure gas tight seal. The valve at the bottom of the rod is gas and liquid tight in the closed position for the unit.

In the open position the source will be exposed inside the container and emanate ^{220}Rn and cause deposit of ^{212}Pb onto the inner surface. In closed position the source is sealed off from the container (Figure 2B) and the container surfaces can be contacted with a suitable solution to dissolve ^{212}Pb.

In one embodiment where the cap has syringe permeable membrane, a sterile syringe with a sterile solution is used to extract the ^{212}Pb without removing the cap. When such unit has been autoclaved before the extraction of ^{212}Pb, the complete procedure can be performed in an aseptic/sterile fashion.

Example 12. Precursor nuclide placed onto quartz wool in a ^{212}Pb single chamber generator.

Methods: A flasks as shown in figure 5, was used. Flask size could vary and typically 10-100 ml flasks were used. When used as a generator the flask was turned-up-side down. The cap was

removed and inside of the center of the cap was placed quarts or glass wool. Radium-224 in solution was placed on the quartz wool and the flask was mounted onto the cap without touching the quartz wool with the flask. The unit was kept tight and stored in up-side-down position for a period of time to produce ^{212}Pb from ingrowth. After typical one to a few days the flask was unscrewed from the cap while being held up-side-down and carefully removed from the cap without touching the quartz wool. The cap with the source was combined with another flask and stored up side down for further ^{212}Pb production. The unscrewed ^{212}Pb containing flask was added a solution of 0.5-2 ml of 0.1 M HCl and the ^{212}Pb extracted from the flask by washing the interior surfaces and collected for use.

Results: Typically, 50-70 percent of the ^{212}Pb activity produced was found in the flask and by carefully washing more than 90% of the ^{212}Pb activity could be collected in the washing solution. The produced ^{212}Pb had a very high purity with ^{224}Ra being as low as 10^{-4} vs ^{212}Pb in newly extracted solutions. The product was very suitable for use in labeling of chelator-containing proteins and small molecules giving very high labeling yields, typically above 97%.

In conclusion, the data showed that quartz wool was very suitable for holding a ^{224}Ra source indicating that quartz/glass/mineral wool, metal wool etc would be suitable for this purpose. It would be possible to use the flask/ quartz wool system in upright position also providing the quartz wool is adhered to the capsule, e.g. with glue, double-sided mounting tape etc. In the current example the flask was used up-side down and the quartz wool was not adhered, but just placed and kept by gravity in position inside the cap.

Example 13. Up-side-down flask system version of single the chamber generator.

Flask based diffusion generator for labeling with ^{212}Pb.

Lead-212 generate therapeutic high-LET radiation as it decays via short-lived alpha emitting daughters resulting in an average of one alpha particle per ^{212}Pb decay. The half-life of ^{212}Pb of 10.6 hours is a limitation to its use and fast and safe production and purification procedures are required. If a ready to use product was to be produced in a centralized production facility and shipped to the end user, the activity level would be reduced to less than 25% in one day. Lead-212 based radioimmunoconjugate has been in clinical testing against peritoneal cancer using ^{212}Pb separated from ^{224}Ra in a cation exchange column and eluted in mineral acid which has to be reconstituted before radiolabeling. This method requires a significant work effort, facilities, and equipment suitable for evaporation of mineral acids etc to work up the ^{212}Pb from the ^{224}Ra generator material. An alternative generator method was developed and tested based on ^{224}Ra absorbed onto quartz wool and placed inside the centered ring of a removable cap (the generator cap), in a generator chamber. The chamber consists of a glass bottle turned upside down and the

removable cap supports the ^{224}Ra labeled quartz wool (Figure 5). When ^{224}Ra decays, the short-lived ^{220}Rn emanates from the quartz wool and causes absorption of the longer-living decay product, ^{212}Pb, onto the interior surfaces of the flask. The flask can be removed from the cap without the glass coming in contact with the quartz wool. After removing the flask from the generator cap, the flask can be rinsed on the inside with 0.1 M HCl to dissolve the ^{212}Pb deposits whereby a highly purified ^{212}Pb solution is made. The operation and washout of the generator flask is made prior to radiolabeling of NG001. The purity of ^{212}Pb vs ^{224}Ra in the solution is, when the generator is operated in a correct manner (i.e. that the source does not come into contact with the walls), better than 99.8%. The generator can be re-used by attaching a new glass bottle to the generator cap and store for typically 1-2 days for the generation of fresh ^{212}Pb.

In summary, the generator method is easier to use and less time consuming compared with ion exchange-based generators. The generator may be re-used several times (although with a decreasing capacity due to radioactive decay depending of source half-life).

Example 14: Size of collector flask,

The flask sizes of 10, 50 and 100 ml was tested (Figure 5, upper part). ^{224}Ra was added to quarts wool placed in the cap of flasks placed upside down. The % ^{212}Pb on the flask compared with the theoretical yield varied from about 40% to 60%. It tended to be an advantage to use a larger flask to cap inner surface volume to obtain high yield. In conclusion, flasks with various sizes could be used for generator purposes but a relatively large flask vs. cap seemed to improve ^{212}Pb yield as relatively less would be lost due to absorption on the cap and the source material.

Example 15: Materials for holding the source.

To hold the source material in place inside the generator, e.g., in the inner cap center, Steel wool, glass wool, quartz wool was tested with ^{224}Ra sources. The materials are porous and fluffy and allows for diffusion. A volume of 100-150 microliter of ^{224}Ra in 0.1 M HCl was deposited onto the materials placed inside the caps of 100 ml flasks. After standing for 2-3 days or more, 52-64% of the ^{212}Pb compared to ^{224}Ra present in the generator would have settled on the glass surfaces, so all the three materials would work. i.e., quartz wool averaged of 5 tests, 59.9% (range 52.1-64.4%), glass wool 54.9% and steel wool 64.1% for one test each as compared to ^{224}Ra activity in the generator. In conclusion, several different materials could be used to hold the source in the one chamber diffusion generator.

Example 16: Sources.

The radionuclides ^{224}Ra and ^{228}Th were used as sources inside the generators. The ^{224}Ra -based generator could be used typically repeatedly up to a few weeks while the ^{228}Th -based unit could be used repeatedly for several months and deliver ^{212}Pb by simply switching the glass flask with an unused one and wash the first flask to produce a ^{212}Pb solution. Yield was not significantly reduced with repeated use except for the decay of the generator radionuclide. As long as the sources are centered inside the cap to avoid contact with the glass bottle, and flasks and caps are kept dry, cross contamination from source to the glass flask was minimal. In conclusion, the single chamber diffusion unit could be used repeatedly for producing ^{212}Pb with both ^{228}Th and ^{224}Ra as the sources. Lead-212 activity on the inner glass surfaces from ^{228}Th a source was found to be on average 49.3% (range 40.9%-66.7%) from four tests.

Example 17: Preparation including heating: To heat up flask before mounting onto the cap with the source material could be a way to produce reduced pressure in the generator. The flask was heated to 90 °C in a heat chamber for at least 15 minutes and then the flask and cap was screwed tightly together to be gas tight. The generator unit was thereafter stored at room temperature causing reduced inner pressure. After 1-4 days the chamber was opened and the ^{212}Pb activity on the glass flask was measured. The yield from four tests using ^{224}Ra on quartz wool was on average 68.1% (range 60.5%-75.9%, indicating improved yield compared with previous data for normal pressure flasks (average 59.9%). In conclusion, reduced chamber pressure may improve the yield of ^{212}Pb with the one chamber diffusion generator.

Example 18: Yield of ^{212}Pb in the washout solution.

A standard solution of 0.1 M HCl was used for extracting the ^{212}Pb trapped on the inner glass surface of 100 ml flasks. The washing solution was carefully shaken and swirled to cover the inside of the flasks for about 2 minutes and then 80% of the volume was taken out and measured and compared with the total count of the flask before the washing procedure. It was assumed that the 80% volumes should be divided by 0.8 to determine the total activity in the liquid. With 0.6 ml about 85% was extracted and with 1 ml 93% was extracted with similar washing effort. From ^{224}Ra based generator on average 86.1% (range 79.4%-93.4%) for 8 tests was extracted from the glass bottles. From ^{228}Th based generator on average 86.5% (range 84.5%-88.5%) for two tests was extracted from the glass bottles. In conclusion, ^{212}Pb trapped on the inner glass surfaces in the generators are easily extracted with 0.1 M HCl.

Example 19. Radiolabeling reactivity of solutions:

The TCMC-chelator-based molecule NG001 (Stenberg et al 2020) was used for testing ^{212}Pb labeling with the generator extracted ^{212}Pb. Lead-212 in 0.1 M HCl was added sodium acetate to adjust pH to about 5.5. Thereafter, NG001 was added to 10-20 micrograms per ml. After 30 minutes reaction on 37 °C using a Thermomixer (Eppendorf, Germany), samples were withdrawn and thin layer chromatography (TLC) was performed by mixing the samples 1:2 with 1 mM EDTMP in 7.5 % bovine serum albumin solution and let it stand for 5 minutes. Thereafter 1-5 microliter was applied onto a chromatography strip (model # 150-772, Biodex) and eluted with 0.9% NaCl solution in a beaker. When the liquid front reached the top of the strip, it was cut in two halves, each placed in a tube and counted separately in a Packard Cobra II gamma counter (Packard Instruments Co Inc, USA). The data showed that after 3 hours the activity of the bottom half would make up typically >99% indicating almost quantitative yield. Blind test without the NG001 but all the other compounds would give less than 3 % on the bottom half of the strip indicating good selectivity for the TLC test. In conclusion, the ^{212}Pb extracted from the generator flask showed excellent reactivity, indicating suitability for radiopharmaceutical use.

Example 20. Radiochemical purity of extracted solutions.

Lead-212 solutions were stored for 10 days or more and recounted for measuring ^{224}Ra. The ^{224}Ra activity was decay corrected back to time 0. The ^{224}Ra vs ^{212}Pb was determined to be on average 0.045% (range 0.01%-0.13%). In conclusion, the ^{212}Pb produced from the generator had high radiochemical purity relevant for pharmaceutical use.

CLAIMS

1. A radioisotope generator comprising:

a solid precursor isotope source configured to emanate one or more gaseous progeny isotopes, the solid precursor isotope source comprising a precursor isotope; and

wherein the solid precursor isotope source is configured to be fluidly coupled to a volume including a collector surface with a gas tight seal, and wherein the solid precursor isotope source and the collector surface are configured such that the one or more gaseous progeny isotopes deposit one or more solid progeny isotopes on the collector surface.

2. The radioisotope generator of claim 1, further comprising a flushing circuit configured to flush the collector surface.

3. The radioisotope generator of claim 1, further comprising a valve associated with the solid precursor isotope source.

4. The radioisotope generator of claim 1, further comprising a vacuum pump attached to the volume.

5. The radioisotope generator of claim 1, wherein the solid precursor isotope source comprises a porous material configured to retain the precursor isotope.

6. The radioisotope generator of claim 5, wherein the precursor isotope is absorbed, adsorbed, and/or encapsulated by the porous material.

7. The radioisotope generator of claim 1, wherein the precursor isotope comprises a thorium 228 isotope (^{228}Th) and/or a radium 224 isotope (^{224}Ra), the one or more gaseous progeny isotopes comprises a radon 220 isotope (^{220}Rn), and the one or more solid progeny isotopes comprises a lead 212 isotope (^{212}Pb).

8. The radioisotope generator of claim 1, wherein the collector surface is an interior surface of a container, and wherein the volume is an internal volume of the container.

9. The radioisotope generator of claim 8, wherein the solid precursor isotope source is configured to be connected to an opening of the container.

10. The radioisotope generator of claim 8, further comprising the container.

11. The radioisotope generator of claim 10, wherein the container is configured to removably connected to the solid precursor isotope source.

12. The radioisotope generator of claim 10, further comprising a chelator disposed on the interior surface, the chelator configured to chelate the one or more solid progeny isotopes.

13. The radioisotope generator of claim 12, wherein the chelator comprises TCMC.

14. The radioisotope generator of claim 1, wherein the volume is configured to receive a solvent configured to dissolve the one or more solid progeny isotopes from the interior surface.

15. The radioisotope generator of claim 1, wherein the radioisotope generator is configured to be converted from a first configuration in which the collector surface is not in fluid communication with the solid precursor isotope source, and a second configuration in which the collector surface is in fluid communication with the solid precursor isotope source.

16. A method of generating a progeny radioisotope, the method comprising:

allowing one or more gaseous progeny isotopes to emanate from a solid precursor isotope source, the solid precursor isotope source comprising a precursor isotope;

fluidly coupling a volume including a collector surface to the solid precursor isotope source using a gas tight seal; and

allowing one or more solid progeny isotopes of the one or more gaseous progeny isotopes to deposit on the collector surface.

17. The method of claim 16, further comprising flushing the collector surface.

18. The method of claim 16, wherein fluidly coupling the volume to the solid precursor isotope comprises opening a valve associated with the solid precursor isotope source.

19. The method of claim 16, further comprising drawing a vacuum in the volume.

20. The method of claim 16, wherein the solid precursor isotope source comprises a porous material configured to retain the precursor isotope.

21. The method of claim 20, wherein the precursor isotope is absorbed, adsorbed, and/or encapsulated by the porous material.

22. The method of claim 16, wherein the precursor isotope comprises a thorium 228 isotope (^{228}Th) and/or a radium 224 isotope (^{224}Ra), the one or more gaseous progeny isotopes comprises a radon 220 isotope (^{220}Rn), and the one or more solid progeny isotopes comprises a lead 212 isotope (^{212}Pb).

23. The method of claim 16, wherein the collector surface is an interior surface of a container, and wherein the volume is an internal volume of the container.

24. The method of claim 23, further comprising connecting the solid precursor isotope source to an opening of the container.

25. The method of claim 23, further comprising removably connecting the solid precursor isotope to the container.

26. The method of claim 23, further comprising chelating the one or more solid progeny isotopes using a chelator disposed on the interior surface.

27. The method of claim 26, wherein the chelator comprises TCMC.

28. The method of claim 23, further comprising receiving a solvent in the volume, and dissolving the one or more solid progeny isotopes from the interior surface in the solvent.

29. The method of claim 16, wherein fluidly coupling the volume to the solid precursor isotope source comprises converting a radioisotope generator from a first configuration in which

the collector surface is not in fluid communication with the solid precursor isotope source to a second configuration in which the collector surface is in fluid communication with the solid precursor isotope source.

30. The method of claim 16, further comprising forming a radiopharmaceutical using the one or more solid progeny isotopes.

ABSTRACT

The present invention relates to assemblies and method for obtaining a container comprising ^{212}Pb on the walls obtained from a ^{212}Pb precursor isotope source. The invention provides an improved system and method for producing ^{212}Pb in high purity without the need for processing, with high yields, and which safely and efficiently can be transported to the locations where it is to be used.

US

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: AERA001.005APC

Title: PRODUCTION OF HIGHLY PURIFIED 212PB

Inventors: Roy H. Larsen

Declaration

This Declaration is directed to U.S. or International Application No. **17/756802**, filed June 2, 2022 and incorporating any amendments made thereto prior to the signature date of this Declaration.

As a named inventor, I declare that:

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 USC 1001 by fine or imprisonment of not more than five (5) years, or both.

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

Assignment from Inventors

WHEREAS, **above-identified inventors** (individual(s) hereinafter "ASSIGNOR") invented certain new and useful improvements, technology, inventions, developments, ideas, ornamental designs, or discoveries related to **PRODUCTION OF HIGHLY PURIFIED 212PB** (collectively hereinafter referred to as the "Work") for which an application for Letters Patent in the United States (identified above) has been filed or prepared for filing with the United States Patent and Trademark Office (hereinafter the "Application"), and ASSIGNOR desires to assign or confirm assignment of the Work and the Application to the below identified Assignee.

AND WHEREAS, **Sciencons AS,** with its principal place of business at **Gullhaugveien 7, NO-0484 Oslo, Norway** (hereinafter the "ASSIGNEE"), desires to acquire or confirm ownership of the entire right, title, and interest in and to the Application and the Work.

NOW, THEREFORE, for good and valuable consideration of which receipt is hereby acknowledged, ASSIGNOR hereby acknowledges that ASSIGNOR has sold, assigned, transferred, and set over, and by these presents does hereby sell, assign, transfer, and set over, unto said ASSIGNEE, **its** successors, legal representatives, and assigns, the entire right, title, and interest throughout the world in and to the Application and the Work, including: all provisional applications relating to the Work and the Application; all nonprovisional applications claiming priority to aforementioned provisional(s) and/or the Application, including, all divisions, continuations, continuations-in-part, and reissues, and all Letters Patent of the United States which may be granted thereon and all reissues and extensions thereof; and all rights of priority under International Conventions and any related Letters Patent which may hereafter be granted or filed in any country or countries foreign to the United States, all extensions, renewals, and reissues thereof.

ASSIGNOR hereby authorizes and requests the Commissioner for Patents of the United States, and any Official of any country or countries foreign to the United States, whose duty it is to issue patents on applications as aforesaid, to issue all related Letters Patent to the ASSIGNEE, **its** successors, legal representatives, and assigns.

COMBINED DECLARATION & ASSIGNMENT (37 CFR 1.63(e))

Application Data Sheet filed previously or concurrently

Docket No.: AERA001.005APC

Title: PRODUCTION OF HIGHLY PURIFIED 212PB

Inventors: Roy H. Larsen

AND ASSIGNOR DOES HEREBY acknowledge and agree that the assigned scope of the Application and the Work includes any currently recited claims, all embodiments, and all claims supported by the Application; Assignor agrees not to contest or disparage claim scope thus supported (including in any later-filed continuing patent applications) for any claims deemed patentable by any government patent office. Assignor also agrees not to challenge the validity, including as a defense to patent infringement, of any issued patent claims resulting from or based on the Work, regardless of the scope of any such claims.

AND ASSIGNOR DOES HEREBY sell, assign, transfer, and convey to ASSIGNEE, **its** successors, legal representatives, and assigns all claims for damages and all remedies arising out of any violation of the rights assigned hereby that may have accrued prior to the date of assignment to ASSIGNEE, or may accrue hereafter, including, but not limited to, the right to sue for, collect, and retain damages for past infringements of said Letters Patent before or after issuance.

AND ASSIGNOR DOES HEREBY covenant and agree that ASSIGNOR will: communicate to said ASSIGNEE, **its** successors, legal representatives, and assigns any facts known to ASSIGNOR respecting the Work; testify in any legal proceeding; assist in the preparation of any other Patent Property relating to the Application and the Work or any improvements made thereto; sign/execute all lawful papers; authorize the filing of, execute, and make all rightful oaths and/or declarations in connection with the Application and the Work including any improvements made thereto, any patent applications filed therefrom, and any continuing application filed from any of the aforementioned applications; and generally do everything possible to aid the ASSIGNEE, **its** successors, legal representatives, and assigns, to obtain and enforce proper patent protection for the Work in all countries.

AND ASSIGNOR DOES HEREBY agree that if any term or provision of this agreement becomes invalid or unenforceable, the remainder shall survive unaffected.

Legal Name of Inventor: Roy H. Larsen

Signature: Roy Larsen Date: 9 June 2022

Witnessed by:

Witness Name (printed): EMANUEL OSTUNI

55725328

PTO/AIA/15 (10-17)
Approved for use through 05/31/2024. OMB 0651-0032
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	A1389.70001US02
First Named Inventor	Roy H. Larsen
Title	PRODUCTION OF HIGHLY PURIFIED 212PB
Priority Mail Express® Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [X] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [X] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [X] **Specification** [*Total Pages* 31] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [X] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 5]
6. **Inventor's Oath or Declaration** [*Total Pages* 2] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   - a. [ ] Newly executed (original or copy)
   - b. [X] A copy from a prior application (37 CFR 1.63(d))
7. [X] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   - [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   - a. [ ] Computer Readable Form (CRF)
   - b. [ ] Specification Sequence Listing on:
     - i. [ ] CD-ROM or CD-R (2 copies); or
     - ii. [ ] Paper
   - c. [ ] Statements verifying identity of above copies

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [ ] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [X] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    - [ ] Copies of citations attached
14. [X] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [X] **Other:** - Fee Transmittal for Processing Fee Under 37 CFR 1.17(i) (PTO/SB/17i) - Certification and Request for Prioritized Examination under 37 CFR1.102(e)

***Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS). (2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[X] The address associated with Customer Number: 23628 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Jeffrey C. Harrigan/	Date	May 31, 2024
Name (Print/Type)	Jeffrey C. Harrigan	Registration No. (Attorney/Agent)	79,725

FEE TRANSMITTAL

Complete if known	
Application Number	Not Yet Assigned
Filing Date	Concurrently Herewith
First Named Inventor	Roy H. Larsen
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Practitioner Docket No.	A1389.70001US02

[x] Applicant asserts small entity status. See 37 CFR 1.27.

[ ] Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

TOTAL AMOUNT OF PAYMENT ($)2,960.00

METHOD OF PAYMENT (check all that apply)

[ ] Check [x] Credit Card [ ] Money Order [ ] None [ ] Other (please identify): _____

[x] Deposit Account Deposit Account Number: 23/2825 Deposit Account Name: Wolf, Greenfield & Sacks, P.C.

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

[ ] Charge fee(s) indicated below

[ ] Charge fee(s) indicated below, **except for the filing fee**

[x] Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17, **except for any excess claims fees or multiple dependent claim fee**

[ ] Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17

[x] Credit any overpayment of fee(s)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

	FILING FEES			SEARCH FEES			EXAMINATION FEES			
Application Type	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**Fees Paid ($)**
Utility	320	128*	64	700	280	140	800	320	160	664.00
Design	220	88	44	160	64	32	640	256	128	
Plant	220	88	44	440	176	88	660	264	132	
Reissue	320	128	64	700	280	140	2,320	928	464	
Provisional	300	120	60	0	0	0	0	0	0	

* The $128 small entity status filing fee for a utility application is further reduced to $64 for a small entity applicant who files the application via Patent Center or EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	**Undiscounted Fee ($)**	**Small Entity Fee ($)**	**Micro Entity Fee ($)**
Each claim over 20 (including Reissues)	100	40	20
Each independent claim over 3 (including Reissues)	480	192	96
Multiple dependent claims	860	344	172

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
30	- 20 or HP =	10	x 40.00	=	400.00

HP = highest number of total claims paid for, if greater than 20.

Multiple Dependent Claims

Fee ($)	**Fee Paid ($)**

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
2	- 3 or HP =		x	=	

HP = highest number of independent claims paid for, if greater than 3.

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $420 ($168 for small entity) ($84 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**	**Fee ($)**	**Fee Paid ($)**
27	- 100 =		/50 =	(round **up** to a whole number) x		=

4. OTHER FEE(S)

	Fees Paid ($)
Non-English specification, $140 fee ($56 small entity) ($28 for micro entity)	
Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, $400 fee ($200 small or micro entity)	
Other (e.g., late filing surcharge): 2817 Request for prioritized examination	1,680.00
2830 Processing fee, except in provisional applications	56.00
2054 Non-DOCX filing surcharge	160.00

SUBMITTED BY

Signature	/Jeffrey C. Harrigan/	Registration No. (Attorney/Agent)	79,725	Telephone	617.646.8000
Name (Print/Type)	Jeffrey C. Harrigan			Date	May 31, 2024

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**05/31/2024 07:36:45 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Christine Doyle
PATENT CENTER #	65761777	FILING DATE	-
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jeffrey Harrigan

Documents

TOTAL DOCUMENTS: 0

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C.

371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**05/31/2024 08:48:21 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Christine Doyle
PATENT CENTER #	65762282	FILING DATE	-
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jeffrey Harrigan

Documents

TOTAL DOCUMENTS: 0

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C.

371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**05/31/2024 10:04:24 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Eileen MacKenzie
PATENT CENTER #	65762642	FILING DATE	-
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jeffrey Harrigan

Documents

TOTAL DOCUMENTS: 0

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)

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APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	05/31/2024 10:04:24 PM Z ET	A1389.70001US02

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

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CONFIRMATION #	5167	FILED BY	Eileen MacKenzie
PATENT CENTER #	65762642	AUTHORIZED BY	Jeffrey Harrigan
CUSTOMER #	23628	FILING DATE	-
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Roy H. Larsen

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 9236	E20245UM05568708	Eileen MacKenzie
PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY	
232825	37 CFR 1.16 (National application filing, search, and examination fees)	

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2817	REQUEST FOR PRIORITIZED EXAMINATION	1680.00	1	1680.00
2111	UTILITY PATENT APPL. SEARCH FEE	280.00	1	280.00
4011	BASIC FILING FEE- UTILITY	64.00	1	64.00
2311	EXAMINATION OF ORIGINAL PATENT APPLICATION	320.00	1	320.00
2054	Non-DOCX Filing Surcharge	160.00	1	160.00

2830	PROCESSING FEE, EXCEPT IN PROVISIONAL APPLICATIONS	56.00	1	56.00
2202	EACH CLAIM IN EXCESS OF 20	40.00	10	400.00
			TOTAL AMOUNT:	**$2,960.00**

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New Applications Under 35 U.S.C. 111

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
18/680,605	05/31/2024		1224	A1389.70001US02	30	2

CONFIRMATION NO. 5167

23628
WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

FILING RECEIPT

OC000000074146116

Date Mailed: 06/18/2024

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Roy H. Lar, Oslo, NORWAY;

Applicant(s)

Sciencons AS, Oslo, NORWAY;

Assignment For Published Patent Application

Sciencons AS, Oslo, NORWAY

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 17/756,802 06/02/2022
which is a 371 of PCT/EP2020/084701 12/04/2020

Foreign Applications (You may be eligible to benefit from the Patent Prosecution Highway program at the USPTO. Please see http://www.uspto.gov for more information.)
EUROPEAN PATENT OFFICE (EPO) 20172038.0 04/29/2020 No Access Code Provided
EUROPEAN PATENT OFFICE (EPO) 19213759.4 12/05/2019 No Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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If Required, Foreign Filing License Granted: 06/17/2024

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/680,605**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers.

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

PRODUCTION OF HIGHLY PURIFIED 212PB

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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AdvanCell - Exhibit 1006 - Page 72

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 18/680,605

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	64		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	280		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	320		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	30 minus 20 =	* 10	x 40 =	400	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*	x =	0			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	1064		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/680,605	05/31/2024	Roy H. Lar	A1389.70001US02

CONFIRMATION NO. 5167

23628
WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

FORMALITIES LETTER

OC000000074146118

Date Mailed: 06/18/2024

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to the above-identified nonprovisional application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- **Drawing Items**

  The drawings submitted on 05/31/2024 are not acceptable because:

  - The figure labeling in the application is improper. Each figure must be labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (1A, 1B, etc.), beginning with Figure 1 (or Figure 1A). See 37 CFR 1.84(u)(1). When properly labeled, each brief description of the figures contained in the specification must correspond to a properly labeled figure.
    - To correct the figure numbering, replacement drawing sheets with proper figure labeling in compliance with 37 CFR 1.84 and 1.121(d) are required.
    - To correct the reference in the specification, a proper substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, providing a brief description of the several views of the drawings corresponding to the corrected labeling of the figures, is required. See 37 CFR 1.74 and 1.77(b)(9).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be addressed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

REPLY VIA ELECTRONIC FILING

A reply may be submitted via electronic filing only by registered users of the appropriate USPTO patent electronic filing system and must include:

- A separate document having the document description, "**Applicant response to Pre-Exam Formalities Notice**"; and
- the item(s) for which a reply period is set forth above.

For more information about electronic filing, contact the Patent Electronic Business Center (EBC) 1-866-217-9197 or visit https://www.uspto.gov/ebc

NOTE: If the reply is not being submitted electronically, a copy of this notice must be included.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/swoldabezgi/

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Kathi Vidal

Kathi Vidal
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office

Derrick Brent
Deputy Under Secretary of Commerce for Intellectual Property and
Deputy Director of the United States Patent and Trademark Office

DocCode - SCORE

Placeholder Sheet for Supplemental Content

Application Number: 18680605 Document Date: 08/14/2024

The presence of this form indicates that the following document type was received in electronic format on the date identified above. This document is stored separately from the typical case contents which are stored in image format.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded and no paper documents or physical media exist.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access this supplemental content via Docket Application Viewer (DAV) or Supplemental Content Viewer (SCV).
- External customers may access this supplemental content via Patent Center.

Form Revision Date: March 1, 2024

Docket No.: A1389.70001US02
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	Not Yet Assigned
Art Unit:	Not Yet Assigned

Certificate of Electronic Filing under 37 C.F.R. § 1.8
I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: August 14, 2024 Electronic Signature for Sheryl E. Mackey: /Sheryl E. Mackey/

REQUEST FOR CORRECTED FILING RECEIPT

Office of Initial Patent Examination's Filing Receipt Corrections
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant hereby requests that a corrected Filing Receipt be issued in the above-identified patent application. The Official Filing Receipt received by Applicant, a copy of which is attached hereto, has an error in "Inventor(s)" section. In particular, Inventor Roy H. Larsen's last name is mis-spelled. The Inventor's correct name is shown below and was provided in the Application Data Sheet filed on May 31, 2024.

Inventor(s)

~~Roy H. Lar, Oslo, NORWAY~~

Roy H. Larsen, Oslo, NORWAY

Applicant additionally requests that all pertinent U.S. Patent and Trademark Office records relating to the subject application be changed to reflect this correction.

As the above is a Patent Office error, Applicant believes no fee is due with this Request for Corrected Filing Receipt. However, if a fee is due with this Request for Corrected Filing Receipt, please charge our Deposit Account No. 23/2825, under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Dated: 8/14/2024

Respectfully submitted,

By /Benjamin J. Walsh/
John S. Harmon, PhD, PE
Registration No.: 67,131
Benjamin J. Walsh
Registration No.: 82,138
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
617.646.8000

SUBSTITUTE SPECIFICATION – CLEAN COPY

Production of highly purified ^{212}Pb

FIELD

The present invention relates to a single chamber diffusion generator (assembly), assemblies and method for obtaining a container comprising ^{212}Pb on the walls obtained from a ^{212}Pb precursor isotope source. The invention provides an improved system and method for producing ^{212}Pb in high purity without the need for processing, with high yields, and which safely and efficiently can be transported to the locations where it is to be used.

BACKGROUND

Assemblies for preparing or producing ^{212}Pb have previously been described and based on ^{228}Th bound to stearate in a chamber with another chamber for collecting the ^{212}Pb after ^{220}Rn has diffused from the first chamber (source chamber) to the second chamber (collector chamber).

In another system the $^{228}Th/^{224}Ra$ was extracted from one vessel with a pump generated airflow and $^{220}Rn/^{212}Pb$ collected in another vessel. The system consisted of an "air loop" for transportation of ^{220}Rn and a "fluid loop" for ^{212}Pb rinsing and after rinse collection. This is a quite complex system which is not suitable for shipment and handling, and the potential for leakage or inappropriate use in for example a hospital is significant.

In another system an emanator source is placed inside one chamber and a gas flow passes through and carry ^{220}Rn to another chamber where $^{220}Rn/^{212}Pb$ is collected. After some time, the carrier gas valve is closed, and the collection unit is added a liquid through a top valve and the liquid is collected through a bottom valve. This system is as well relatively complex. Both of these systems need significant work effort of skilled workers and relatively advanced lab equipment and space to operate.

Also, generator systems for ^{212}Pb not relying on ^{220}Rn emanation and diffusion has been presented previously. In one existing generator system ^{224}Ra is bound to ion exchange material and the ^{212}Pb extracted by elution with acid which must be evaporated before it can be used for radiolabeling in another existing system the ^{212}Pb in a solution with ^{224}Ra is used for labelling following the removal of ^{224}Ra by size exclusion purification. Both these methods are working but requires extra time for processing, more so for the first method than the second.

^{212}Pb has a half-life of only 10.6 h. This half-life makes the radioisotope idea for medical applications such as anti-cancer treatment because it acts on its target and without prolonged side effects from a long half-life. However, this feature also makes is difficult to use in a commercial

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setting involving centralized production and long-distance shipment to end users simply because it decays fast which gives lower yields over time.

Thus a challenge for the current emanation and diffusion systems is transport distances which can reduce efficiency significantly due to decay of ^{220}Rn before reaching the collection vessels. For example, one system reported a total yield from a 3 day operation of 2.01 MBq ^{212}Pb collected compared from a ^{228}Th source of 7.05 MBq, *i.e.* less than 30% yield. Increasing the operation time did not increase the amount collected and the system was sensitive to the air flow rate.

There is a need for alpha-emitter therapeutics for biomedical applications. Lead-212 (^{212}Pb) is a beta-emitter that decays to short lived progenies producing alpha particles and can thus act as an alpha emitter generator *in vivo* useful in alpha emitter therapeutics.

This industry therefore needs an improved system and method for producing ^{212}Pb in high purity without the need for processing, with high yields, and which safely and efficiently can be transported to the locations where it is to be used.

SUMMARY

An object of the present invention relates to a method for obtaining a container comprising ^{212}Pb on the walls comprising the steps of providing an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, connecting the first part and the second part such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container and such that a single chamber container assembly is provided, allowing the ^{212}Pb precursor isotope source sufficient time to decay to progenies ^{220}Rn, ^{216}Po, or ^{212}Pb, and sufficient time for ^{220}Rn, ^{216}Po and/or ^{212}Pb to settle onto the inner walls of the single chamber container assembly, removing or isolating the remaining ^{212}Pb precursor isotope from the single chamber assembly without having the ^{212}Pb precursor isotope source come into contact with an inner wall of the single chamber container assembly, and obtaining a container comprising ^{212}Pb on an inner wall of the container and substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. The described system may be termed a single chamber diffusion generator for ^{212}Pb.

In the following, precursor isotope is defined as a mother nuclide, grandmother nuclide, great grandmother nuclide etc. for ^{212}Pb i.e., ^{216}Po, ^{220}Rn, ^{224}Ra etc.

A further object of the present invention relates to an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the

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^{212}Pb precursor isotope source does not come into contact with an inner wall of the container, and such that a single chamber container assembly is provided.

Yet another object of the present invention relates to a single chamber container assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container.

In one or more embodiments of the invention the single chamber container assembly is gas tight.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is selected from the group consisting of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and/or ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{228}Th and ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th.The ^{212}Pb activity may vary from typically 0% to 114% of the ^{224}Ra precursor activity in the generator depending on the ingrowth status. The ^{212}Pb activity can be at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % of the ^{224}Ra precursor activity.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{228}Th measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{224}Ra measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the total amount of radioactivity in the single chamber container assembly is 1 kBq – 100 GBq.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in the form of an inorganic or organic salt, such as $RaCl_2$.

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In one or more embodiments of the invention the ^{212}Pb precursor isotope source is bound to a non-radioactive material, such as particles or a holding material.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a dry form or in a liquid solution, such as an aqueous solution or a dispersion.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a liquid solution that is at acidic, neutral or basic pH.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere that is made of a material suitable for application of a liquid.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers, cellulose.

In one or more embodiments of the invention a strip or sphere is attached to the second part, which comprises means for holding the strip or sphere, such as a rod.

In one or more embodiments of the invention the second part comprises a syringe, or wherein the rod is the syringe.

In one or more embodiments of the invention the syringe tip has been pushed through a rubber cap.

In one or more embodiments of the invention the second part comprises a rod that is attached to the means for opening and closing the container.

In one or more embodiments of the invention the means for opening and closing the container is a cap, cover or a lid.

In one or more embodiments of the invention the cap, cover or a lid is made of a material selected from the group consisting of rubber, glass, paper, plastic, metal, ceramic, and natural or synthetic fibers.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is placed on or in a sphere, suitable for holding the source but allowing radon diffusion.

In one or more embodiments of the invention the container comprises a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the gas permeable barrier impervious to the ^{212}Pb precursor isotope source is in contact with the ^{212}Pb precursor isotope source.

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In one or more embodiments of the invention the container does not comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the volume of the container is 1 µl to 10 liters, such as 1 µl to 1 liter, such as 100 µl to 10 ml, such as 100 µl to 100 ml.

In one or more embodiments of the invention the substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container is less defined as less than 3 % ^{224}Ra of the ^{212}Pb precursor isotope source, such as less than 1 %, such as less than 0,5 %, as measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the inner walls of the container are coated. The coating may be a film of salt or other suitable material on the inner walls.

In one or more embodiments of the invention the inner walls of the container are coated with a compound that comprises a chelator which can complex with ^{212}Pb.

In one or more embodiments of the invention the inner walls of the container are coated with a chelator which is TCMC or a variant hereof.

In one or more embodiments of the invention the container comprises an aqueous or an oil solution.

DETAILED DESCRIPTION

The present inventors have in response to the need for a simpler, safer system with less size and transport distances to handle the short half-life of ^{220}Rn and ^{212}Pb, designed an assembly whereby the radon producing source is placed inside the collector chamber or container. Instead of using ^{228}Th only as a source the present invention is flexible and can use pure ^{224}Ra or a combination of ^{228}Th or ^{224}Ra as source, or even their precursor isotopes (Figure 1).

The assembly of the present inventions can be made very compact and very simple, allowing for a shippable and disposable ^{212}Pb-generator unit. In the present context is assembly, diffusion generator and system are used interchangeably. The described assembly or system may therefore be termed a single chamber diffusion generator for ^{212}Pb.

Thus, an object of the present invention relates to a method for obtaining a container comprising ^{212}Pb on the inner walls comprising the steps of providing an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, connecting the first part and the second part such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container and such that a single chamber container assembly is provided, allowing the ^{212}Pb precursor isotope source

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sufficient time to decay to progenies ^{220}Rn, ^{216}Po, and/or ^{212}Pb, and sufficient time for ^{220}Rn, ^{216}Po and/or ^{212}Pb to settle onto the inner walls of the single chamber container assembly, removing or isolating the remaining ^{212}Pb precursor isotope from the single chamber assembly without having the ^{212}Pb precursor isotope source come into contact with an inner wall of the single chamber container assembly, and obtaining a container comprising ^{212}Pb on an inner wall of the container and substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. Examples of such containers or assemblies are described in the examples of the present disclosure and can also be seen in Figures 2-5B.

An aspect of the invention relates to a method of obtaining a ^{212}Pb solution comprising obtaining the above container comprising ^{212}Pb on the walls and collect the ^{212}Pb in a solution. The ^{212}Pb can be collected in a solution that is in the container before the ^{212}Pb is generated or using a solution that is introduced to the container after the ^{212}Pb has been generated, and then collected. The collection can be done for example using a syringe.

A further object of the present invention relates to an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container, and such that a single chamber container assembly is provided.

Yet another object of the present invention relates to a single chamber container assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container.

A huge advantage with the described assembly (or also defined herein as a container, system or a generator) is the ability to supply ^{212}Pb without the activity level is dictated by the short (10.6 h) half-life of ^{212}Pb. With the described system it is possible to produce a diffusion generator in a centralized production facility and ship it to the end user. A portable disposable generator could be made and shipped to *e.g.* a hospital from one end or the world to the other. For such a disposable unit, a pure ^{224}Ra (without ^{228}Th) is preferable as this would become inactive after 40-50 days approximately avoiding generation of long-lived radioactive waste. Such a diffusion source will steadily produce ^{220}Rn/^{212}Pb in a fashion dictated by the half-life of ^{224}Ra (Table 1 and Figure 1). The container, comprising the ^{212}Pb precursor isotope source, will produce ^{212}Pb due to the nature of decaying isotopes. The amount of ^{212}Pb deposited on will depend on several factors including the choice of ^{212}Pb precursor isotope source and time. The time is an important factor. An object of

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the invention relates to a method for preparing a substantially pure ^{212}Pb solution, the method comprising obtaining the assemblies and containers described herein, wherein the ^{212}Pb precursor isotope source is kept in the sealed assemblies and containers for a given time, the ^{212}Pb precursor isotope source is isolated or removed without coming into contact, and the ^{212}Pb on the walls are then collected by adding a solution that is suitable for collecting the ^{212}Pb. The time that the ^{212}Pb precursor isotope source is kept in the assemblies and containers of the present invention can be from minutes, to hours, to days, to years, depending on the choice of ^{212}Pb precursor isotope source and the amount of ^{212}Pb needed. The time can be at least one day. The time can be at least one day. The time can be at least two days. The time can be at least four days. The time can be at least a week. The time can be at least two weeks. The time can be at least two weeks. The time can be at least a month. The time can be at least a year.

^{212}Pb is a member of the thorium natural radionuclide series and can be found in materials containing ^{232}Th ($t_{1/2}$=1.4x10^{10} years). The ^{212}Pb precursor can therefore be chosen based on the intended use. A precursor with longer half-life can be chosen to generate an assembly or system that that will act as a ^{212}Pb generator for continuous production over a longer period of time. Alternatively, an isotope with a shorter half-life be used is the intended use for example is at a hospital or similar where generation of long-lived radioactive waste can be problematic. Naturally a mix of different precursors will therefore also be relevant and also where specific assemblies are needed for the generation of a specific amount of ^{212}Pb over a specific period of time.

Thus, in one or more embodiments of the invention the ^{212}Pb precursor isotope source is selected from the group consisting of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and/or ^{224}Ra. Thus, in the following ^{212}Pb precursor isotope is defined as a mother nuclide, grandmother nuclide, great grandmother nuclide etc. for ^{212}Pb, *i.e.* ^{216}Po, ^{220}Rn, ^{224}Ra ^{228}Th, ^{228}Ac, ^{228}Ra, ^{232}Th.

The decay of these radioisotopes can be seen in figure 1 which clearly indicate the possibility of creating a ^{212}Pb precursor isotope source with different decay profiles and different combinations of precursor isotopes will be able to generate ^{212}Pb at different rates over different periods of time.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{228}Th and ^{224}Ra. The source can also be each of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra individually, but due to the decay will a mixture naturally over time occur because ^{232}Th will decay to ^{228}Ra and so on. The key is that the gaseous ^{220}Rn is produced because it will diffuse from the source and later settle on the inner walls of the container as ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least

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50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{228}Th measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th. The ^{212}Pb activity may vary from typically 0% to 114% of the ^{224}Ra precursor activity in the generator depending on the ingrowth status. The ^{212}Pb activity can be at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 20 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 30 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 40 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 50 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 60 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 70 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 80 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 90 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 100 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 110 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 20 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 30 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 40 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 50 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 60 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 70 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 80 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 90 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 100 % of the ^{224}Ra precursor activity.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{224}Ra measured as % radioactivity relative to ^{212}Pb.

The assembly working as a ^{212}Pb generator unit can be mass produced in a centralized production facility and shipped to end users for application in production of radiopharmaceuticals. It can also be adapted and used for large scale centralized production of ^{212}Pb. Thus, the amount of radioactivity in the assembly can adjusted according to its intended use. In one or more embodiments of the invention will the total amount of radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10

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MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 kBq – 100 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 kBq – 10 MBq. The total amount of radioactivity in the single chamber container assembly can be 100 kBq – 10 MBq. The total amount of radioactivity in the single chamber container assembly can be 1 MBq – 1 GBq. The total amount of radioactivity in the single chamber container assembly can be 10 MBq – 10 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 MBq – 1 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 GBq – 100 GBq.

In one or more embodiments of the invention will the amount of ^{212}Pb radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq. In one or more embodiments of the invention will the amount of ^{212}Pb precursor isotope source radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq.

The ^{212}Pb precursor isotope source can be in different forms, sizes and shapes depending on the application type. Thus, in one or more embodiments of the invention the ^{212}Pb precursor isotope source is in the form of an inorganic or organic salt, such as $RaCl_2$. The ^{212}Pb precursor isotope source can also be in a dry form or in a liquid solution, such as an aqueous solution or a dispersion. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a liquid solution that is at acidic, neutral or basic pH. The pH can be 1-14, such as pH 1-6, pH 2-6, pH 2-8, pH 4-8, pH 5-7, pH 6-8, pH 7-8, pH 7,2, pH 8-10, pH 8-12, or pH 10-14.

The solution can be an aqueous solution. The solution can be a 0,1M aqueous HCl solution. This solution can also be used to dissolve the ^{212}Pb on the walls of the assembly.

The assembly working as a generator system may be used for preparing single patient dosing or for multiple patient dosing, or even for industrial use. The amount of radioisotope can therefore be adjusted depending on the application of the assembly.

The ^{212}Pb precursor isotope source can be placed on the rod, either directly or on a strip attached to the rod, typically in a very small liquid volume. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere that is made of a material suitable for application of a liquid. Such liquid can be in the amount of 1 µl to 1 ml, such as 1 µl to 10 µl, such as 1 µl to 100 µl.

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When the container, which can be a vial, can be empty or contain a small volume of liquid in the bottom, that is not touching the source. In one or more embodiments of the invention the container comprises an aqueous or an oil solution.

It is important that the source does not drip or chip of in a fashion that causes cross contamination of the inner surfaces of the collector unit (container) with source material and that the source and source holder can be removed and or withdrawn from the collector without causing cross contamination by contact.

In one or embodiments the source is surrounded by a grid or encapsulated in a porous material to reduce risk of cross-contamination. This encapsulation can be a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

Thus, in one or more embodiments of the invention the container does or does not comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is placed on or in a sphere, suitable for holding the source but allowing radon diffusion. The container may comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source, and the gas permeable barrier impervious to the ^{212}Pb precursor isotope source can be in contact with the ^{212}Pb precursor isotope source. In one or more embodiments of the invention the single chamber container assembly is gas tight.

Figure 2 shows an example of the single chamber container assembly where the container (the first part) is connected with a cap and a rod attached to the cap is used to hold the ^{212}Pb precursor isotope source (the second part) without having this source touch an inner wall of the container during the entire process.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source can therefore be bound to a non-radioactive material, such as particles or a holding material. These can ensure that the source does not contaminate the container. The ^{212}Pb precursor isotope source can be deposited on a strip, sphere or a rod which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers. The strip or sphere can be attached to the second part or be contained or comprised in the second parts, which comprises means for holding the strip or sphere. Such means can for example be a rod.

In one or more embodiments of the invention the second part comprises, optionally, a rod that is attached to the means for opening and closing the container. The means for opening and closing the container can be a cap, cover or a lid which can be made of a material selected from the group consisting of rubber, glass, paper, plastic, metal, ceramic, and natural or synthetic fibers, cellulose

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ion exchange resin, natural mineral, polymer. Alternatively, the source is attached to a material placed onto the cap with or without being adhered to the cap. If the cap is placed on the bottom, the source material can be simply placed onto the interior of the cap without touching the ^{212}Pb collector part and kept in place by gravitation. In such case the generator unit should be stored and handled in position whereby cap with the source is always kept at the bottom.

The means for opening and closing the container can comprise the ^{212}Pb precursor isotope source. The ^{212}Pb precursor isotope source can be placed on a sponge, a wool or another substance that is capable of keeping the ^{212}Pb precursor isotope source in the means for opening and closing the container. The wool can be a quartz wool. The wool can also be a mineral wool. The wool can also be a glass wool. The substance that is capable of keeping the ^{212}Pb precursor isotope source in the means for opening and closing the container can be attached by glue, double-sided mounting tape or other means for attachment.

In one or more embodiments of the invention the second part comprises a syringe, or wherein the rod is the syringe. The means for holding can be deposited on a strip or sphere which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers cellulose ion exchange resin, natural mineral, polymer.

In one or more embodiments of the invention the syringe tip has been pushed through a rubber cap. An alternative design is where the second part is a rubber cap, or septum of another material permeable, and preferential self-sealing, with a syringe tip, with means for holding the ^{212}Pb precursor isotope source attached to the cap or to the inner walls of the container. In this case will user of the assembly be able to dissolve the ^{212}Pb from the inner walls of the container in an aqueous solution though a syringe that is pushed through the cap. The resulting ^{212}Pb in aqueous solution can afterwards be collected by the same syringe which will generate the option of working in a GMP environment which can be directly applied for patient use. Thus, in one embodiment the ^{212}Pb precursor isotope source be withdrawn into a capsule or similar allowing the container to be washed e.g., by using a solution transferred via a syringe through a rubber septum, without having to disassemble the two units. In another embodiment the assembly can be autoclaved, and the solution be of a physiological acceptable composition containing a chelator for disease targeting allowing withdrawal into a syringe and direct infusion with or without the use of a sterile syringe filter. In one embodiment the assembly including all subunits is autoclavable and with a syringe permeable zone on the cap allowing aseptic extraction of ^{212}Pb from the assembly.

After a few hours or days of operation the assembly with the ^{212}Pb precursor isotope source can be used for producing ^{212}Pb by retracting the ^{212}Pb precursor isotope source, e.g., by changing the cap with the attached ^{212}Pb precursor isotope source to a new cap without radioactivity and

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washing the inner surface with a suitable solution to dissolve surface deposited ^{212}Pb and progenies. Since the ^{212}Pb solution is free from long lived predecessor radionuclides it can be used directly without further chemical processing to label carrier molecules for e.g. cancer therapy.

The ^{212}Pb precursor isotope source can be associated with a needle, rod or a strip of a material of which ^{212}Pb precursor isotope source is attached to allow diffusion of ^{220}Rn. The source may or may not contain a holder for the radioactive part and a grid or ring or similar surrounding the source to prevent cross contamination when the ^{212}Pb precursor isotope source is withdrawn from the container. In one embodiment it may be attached to a screw cap that can be used to close the container. The ^{212}Pb precursor isotope source can be isolated from the container by withdrawing the source into a cover. This will ensure that the source does not cross contaminate the inner walls of the container while the ^{212}Pb is extracted, and also limit risk of exposure to the user of the assembly. It is important that after a period of decay the ^{212}Pb precursor isotope source and the ^{212}Pb adsorbed onto the vial inner surfaces can be separated by withdrawing the ^{212}Pb precursor isotope source form the container, e.g. by replacing the screw cap of which the source is attached by a rod or similar with a standard gas tight screw cap. Thus, in one special embodiment is the ^{212}Pb precursor isotope source equipped with a retractable radioactive source that is withdrawn into the cap similar to a "click pen system" or similar for isolating the source from the generator unit's interior surfaces and thus not require the disassembling and replacement of the cap (e.g. Figures 2 and 4A-4B). Thus, the second part of the assembly can comprise a piston that can be in open and closed positions. The second part of the assembly can also comprise a chamber with a gas tight o-ring seal. In one or more further embodiments the assembly comprises a gas and liquid tight lid or valve in the second part.

The second part of the assembly can, optionally, comprise a needle, rod or strip which may be supplied with a small ball of a material that can absorb radium or thorium including glass wool, quartz wool, mineral wool, metal, paper, cotton, stearate or another fatty acid, metal, cellulose, natural mineral, polymer, ion exchange resin, or other fibrous material. The composition of the holder of the precursor isotope should be chosen with care according to the known affinity of radon for various materials. A material that ^{228}Th and or ^{224}Ra has a good adsorption or absorption to and ^{220}Rn has a low affinity for would be suitable. The container can be made of a glass (including quartz), polymer and or metal, such as a glass vial, with a screw cap or similar, whereby the source is attached to the screw cap. The container (or assembly) can be a glass flask placed up-side down and with for example quartz wool with ^{224}Ra or ^{228}Th placed in the center of the inside of the cap. ^{212}Pb can be produced by unscrewing the flask standing up-side down from the cap with the source, and thereafter washing the interior of the flask with a solution to dissolve ^{212}Pb. The container can have a volume of 1 µl to 10 liters, such as 1 µl to 1 liter, such as 100 µl to 10 ml,

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such as 100 µl to 100 ml. The volume will depend on the use, where single use generally will be smaller and industrial batch containers will be larger.

Minimizing risk of cross contamination is important and the assembly has to be designed so that the ^{212}Pb precursor isotope source does not come into contact with the inner walls of the container. Thus, in one or more embodiments of the invention the container is substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. The definition of substantially free depends on use of the ^{212}Pb produced in the assembly. In one or more embodiments of the invention is "substantially free" defined as less than 3 % ^{224}Ra of the ^{212}Pb precursor isotope source, such as less than 1 %, such as less than 0,5 %, as measured as % radioactivity relative to ^{212}Pb. In one or more embodiments of the invention, the substantially free refers to the purity of ^{212}Pb vs ^{224}Ra in a solution from the walls of the container. This purity can be better than 95 %. This purity can be better than 98 %. This purity can be better than 99 %. This purity can be better than 99,5 %. This purity can be better than 99,8 %.

The container is surrounding, but not touching, the ^{212}Pb precursor isotope source. This should be made of an appropriate material, for example glass, plexiglass, metal, ceramics, polymer including polypropylene and Teflon or other materials suitable for allowing deposition of ^{220}Rn and/or ^{212}Pb on its inner walls and allowing ^{212}Pb to be dissolved when washed with a suitable solution for further use in radiolabeling. A solution can be used to wash the inner walls of the container to extract radionuclides, mainly ^{212}Pb and progenies. It may be present during the ^{212}Pb production period in the assembly or be applied after the ^{212}Pb precursor isotope source has been removed or withdrawn. In one embodiment the solution and an acidic or alkaline solution that can be transferred and neutralized before use for administration to a patient. In one embodiment the solution may be water of a suitable purity for pharmaceutical use. Solution volume of 1 ul to 1 liter for single dosing, e.g. 100 ul to 10 ml, and 1 ul to 10 liter or higher for multiple dosing may be used.

The container may or may not contain a surface film on the inner surfaces or some liquid to assist in collecting the diffusion product. This surface film can for example be a coating. Size and volume may be in microliter to ml for single dosing units and in microliters to tens of liters or higher for multiple dosing. The inner walls of the container can be coated. This coating can ensure that ^{212}Pb settles in an optimal way. In one or more embodiments of the invention the inner walls of the container are coated with a compound that comprises a chelator which can complex with ^{212}Pb. It is also possible that the inner walls are coated with one or more compounds where a complex with ^{212}Pb is needed. In one or more embodiments of the invention the inner walls of the container are coated with a chelator capable of chelating ^{212}Pb. This chelator can be TCMC or a variant hereof. The coating may be a film of salt or other suitable material on the inner walls.

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In a special embodiment the container is washed directly with the reaction solution containing the complexing agent to yield a radiolabeling solution which after a suitable reaction time can be used directly for therapeutic purposes. In one embodiment the final product solution is autoclaved and or sterile filtered before administration to a subject in need thereof.

In one embodiment the assembly can be attached to a flushing and filtering circuit whereby when the source is retraced from the chamber a reservoir of a solution is connected and an outlet with a sterile filter and a syringe or vacuum pump is attached to flush the chamber and collect the flushing solution, *e.g.*, in similar fashion as for ^{99m}Tc-generators.

In general, surface ratios between precursor source holder and the collector chamber inner surfaces should be optimized so that as much as possible of the generated ^{212}Pb settles on the collector chamber surfaces. The surfaces may be smooth, or porous or may contain structures to increase surface area relative to the diffusion subunit, container or assembly.

The production can be a production period of 5 hours, 10, hours, 20 hours or more. Afterwards the source may be withdrawn from the chamber into a tube-shaped holder or similar with a gas and liquid tight lid in the bottom that closes when the source is completely withdrawn. This allows for addition of a washing solution, *e.g.*, by a syringe, or activation of a flushing and collecting circuit *e.g.* similar to that of a ^{99m}Tc generator.

In a special embodiment the single chamber diffusion unit has its ^{212}Pb precursor isotope source as a film on the inside surfaces of the assembly and has the ^{212}Pb collector unit (container) inserted into the source covered surfaces without touching these, *i.e.* a reverse configuration compared to what is shown in figure 2.

In another embodiment the diffusion generator is subject to temperature manipulation, either elevated or reduced temperature vs 20 ^{o}C.

The use of the invention for includes in the production of radiopharmaceuticals, medical devices and or standardization sources for ^{212}Pb. The assembly of the present invention can be used to generate a ^{212}Pb standard for calibrations.

In one or more embodiments of the invention is the assembly of the present invention comprised in kit with the ^{212}Pb precursor isotope source, and a solution containing a chelator, and a compound that for use in therapy. Such compound can be a nano- or microparticle. In one embodiment such a kit will contain a ^{212}Pb precursor isotope source, a solution for washing the inner walls of the container and a solution or dry form of a carrier compound, for example a chelator, micro- or nanoparticles.

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Tables

Table 1. Main radiation properties of the ^{224}Ra series.

Radionuclide (half-life)	Alphas and betas (mean energy in MeV)	X-rays and gammas Energy and % abundance
^{224}Ra (3.6 days)	α 5.6	241 keV, 4.1%
^{220}Rn (55.6 s)	α 6.3	
^{216}Po (145 ms)	α 6.8	
^{212}Pb (10.6 h)	β 0.1	75 keV, 10.3% 77 keV, 17.1% 87 keV, 6.0% 90 keV, 1.5% 239 keV, 43.6% 300 keV, 3.3%
^{212}Bi (1 h)	α 6.1 × 0.36 (2.2 MeV effective[1]) β 0.7 × 0.64 (0.4 MeV effective)	727 keV, 6.7% (4.3% effective)
^{212}Po (299 ns) (64% branch)	α 8.8 (5.6 effective)	
^{208}Tl (3.1 min) (36% branch)	β 0.6 (0.2 MeV effective)	75 keV, 3.4% (1.2% effective) 511 keV, 22.6% (8.1% effective) 583 keV, 85.0% (30.6% effective) 860 keV, 12.5% (4.5% effective) 2615 keV, 99.8% (35.9% effective)

[1]Average per ^{224}Ra transformation due to branching. Only X-rays or gammas above 1% effective abundance accounted for. Adds up to a total effective energy of approximately 26.5 MeV of alpha of 0.7 MeV of beta per complete decay of a ^{224}Ra atom via progenies to a stable ^{208}Pb atom.

Table 2. A pure ^{212}Pb source with initial 100 MBq ^{212}Pb kept sealed and emptied for ^{212}Pb only once.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	23.1	4.4	0.92	0.192

Table 3. Lead-212 production from a source with initial 100 MBq ^{224}Ra kept sealed and emptied for ^{212}Pb only once.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	70.3	72.9	63.4	53.1
70% extraction recovery (MBq ^{212}Pb) in final product	49.2	51.0	44.4	37.2

Table 4. Lead-212 production from a source with initial 100 MBq ^{224}Ra source emptied for ^{212}Pb every 24 h.

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Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	70.3	58.2	48.1	39.8
70% extraction recovery (MBq ^{212}Pb) in final product	49.2	40.7	33.7	27.9

The following figures and examples are provided below to illustrate the present invention. They are intended to be illustrative and are not to be construed as limiting in any way.

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BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows the decay of ^{232}Th to its progenies. The decay type (alpha or beta) is indicated and so is the half-lives. These half-lives are important because they dictate the decay rate and are therefore also key in deciding the optimal mix of isotopes as ^{212}Pb precursor isotope source for the production of ^{212}Pb.

Figure 2A shows a figure of the single chamber container assembly with the container (A), the ^{212}Pb precursor isotope source (B) that generates the ^{220}Rn gas which is released into the single chamber container assembly and after decay settled as ^{212}Pb onto the inner walls of the container (C). The upper part of the single chamber container assembly (D) is the second part which comprises the ^{212}Pb precursor isotope source and in this case a cover/cap with a rod attached pointing towards the centre of the container thus enabling ^{212}Pb precursor isotope source release of ^{220}Rn into the container. Figure 2B shows a situation where the ^{212}Pb precursor isotope source (B) has been withdrawn into a gas tight seal that ensures that no ^{220}Rn is released into the container. The ^{212}Pb precursor isotope source can also be removed entirely from the assembly.

Figures 3A-3B show pictures of a crude version of the generator system based on a 3 ml v-vial with a membrane inserted open top screw cap penetrated by a syringe tip (with position fixed by tape on top of screw cap) and with a strip of laboratory bench paper attached to the syringe tip (left picture shows the ^{212}Pb precursor isotope source and container). The ^{212}Pb precursor isotope source is placed onto the strip by a pipette before the screwcap with the source is carefully attached to the vial (right picture). It is very important that the source is not touching the vial when assembling and disassembling the unit to avoid cross-contamination.

Figures 4A-4B. An example of a single chamber diffusion generator for ^{212}Pb with a retractable source simplifying washout of ^{212}Pb from the inner surfaces by having syringe permeable zones on the lid supplied with septum, a syringe could be used for washing of the interior surfaces without radionuclide cross contamination when the unit is put in closed position (FIG. 4B).

Figures 5A-5B. Figure 5A shows a 100, 50 and 10 ml generator unit for ^{212}Pb production. Figure 5B shows the cap with quartz wool in the center of the inner surface. The ^{212}Pb precursor nuclide

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solution can be placed onto the quartz wool and the flask mounted for up-side-down storage to produce ^{212}Pb deposited on the flask' inner surface generated via ^{220}Rn diffusion from the precursor source material.

EXAMPLES

Example 1 - Calculation of the relative ^{212}Pb daughter nuclide level at various time points

Background. The development and use of pure ^{212}Pb in therapeutic radiopharmaceuticals is hampered by the short half-life (10.6 h) of the radionuclide making it almost impossible to produce a product in a centralized fashion and shipped to the end user. If ^{224}Ra is used as a short-term generator for ^{212}Pb the level of ^{212}Pb activity can be maintained essentially according to the half-life of ^{224}Ra, which is 3.6 days. The variation in ^{212}Pb level in a sealed source of pure ^{224}Ra is shown.

Method: The ingrowth of ^{212}Pb from a pure ^{224}Ra source were calculated using a universal activity calculator.

Results: Table 2 shows the amount of ^{212}Pb at various time points after the production of a pure (^{224}Ra-free) pharmaceutical solution and storage in a gas tight container. As can be seen the pure ^{212}Pb source rapidly decays and lose more than 75% per 24 h. Table 3 shows the amount of ^{212}Pb present in a sealed source of ^{224}Ra at the same time points. As can be seen the ^{212}Pb activity is maintained at a high level (> 50%) at least up to 96 h.

Table 4 shows the effect of "milking" a ^{224}Ra precursor-based generator for ^{212}Pb several times during a 96-h period.

The data also shows that significant amount of daughter nuclide is present within a relatively short time frame when starting with pure ^{224}Ra. It is noteworthy though that the ratio of ^{212}Pb to ^{224}Ra in the solution reaches 1 after 36 hours and thereafter gradually increases to about 1.1 of which is kept for the rest of the time until complete decay. In conclusion, using ^{224}Ra as a source for ^{212}Pb makes the logistic of centralized production and shipment to end users possible providing an easy way to extract the ^{212}Pb from ^{224}Ra exist.

Example 2 - Preparation of radionuclides and counting of radioactive samples

In the following, all work with the concentrated radioactive preparations including evaporation of solvent etc was performed in a glove-box. A source of ^{228}Th in 1 M HNO3 was acquired from a commercial supplier. Ac-resin was obtained from Eichrom Technologies LLC (Lisle, IL, USA) in the form of a pre-packed cartridge.

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Radium-224 was made from ^{228}Th bound to Actinide resin (Eichrom Technologies, LLC) by eluting a column containing actinide resin with immobilized ^{228}Th with 1 M HCl. The eluate was purified on a second Ac-resin column and the eluate evaporated to dryness using an evaporation vial with a cap with gas inlet and outlet placed in a heater block at approximately 110 ◦C and a gentle stream of nitrogen gas to evaporate of the solvent. When the evaporation vial was empty from solvent it was added 0.1 M HCl to dissolve the residue, typically 200-400 µl. Typically, more than 70% of the ^{224}Ra present in the ^{228}Th source could be extracted and purified using the described methods.

Radioactive samples were counted on a Cobra II Autogamma counter (Packard Instruments, Downer Grove, IL, USA). During extraction of ^{224}Ra from the ^{228}Th source, a CRC-25R dose calibrator (Capintec Inc., Ramsey, NJ, USA) was used.

Example 3 - Determining net count rate for ^{212}Pb in a ^{212}Pb/^{224}Ra mixture before radioactive equilibrium has been reached

After more than 3 days, i.e., “equilibrium” a sample kept gas tight will for practical purposes have 1.1 times ^{212}Pb vs ^{224}Ra.

In a gas tight unit regardless of whether ^{212}Pb is at or lower than equilibrium it can be assumed that this is reached after 3 days since surplus ^{212}Pb is reduced by 99% and the ingrowth of ^{212}Pb from ^{224}Ra is practically complete vs. “equilibrium”.

Using the Cobra II Autogamma counter with a counting window setting from 70-80 KeV gives mainly the ^{212}Pb with very little contribution from other radionuclides in the ^{224}Ra series. Radium-224 must be indirectly counted when the initial ^{212}Pb has vanished and equilibrium between ^{224}Ra and ^{212}Pb has been reached (after approximately 3 days). This indirect counting requires the sample to be stored in a relatively gas tight containers as otherwise the ^{220}Rn may escape preventing the radionuclide equilibrium of 1.1 between ^{212}Pb and ^{224}Ra to be reached.

Since sampling and counting may be separated by some time, the net count rate for ^{212}Pb can be adjusted for decay to determine the net ^{212}Pb count rate at the time of sampling. By storing ^{212}Pb samples for a week or longer and remeasure, the amount of ^{224}Ra contaminant can be determined as activity after about 110 hours of storage would not be ^{212}Pb but must be from longer lived precursor isotope.

Example 4 - A simplified single chamber (diffusion chamber generator) assembly for ^{212}Pb production (Figures 3A-3B).

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A 3 ml v-vial with an open top cap. The open top cap was supplied with a membrane permeable by a syringe tip. A syringe tip was pushed through the membrane and fixed with tape on top to lock the position of the tip with regard to the open top cap. On the syringe tip vas placed a strip of absorbent paper about 0.5 X 3 cm by inserting the syringe tip in two holes in the strip. The paper strip was added 2-40 ul ^{224}Ra solution. Thereafter the cap was placed carefully onto the v-vial while the syringe tip and radioactive strip were not to touch the inside of the v-vial. Thereafter the assembly was standing for various time to produce ^{212}Pb via ^{220}Rn diffusion from the strip to the space surrounding the strip. The ^{212}Pb tended to settle on the inner surfaces of the v-vial. Depending on the liquid volumes used for applying the ^{224}Ra source onto the strip, there may be some condensation of liquid due to evaporation/condensation of the liquid applied. Alternatively, the source could be dried before assembling the unit to avoid any solvent condensation on the v-vial inner surfaces.

Example 5A: Production of ^{212}Pb with the ^{212}Pb precursor isotope source absorbed on a paper strip.

Methods: The assembly was assembled with ^{224}Ra placed on the strip of the diffusion subunit inserted in a v-vial according to Figures 3A-3B, and was standing for 17.5 h or more to produce ^{220}Rn and ^{212}Pb. Production of ^{212}Pb evaluation of radiochemical purity of product. At the end of the production period the whole unit was measured on a Capintec dose calibrator. The product was evaluated by separating the source from the container and cap the latter with a gas tight screw cap and measure immediately in the Capintec dose calibrator. The purity of the product was determined by measuring the collector subunit again after a few days when all the ^{212}Pb had decayed but the presence of longer-lived predecessor nuclides ^{224}Ra and ^{228}Th would have been measurable. Results: Highly purified ^{212}Pb was collected in the collector subunit with a relevant yield of 65.6% (range 62.7-69.9% n=4) and with no measurable longer-lived precursor nuclides present (< 0.5%). In conclusion: The assembly was effective in producing and collecting purified ^{212}Pb in an easy manner without need for further purification.

Example 5B: Production of ^{212}Pb with the ^{212}Pb precursor isotope source absorbed on a parafilm strip. The experiment from 5A was repeated except that a parafilm strip was used instead of paper a strip to carry the precursor isotope source.

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Results: The yield of ^{212}Pb on the inner surfaces of the collector subunit (vial or container) was found to be only 19.3%. In contrast a unit with paper strip run in parallel with exact same configuration and emanation period gave a yield of 63.9%. In conclusion, the material used for absorbing and holding the ^{212}Pb precursor isotope source could greatly affect the yield of ^{212}Pb on the collector subunit or container.

Example 6: Dissolving of ^{212}Pb from the container using a solution.

Methods: The collector vial was added 0.3-0.5 ml 0.1 M HCl which was gently swirled to contact the inner surfaces with the liquid and counted in the Capintec dose calibrator. Thereafter the liquid was transferred to an Eppendorf tube and measured in the Capitec dose calibrator. The extraction yield was 74.0 % (range 70.0-76.9%, n=3) when the collector subunit (3 ml v-vial), was washed one single time with 0.3 ml 0.1 M HCl. In conclusion, ^{212}Pb absorbed onto the surfaces of the container was rapidly and with good yield dissolved by a solution useful for radiopharmaceutical processing.

Example 7: Thin layer chromatography analyses

Thin layer chromatography (TLC) was performed using chromatography strips (model # 150-772, Biodex Medical Systems Inc, Shirley, NY, USA). A small beaker with about 0.5 ml of 0.9% NaCl was used to place strips with a sample spot in. To the strip was typically added 1-4 µl of sample at approximately 10% above the bottom of the strip. After the solvent front had moved to about 20% from the top of the strip, the strip was cut in half and each half was placed in a 5 ml test tube for counting. In this system radiolabeled antibody and free radionuclide does not migrate from the bottom half while radionuclide complexed with EDTA migrates to the upper half. A formulation buffer (FB) consisting of 7.5% human serum albumin and 1 mM EDTA in DPBS and adjusted to approximately pH 7 with NaOH was mixed with the radioconjugates in ratio 2:1 for at least 5 minutes before application to the strips to determine free radionuclide. It was verified that in a test solution with free ^{212}Pb was the radionuclide was completely (> 99%) complexed by the EDTA, when mixed with FB, and would travel to the upper half of the TLC strip.

Example 8: In situ chelation of ^{212}Pb in solutions.

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Background: The labeling properties of the ^{212}Pb extracted with 0.1 M HCl from the containers was evaluated. Methods: A 10:1 ratio of ^{212}Pb in 0.1 M HCl and 5 M ammonium acetate was used before addition of the chelators, resulting in a pH range of 5 – 6 for the reactions. Reaction times of 15-30 minutes at 37 °C, were tested. For PSMA-617 solutions of 5 µg per 100 µl was labeled with good yield of 96.6% as determined by TLC. Also, TCMC-conjugated Herceptin antibody solution of approximately 1.0 mg/ml was labeled with pure ^{212}Pb with a good yield of 98.9%. In conclusion: Lead-212 produced with the assembly was readily complexed with small molecular and large molecular conjugates indicating suitability for use in production of ^{212}Pb based radiopharmaceuticals.

Example 9 - Production of ^{212}Pb from the ^{224}Ra source when unit is kept sealed and emptied only at one time point

Table 3, lower row, shows the example of an output from a diffusion generator emptied after various time points after insertion of the source of 100 MBq of ^{224}Ra into the unit. As shown the generator gives a relatively stable output of ^{212}Pb for up to 96 h.

Example 10 - Production of ^{212}Pb from the ^{224}Ra source when unit is emptied once a day for four days e.g. if used for fractionated radionuclide therapy etc.

Table 4 shows the output when the assembly is “milked” once every 24 h. The combined output is a total of 151.5 MBq of ^{212}Pb when starting with a 100 MBq source. In conclusion, the one chamber assembly is suitable for single dose as well as fractionated dose production.

Example 11 - Example of an assembly with a retractable source (Figure 2 and Figures 4A-4B)

The materials used may be of glass (including quartz), polymer, metal, ceramic or other suitable materials for pharmaceutical containers. The rod in Figure 2 (piston in Figures 4A-4B) slides in a tube with o rings or similar at the top to secure gas tight seal. The valve at the bottom of the rod is gas and liquid tight in the closed position for the unit.

In the open position the source will be exposed inside the container and emanate ^{220}Rn and cause deposit of ^{212}Pb onto the inner surface. In closed position the source is sealed off from the container (Figure 2B) and the container surfaces can be contacted with a suitable solution to dissolve ^{212}Pb.

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In one embodiment where the cap has syringe permeable membrane, a sterile syringe with a sterile solution is used to extract the ^{212}Pb without removing the cap. When such unit has been autoclaved before the extraction of ^{212}Pb, the complete procedure can be performed in an aseptic/sterile fashion.

Example 12. Precursor nuclide placed onto quartz wool in a ^{212}Pb single chamber generator.

Methods: A flask as shown in Figures 5A-5B, was used. Flask size could vary and typically 10-100 ml flasks were used. When used as a generator the flask was turned-up-side down. The cap was removed and inside of the center of the cap was placed quarts or glass wool. Radium-224 in solution was placed on the quartz wool and the flask was mounted onto the cap without touching the quartz wool with the flask. The unit was kept tight and stored in up-side-down position for a period of time to produce ^{212}Pb from ingrowth. After typical one to a few days the flask was unscrewed from the cap while being held up-side-down and carefully removed from the cap without touching the quartz wool. The cap with the source was combined with another flask and stored up side down for further ^{212}Pb production. The unscrewed ^{212}Pb containing flask was added a solution of 0.5-2 ml of 0.1 M HCl and the ^{212}Pb extracted from the flask by washing the interior surfaces and collected for use.

Results: Typically, 50-70 percent of the ^{212}Pb activity produced was found in the flask and by carefully washing more than 90% of the ^{212}Pb activity could be collected in the washing solution. The produced ^{212}Pb had a very high purity with ^{224}Ra being as low as 10^{-4} vs ^{212}Pb in newly extracted solutions. The product was very suitable for use in labeling of chelator-containing proteins and small molecules giving very high labeling yields, typically above 97%.

In conclusion, the data showed that quartz wool was very suitable for holding a ^{224}Ra source indicating that quartz/glass/mineral wool, metal wool etc would be suitable for this purpose. It would be possible to use the flask/ quartz wool system in upright position also providing the quartz wool is adhered to the capsule, e.g. with glue, double-sided mounting tape etc. In the current example the flask was used up-side down and the quartz wool was not adhered, but just placed and kept by gravity in position inside the cap.

Example 13. Up-side-down flask system version of single the chamber generator.

Flask based diffusion generator for labeling with ^{212}Pb.

Lead-212 generate therapeutic high-LET radiation as it decays via short-lived alpha emitting daughters resulting in an average of one alpha particle per ^{212}Pb decay. The half-life of ^{212}Pb of

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10.6 hours is a limitation to its use and fast and safe production and purification procedures are required. If a ready to use product was to be produced in a centralized production facility and shipped to the end user, the activity level would be reduced to less than 25% in one day. Lead-212 based radioimmunoconjugate has been in clinical testing against peritoneal cancer using ^{212}Pb separated from ^{224}Ra in a cation exchange column and eluted in mineral acid which has to be reconstituted before radiolabeling. This method requires a significant work effort, facilities, and equipment suitable for evaporation of mineral acids etc to work up the ^{212}Pb from the ^{224}Ra generator material. An alternative generator method was developed and tested based on ^{224}Ra absorbed onto quartz wool and placed inside the centered ring of a removable cap (the generator cap), in a generator chamber. The chamber consists of a glass bottle turned upside down and the removable cap supports the ^{224}Ra labeled quartz wool (Figures 5A-5B). When ^{224}Ra decays, the short-lived ^{220}Rn emanates from the quartz wool and causes absorption of the longer-living decay product, ^{212}Pb, onto the interior surfaces of the flask. The flask can be removed from the cap without the glass coming in contact with the quartz wool. After removing the flask from the generator cap, the flask can be rinsed on the inside with 0.1 M HCl to dissolve the ^{212}Pb deposits whereby a highly purified ^{212}Pb solution is made. The operation and washout of the generator flask is made prior to radiolabeling of NG001. The purity of ^{212}Pb vs ^{224}Ra in the solution is, when the generator is operated in a correct manner (i.e. that the source does not come into contact with the walls), better than 99.8%. The generator can be re-used by attaching a new glass bottle to the generator cap and store for typically 1-2 days for the generation of fresh ^{212}Pb.

In summary, the generator method is easier to use and less time consuming compared with ion exchange-based generators. The generator may be re-used several times (although with a decreasing capacity due to radioactive decay depending of source half-life).

Example 14: Size of collector flask,

The flask sizes of 10, 50 and 100 ml was tested (Figures 5A-5B, upper part). ^{224}Ra was added to quarts wool placed in the cap of flasks placed upside down. The % ^{212}Pb on the flask compared with the theoretical yield varied from about 40% to 60%. It tended to be an advantage to use a larger flask to cap inner surface volume to obtain high yield. In conclusion, flasks with various sizes could be used for generator purposes but a relatively large flask vs. cap seemed to improve ^{212}Pb yield as relatively less would be lost due to absorption on the cap and the source material.

Example 15: Materials for holding the source.

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To hold the source material in place inside the generator, e.g., in the inner cap center, Steel wool, glass wool, quartz wool was tested with ^{224}Ra sources. The materials are porous and fluffy and allows for diffusion. A volume of 100-150 microliter of ^{224}Ra in 0.1 M HCl was deposited onto the materials placed inside the caps of 100 ml flasks. After standing for 2-3 days or more, 52-64% of the ^{212}Pb compared to ^{224}Ra present in the generator would have settled on the glass surfaces, so all the three materials would work. i.e., quartz wool averaged of 5 tests, 59.9% (range 52.1-64.4%), glass wool 54.9% and steel wool 64.1% for one test each as compared to ^{224}Ra activity in the generator. In conclusion, several different materials could be used to hold the source in the one chamber diffusion generator.

Example 16: Sources.

The radionuclides ^{224}Ra and ^{228}Th were used as sources inside the generators. The ^{224}Ra -based generator could be used typically repeatedly up to a few weeks while the ^{228}Th -based unit could be used repeatedly for several months and deliver ^{212}Pb by simply switching the glass flask with an unused one and wash the first flask to produce a ^{212}Pb solution. Yield was not significantly reduced with repeated use except for the decay of the generator radionuclide. As long as the sources are centered inside the cap to avoid contact with the glass bottle, and flasks and caps are kept dry, cross contamination from source to the glass flask was minimal. In conclusion, the single chamber diffusion unit could be used repeatedly for producing ^{212}Pb with both ^{228}Th and ^{224}Ra as the sources. Lead-212 activity on the inner glass surfaces from ^{228}Th a source was found to be on average 49.3% (range 40.9%-66.7%) from four tests.

Example 17: Preparation including heating: To heat up flask before mounting onto the cap with the source material could be a way to produce reduced pressure in the generator. The flask was heated to 90 °C in a heat chamber for at least 15 minutes and then the flask and cap was screwed tightly together to be gas tight. The generator unit was thereafter stored at room temperature causing reduced inner pressure. After 1-4 days the chamber was opened and the ^{212}Pb activity on the glass flask was measured. The yield from four tests using ^{224}Ra on quartz wool was on average 68.1% (range 60.5%-75.9%, indicating improved yield compared with previous data for normal pressure flasks (average 59.9%). In conclusion, reduced chamber pressure may improve the yield of ^{212}Pb with the one chamber diffusion generator.

Example 18: Yield of ^{212}Pb in the washout solution.

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A standard solution of 0.1 M HCl was used for extracting the ^{212}Pb trapped on the inner glass surface of 100 ml flasks. The washing solution was carefully shaken and swirled to cover the inside of the flasks for about 2 minutes and then 80% of the volume was taken out and measured and compared with the total count of the flask before the washing procedure. It was assumed that the 80% volumes should be divided by 0.8 to determine the total activity in the liquid. With 0.6 ml about 85% was extracted and with 1 ml 93% was extracted with similar washing effort. From ^{224}Ra based generator on average 86.1% (range 79.4%-93.4%) for 8 tests was extracted from the glass bottles. From ^{228}Th based generator on average 86.5% (range 84.5%-88.5%) for two tests was extracted from the glass bottles. In conclusion, ^{212}Pb trapped on the inner glass surfaces in the generators are easily extracted with 0.1 M HCl.

Example 19. Radiolabeling reactivity of solutions:

The TCMC-chelator-based molecule NG001 (Stenberg et al 2020) was used for testing ^{212}Pb labeling with the generator extracted ^{212}Pb. Lead-212 in 0.1 M HCl was added sodium acetate to adjust pH to about 5.5. Thereafter, NG001 was added to 10-20 micrograms per ml. After 30 minutes reaction on 37 °C using a Thermomixer (Eppendorf, Germany), samples were withdrawn and thin layer chromatography (TLC) was performed by mixing the samples 1:2 with 1 mM EDTMP in 7.5 % bovine serum albumin solution and let it stand for 5 minutes. Thereafter 1-5 microliter was applied onto a chromatography strip (model # 150-772, Biodex) and eluted with 0.9% NaCl solution in a beaker. When the liquid front reached the top of the strip, it was cut in two halves, each placed in a tube and counted separately in a Packard Cobra II gamma counter (Packard Instruments Co Inc, USA). The data showed that after 3 hours the activity of the bottom half would make up typically >99% indicating almost quantitative yield. Blind test without the NG001 but all the other compounds would give less than 3 % on the bottom half of the strip indicating good selectivity for the TLC test. In conclusion, the ^{212}Pb extracted from the generator flask showed excellent reactivity, indicating suitability for radiopharmaceutical use.

Example 20. Radiochemical purity of extracted solutions.

Lead-212 solutions were stored for 10 days or more and recounted for measuring ^{224}Ra. The ^{224}Ra activity was decay corrected back to time 0. The ^{224}Ra vs ^{212}Pb was determined to be on average 0.045% (range 0.01%-0.13%). In conclusion, the ^{212}Pb produced from the generator had high radiochemical purity relevant for pharmaceutical use.

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APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**08/14/2024 02:39:58 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Sheryl Mackey
PATENT CENTER #	66784855	FILING DATE	05/31/2024
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Lar
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Benjamin Walsh

Documents

TOTAL DOCUMENTS: 7

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
A138970001US02-TRN-BJW.pdf	1	Miscellaneous Incoming Letter	26 KB
A138970001US02-RCFR-BJW.pdf	2	Request for Corrected Filing Receipt	31 KB
A138970001US02-MUFR-BJW.pdf	7	Request for Corrected Filing Receipt	645 KB
A138970001US02-RCAP-BJW.pdf	2	Applicant Response to Pre-Exam Formalities Notice	26 KB
A138970001US02-MUSPEC-BJW.pdf	25	Specification	153 KB
A138970001US02-SUBSPEC-BJW.pdf	26	Specification	153 KB

A138970001US02-RDRW-BJW.pdf	5	Drawings-other than black and white line drawings	919 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
18/680,605	05/31/2024		1224	A1389.70001US02	30	2

CONFIRMATION NO. 5167

23628
WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

FILING RECEIPT

OC0000000074146116

Date Mailed: 06/18/2024

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

~~Roy H. Lar, Oslo, NORWAY~~; **Roy H. Larsen, Oslo, NORWAY;**

Applicant(s)

Sciencons AS, Oslo, NORWAY;

Assignment For Published Patent Application

Sciencons AS, Oslo, NORWAY

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 17/756,802 06/02/2022
which is a 371 of PCT/EP2020/084701 12/04/2020

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/680,605**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers.

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

PRODUCTION OF HIGHLY PURIFIED 212PB

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/680,605	05/31/2024	Roy H. Lar	A1389.70001US02

CONFIRMATION NO. 5167

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FORMALITIES LETTER

OC000000074146118

Date Mailed: 06/18/2024

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to the above-identified nonprovisional application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- **Drawing Items**

  The drawings submitted on 05/31/2024 are not acceptable because:

  - The figure labeling in the application is improper. Each figure must be labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (1A, 1B, etc.), beginning with Figure 1 (or Figure 1A). See 37 CFR 1.84(u)(1). When properly labeled, each brief description of the figures contained in the specification must correspond to a properly labeled figure.
    - To correct the figure numbering, replacement drawing sheets with proper figure labeling in compliance with 37 CFR 1.84 and 1.121(d) are required.
    - To correct the reference in the specification, a proper substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, providing a brief description of the several views of the drawings corresponding to the corrected labeling of the figures, is required. See 37 CFR 1.74 and 1.77(b)(9).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

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Derrick Brent
Deputy Under Secretary of Commerce for Intellectual Property and
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Docket No.: A1389.70001US02
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	Not Yet Assigned
Art Unit:	Not Yet Assigned

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Dated: August 14, 2024 Electronic Signature for Sheryl E. Mackey: /Sheryl E. Mackey/

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

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Dear Commissioner:

In response to the Notice to File Corrected Application Papers – Filing Date Granted mailed June 18, 2024, Applicant respectfully submits a Substitute Specification (both Marked-up and Clean Copies) and Replacement Drawings (5 figures, 5 pages).

The amendments made to the specification are limited to the minor typographical revisions and figure labeling formalities raised in the Notice. No new matter was added by these amendments.

Applicant believes no fee is due with this Response to Notice to File Corrected Application Papers. However, if a fee is due with this Response, please charge our Deposit Account No. 23/2825, under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Dated: August 14, 2024

Respectfully submitted,

By /Benjamin J. Walsh/
John S. Harmon, PhD, PE
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SUBSTITUTE SPECIFICATION – MARKED-UP COPY

Production of highly purified ^{212}Pb

FIELD

The present invention relates to a single chamber diffusion generator (assembly), assemblies and method for obtaining a container comprising ^{212}Pb on the walls obtained from a ^{212}Pb precursor isotope source. The invention provides an improved system and method for producing ^{212}Pb in high purity without the need for processing, with high yields, and which safely and efficiently can be transported to the locations where it is to be used.

BACKGROUND

Assemblies for preparing or producing ^{212}Pb have previously been described and based on ^{228}Th bound to stearate in a chamber with another chamber for collecting the ^{212}Pb after ^{220}Rn has diffused from the first chamber (source chamber) to the second chamber (collector chamber).

In another system the $^{228}Th/^{224}Ra$ was extracted from one vessel with a pump generated airflow and $^{220}Rn/^{212}Pb$ collected in another vessel. The system consisted of an "air loop" for transportation of ^{220}Rn and a "fluid loop" for ^{212}Pb rinsing and after rinse collection. This is a quite complex system which is not suitable for shipment and handling, and the potential for leakage or inappropriate use in for example a hospital is significant.

In another system an emanator source is placed inside one chamber and a gas flow passes through and carry ^{220}Rn to another chamber where $^{220}Rn/^{212}Pb$ is collected. After some time, the carrier gas valve is closed, and the collection unit is added a liquid through a top valve and the liquid is collected through a bottom valve. This system is as well relatively complex. Both of these systems need significant work effort of skilled workers and relatively advanced lab equipment and space to operate.

Also, generator systems for ^{212}Pb not relying on ^{220}Rn emanation and diffusion has been presented previously. In one existing generator system ^{224}Ra is bound to ion exchange material and the ^{212}Pb extracted by elution with acid which must be evaporated before it can be used for radiolabeling in another existing system the ^{212}Pb in a solution with ^{224}Ra is used for labelling following the removal of ^{224}Ra by size exclusion purification. Both these methods are working but requires extra time for processing, more so for the first method than the second.

^{212}Pb has a half-life of only 10.6 h. This half-life makes the radioisotope idea for medical applications such as anti-cancer treatment because it acts on its target and without prolonged side effects from a long half-life. However, this feature also makes is difficult to use in a commercial

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setting involving centralized production and long-distance shipment to end users simply because it decays fast which gives lower yields over time.

Thus a challenge for the current emanation and diffusion systems is transport distances which can reduce efficiency significantly due to decay of ^{220}Rn before reaching the collection vessels. For example, one system reported a total yield from a 3 day[[s]] operation of 2.01 MBq ^{212}Pb collected compared from a ^{228}Th source of 7.05 MBq, *i.e.* less than 30% yield. Increasing the operation time did not increase the amount collected and the system was sensitive to the air flow rate.

There is a need for alpha-emitter therapeutics for biomedical applications. Lead-212 (^{212}Pb) is a beta-emitter that decays to short lived progenies producing alpha particles and can thus act as an alpha emitter generator *in vivo* useful in alpha emitter therapeutics.

This industry therefore needs an improved system and method for producing ^{212}Pb in high purity without the need for processing, with high yields, and which safely and efficiently can be transported to the locations where it is to be used.

SUMMARY

An object of the present invention relates to a method for obtaining a container comprising ^{212}Pb on the walls comprising the steps of providing an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, connecting the first part and the second part such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container and such that a single chamber container assembly is provided, allowing the ^{212}Pb precursor isotope source sufficient time to decay to progenies ^{220}Rn, ^{216}Po, or ^{212}Pb, and sufficient time for ^{220}Rn, ^{216}Po and/or ^{212}Pb to settle onto the inner walls of the single chamber container assembly, removing or isolating the remaining ^{212}Pb precursor isotope from the single chamber assembly without having the ^{212}Pb precursor isotope source come into contact with an inner wall of the single chamber container assembly, and obtaining a container comprising ^{212}Pb on an inner wall of the container and substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. The described system may be termed a single chamber diffusion generator for ^{212}Pb.

In the following, precursor isotope is defined as a mother nuclide, grandmother nuclide, great grandmother nuclide etc. for ^{212}Pb i.e., ^{216}Po, ^{220}Rn, ^{224}Ra etc.

A further object of the present invention relates to an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container, and such that a single chamber container assembly is provided.

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Yet another object of the present invention relates to a single chamber container assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container.

In one or more embodiments of the invention the single chamber container assembly is gas tight.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is selected from the group consisting of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and/or ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{228}Th and ^{224}Ra.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th.The ^{212}Pb activity may vary from typically 0% to 114% of the ^{224}Ra precursor activity in the generator depending on the ingrowth status. The ^{212}Pb activity can be at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % of the ^{224}Ra precursor activity.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{228}Th measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{224}Ra measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the total amount of radioactivity in the single chamber container assembly is 1 kBq – 100 GBq.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in the form of an inorganic or organic salt, such as $RaCl_2$.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is bound to a non-radioactive material, such as particles or a holding material.

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In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a dry form or in a liquid solution, such as an aqueous solution or a dispersion.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a liquid solution that is at acidic, neutral or basic pH.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere that is made of a material suitable for application of a liquid.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers, cellulose.

In one or more embodiments of the invention a strip or sphere is attached to the second part, which comprises means for holding the strip or sphere, such as a rod.

In one or more embodiments of the invention the second part comprises a syringe, or wherein the rod is the syringe.

In one or more embodiments of the invention the syringe tip has been pushed through a rubber cap.

In one or more embodiments of the invention the second part comprises a rod that is attached to the means for opening and closing the container.

In one or more embodiments of the invention the means for opening and closing the container is a cap, cover or a lid.

In one or more embodiments of the invention the cap, cover or a lid is made of a material selected from the group consisting of rubber, glass, paper, plastic, metal, ceramic, and natural or synthetic fibers.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is placed on or in a sphere, suitable for holding the source but allowing radon diffusion.

In one or more embodiments of the invention the container comprises a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the gas permeable barrier impervious to the ^{212}Pb precursor isotope source is in contact with the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the container does not comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the volume of the container is 1 µl to 10 liters, such as 1 µl to 1 liter, such as 100 µl to 10 ml, such as 100 µl to 100 ml.

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In one or more embodiments of the invention the substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container is less defined as less than 3 % ^{224}Ra of the ^{212}Pb precursor isotope source, such as less than 1 %, such as less than 0,5 %, as measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the inner walls of the container are coated. The coating may be a film of salt or other suitable material on the inner walls.

In one or more embodiments of the invention the inner walls of the container are coated with a compound that comprises a chelator which can complex with ^{212}Pb.

In one or more embodiments of the invention the inner walls of the container are coated with a chelator which is TCMC or a variant hereof.

In one or more embodiments of the invention the container comprises an aqueous or an oil solution.

DETAILED DESCRIPTION

The present inventors have in response to the need for a simpler, safer system with less size and transport distances to handle the short half-life of ^{220}Rn and ^{212}Pb, designed an assembly whereby the radon producing source is placed inside the collector chamber or container. Instead of using ^{228}Th only as a source [[is]] the present invention <u>is</u> flexible and can ~~able to~~ use pure ^{224}Ra or a combination of ^{228}Th or ^{224}Ra as source, or even their precursor isotopes (Figure 1).

The assembly of the present inventions can be made very compact and very simple, allowing for a shippable and disposable ^{212}Pb-generator unit. In the present context is assembly, diffusion generator and system are used interchangeably. The described assembly or system may therefore be termed a single chamber diffusion generator for ^{212}Pb.

Thus, an object of the present invention relates to a method for obtaining a container comprising ^{212}Pb on the inner walls comprising the steps of providing an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, connecting the first part and the second part such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container and such that a single chamber container assembly is provided, allowing the ^{212}Pb precursor isotope source sufficient time to decay to progenies ^{220}Rn, ^{216}Po, and/or ^{212}Pb, and sufficient time for ^{220}Rn, ^{216}Po and/or ^{212}Pb to settle onto the inner walls of the single chamber container assembly, removing or isolating the remaining ^{212}Pb precursor isotope from the single chamber assembly without having the ^{212}Pb precursor isotope source come into contact with an inner wall of the single chamber container assembly, and obtaining a container comprising ^{212}Pb on an inner wall of the container

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and substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. Examples of such containers or assemblies are described in the examples of the present disclosure and can also be seen in ~~figures~~ Figures 2-5B.

An aspect of the invention relates to a method of obtaining a ^{212}Pb solution comprising obtaining the above container comprising ^{212}Pb on the walls and collect the ^{212}Pb in a solution. The ^{212}Pb can be collected in a solution that is in the container before the ^{212}Pb is generated or using a solution that is introduced to the container after the ^{212}Pb has been generated, and then collected. The collection can be done for example using a syringe.

A further object of the present invention relates to an assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container, and such that a single chamber container assembly is provided.

Yet another object of the present invention relates to a single chamber container assembly comprising a first part and a second part, wherein the first part comprises a container and the second part comprises a ^{212}Pb precursor isotope source, wherein the first part and the second part are connected such that the ^{212}Pb precursor isotope source does not come into contact with an inner wall of the container.

A huge advantage with the described assembly (or also defined herein as a container, system or a generator) is the ability to supply ^{212}Pb without the activity level is dictated by the short (10.6 h) half-life of ^{212}Pb. With the described system it is possible to produce a diffusion generator in a centralized production facility and ship it to the end user. A portable disposable generator could be made and shipped to *e.g.* a hospital from one end or the world to the other. For such a disposable unit, a pure ^{224}Ra (without ^{228}Th) is preferable as this would become inactive after 40-50 days approximately avoiding generation of long-lived radioactive waste. Such a diffusion source will steadily produce ^{220}Rn/^{212}Pb in a fashion dictated by the half-life of ^{224}Ra (Table 1 and Figure 1). The container, comprising the ^{212}Pb precursor isotope source, will produce ^{212}Pb due to the nature of decaying isotopes. The amount of ^{212}Pb deposited on will depend on several factors including the choice of ^{212}Pb precursor isotope source and time. The time is an important factor. An object of the invention relates to a method for preparing a substantially pure ^{212}Pb solution, the method comprising obtaining the assemblies and containers described herein, wherein the ^{212}Pb precursor isotope source is kept in the sealed assemblies and containers for a given time, the ^{212}Pb precursor isotope source is isolated or removed without coming into contact, and the ^{212}Pb on the walls are then collected by adding a solution that is suitable for collecting the ^{212}Pb. The time that the ^{212}Pb precursor isotope source is kept in the assemblies and containers of the present

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invention can be from minutes, to hours, to days, to years, depending on the choice of ^{212}Pb precursor isotope source and the amount of ^{212}Pb needed. The time can be at least one day. The time can be at least one day. The time can be at least two days. The time can be at least four days. The time can be at least a week. The time can be at least two weeks. The time can be at least two weeks. The time can be at least a month. The time can be at least a year.

^{212}Pb is a member of the thorium natural radionuclide series and can be found in materials containing ^{232}Th ($t_{1/2}$=1.4x10^{10} years). The ^{212}Pb precursor can therefore be chosen based on the intended use. A precursor with longer half-life can be chosen to generate an assembly or system that that will act as a ^{212}Pb generator for continuous production over a longer period of time. Alternatively, an isotope with a shorter half-life be used is the intended use for example is at a hospital or similar where generation of long-lived radioactive waste can be problematic. Naturally a mix of different precursors will therefore also be relevant and also where specific assemblies are needed for the generation of a specific amount of ^{212}Pb over a specific period of time.

Thus, in one or more embodiments of the invention the ^{212}Pb precursor isotope source is selected from the group consisting of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and/or ^{224}Ra. Thus, in the following ^{212}Pb precursor isotope is defined as a mother nuclide, grandmother nuclide, great grandmother nuclide etc. for ^{212}Pb, *i.e.* ^{216}Po, ^{220}Rn, ^{224}Ra ^{228}Th, ^{228}Ac, ^{228}Ra, ^{232}Th.

The decay of these radioisotopes can be seen in figure 1 which clearly indicate the possibility of creating a ^{212}Pb precursor isotope source with different decay profiles and different combinations of precursor isotopes will be able to generate ^{212}Pb at different rates over different periods of time.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is a mixture of ^{228}Th and ^{224}Ra. The source can also be each of ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th and ^{224}Ra individually, but due to the decay will a mixture naturally over time occur because ^{232}Th will decay to ^{228}Ra and so on. The key is that the gaseous ^{220}Rn is produced because it will diffuse from the source and later settle on the inner walls of the container as ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{228}Th measured as % radioactivity relative to ^{212}Pb.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th. The ^{212}Pb activity may vary from typically 0% to 114% of the ^{224}Ra precursor activity in the generator depending on the ingrowth status. The ^{212}Pb activity can be at least 90 %, such as at least 80 %, such as at least

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70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 10 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 20 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 30 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 40 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 50 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 60 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 70 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 80 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 90 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 100 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be at least at least 110 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 20 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 30 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 40 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 50 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 60 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 70 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 80 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 90 % of the ^{224}Ra precursor activity. The ^{212}Pb activity can be up to 100 % of the ^{224}Ra precursor activity.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{224}Ra that has at least 90 %, such as at least 80 %, such as at least 70 %, such as at least 60 %, such as at least 50 %, such as at least 40 %, such as at least 30 %, such as at least 20 %, such as at least 10 % ^{224}Ra measured as % radioactivity relative to ^{212}Pb.

The assembly working as a ^{212}Pb generator unit can be mass produced in a centralized production facility and shipped to end users for application in production of radiopharmaceuticals. It can also be adapted and used for large scale centralized production of ^{212}Pb. Thus, the amount of radioactivity in the assembly can adjusted according to its intended use. In one or more embodiments of the invention will the total amount of radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 kBq – 100 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 kBq – 10 MBq. The total amount of radioactivity in the single chamber container assembly can be 100 kBq – 10 MBq. The total amount of radioactivity in the single chamber container assembly can be 1 MBq – 1 GBq. The total amount of radioactivity in the single chamber container assembly can be 10 MBq – 10 GBq. The total amount of radioactivity in the single chamber container assembly

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can be 1 MBq – 1 GBq. The total amount of radioactivity in the single chamber container assembly can be 1 GBq – 100 GBq.

In one or more embodiments of the invention will the amount of ^{212}Pb radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq. In one or more embodiments of the invention will the amount of ^{212}Pb precursor isotope source radioactivity in the single chamber container assembly therefore can be 1 kBq – 100 GBq, such as 1 kBq – 10 MBq, such as 100 kBq – 10 MBq, such as 1 MBq – 1 GBq, such as 10 MBq – 10 GBq, such as 1 MBq – 1 GBq, such as 1 GBq – 100 GBq.

The ^{212}Pb precursor isotope source can be in different forms, sizes and shapes depending on the application type. Thus, in one or more embodiments of the invention the ^{212}Pb precursor isotope source is in the form of an inorganic or organic salt, such as $RaCl_2$. The ^{212}Pb precursor isotope source can also be in a dry form or in a liquid solution, such as an aqueous solution or a dispersion. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is in a liquid solution that is at acidic, neutral or basic pH. The pH can be 1-14, such as pH 1-6, pH 2-6, pH 2-8, pH 4-8, pH 5-7, pH 6-8, pH 7-8, pH 7,2, pH 8-10, pH 8-12, or pH 10-14.

The solution can be an aqueous solution. The solution can be a 0,1M aqueous HCl solution. This solution can also be used to dissolve the ^{212}Pb on the walls of the assembly.

The assembly working as a generator system may be used for preparing single patient dosing or for multiple patient dosing, or even for industrial use. The amount of radioisotope can therefore be adjusted depending on the application of the assembly.

The ^{212}Pb precursor isotope source can be placed on the rod, either directly or on a strip attached to the rod, typically in a very small liquid volume. In one or more embodiments of the invention the ^{212}Pb precursor isotope source is deposited on a strip or sphere that is made of a material suitable for application of a liquid. Such liquid can be in the amount of 1 µl to 1 ml, such as 1 µl to 10 µl, such as 1 µl to 100 µl.

When the container, which can be a vial, can be empty or contain a small volume of liquid in the bottom, that is not touching the source. In one or more embodiments of the invention the container comprises an aqueous or an oil solution.

It is important that the source does not drip or chip of in a fashion that causes cross contamination of the inner surfaces of the collector unit (container) with source material and that the source and source holder can be removed and or withdrawn from the collector without causing cross contamination by contact.

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In one or embodiments the source is surrounded by a grid or encapsulated in a porous material to reduce risk of cross-contamination. This encapsulation can be a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

Thus, in one or more embodiments of the invention the container does or does not comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source is placed on or in a sphere, suitable for holding the source but allowing radon diffusion. The container may comprise a gas permeable barrier impervious to the ^{212}Pb precursor isotope source, and the gas permeable barrier impervious to the ^{212}Pb precursor isotope source can be in contact with the ^{212}Pb precursor isotope source. In one or more embodiments of the invention the single chamber container assembly is gas tight.

Figure 2 shows an example of the single chamber container assembly where the container (the first part) is connected with a cap and a rod attached to the cap is used to hold the ^{212}Pb precursor isotope source (the second part) without having this source touch an inner wall of the container during the entire process.

In one or more embodiments of the invention the ^{212}Pb precursor isotope source can therefore be bound to a non-radioactive material, such as particles or a holding material. These can ensure that the source does not contaminate the container. The ^{212}Pb precursor isotope source can be deposited on a strip, sphere or a rod which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers. The strip or sphere can be attached to the second part or be contained or comprised in the second parts, which comprises means for holding the strip or sphere. Such means can for example be a rod.

In one or more embodiments of the invention the second part comprises, optionally, a rod that is attached to the means for opening and closing the container. The means for opening and closing the container can be a cap, cover or a lid which can be made of a material selected from the group consisting of rubber, glass, paper, plastic, metal, ceramic, and natural or synthetic fibers, cellulose ion exchange resin, natural mineral, polymer. Alternatively, the source is attached to a material placed onto the cap with or without being adhered to the cap. If the cap is placed on the bottom, the source material can be simply placed onto the interior of the cap without touching the ^{212}Pb collector part and kept in place by gravitation. In such case the generator unit should be stored and handled in position whereby cap with the source is always kept at the bottom.

The means for opening and closing the container can comprise the ^{212}Pb precursor isotope source. The ^{212}Pb precursor isotope source can be placed on a sponge, a wool or another substance that is capable of keeping the ^{212}Pb precursor isotope source in the means for opening and closing the

container. The wool can be a quartz wool. The wool can also be a mineral wool. The wool can also be a glass wool. The substance that is capable of keeping the ^{212}Pb precursor isotope source in the means for opening and closing the container can be attached by glue, double-sided mounting tape or other means for attachment.

In one or more embodiments of the invention the second part comprises a syringe, or wherein the rod is the syringe. The means for holding can be deposited on a strip or sphere which is made of material that is selected from the group consisting of paper, plastic, metal, ceramic, and natural or synthetic fibers cellulose ion exchange resin, natural mineral, polymer.

In one or more embodiments of the invention the syringe tip has been pushed through a rubber cap. An alternative design is where the second part is a rubber cap, or septum of another material permeable, and preferential self-sealing, with a syringe tip, with means for holding the ^{212}Pb precursor isotope source attached to the cap or to the inner walls of the container. In this case will user of the assembly be able to dissolve the ^{212}Pb from the inner walls of the container in an aqueous solution though a syringe that is pushed through the cap. The resulting ^{212}Pb in aqueous solution can afterwards be collected by the same syringe which will generate the option of working in a GMP environment which can be directly applied for patient use. Thus, in one embodiment the ^{212}Pb precursor isotope source be withdrawn into a capsule or similar allowing the container to be washed e.g., by using a solution transferred via a syringe through a rubber septum, without having to disassemble the two units. In another embodiment the assembly can be autoclaved, and the solution be of a physiological acceptable composition containing a chelator for disease targeting allowing withdrawal into a syringe and direct infusion with or without the use of a sterile syringe filter. In one embodiment the assembly including all subunits is autoclavable and with a syringe permeable zone on the cap allowing aseptic extraction of ^{212}Pb from the assembly.

After a few hours or days of operation the assembly with the ^{212}Pb precursor isotope source can be used for producing ^{212}Pb by retracting the ^{212}Pb precursor isotope source, e.g., by changing the cap with the attached ^{212}Pb precursor isotope source to a new cap without radioactivity and washing the inner surface with a suitable solution to dissolve surface deposited ^{212}Pb and progenies. Since the ^{212}Pb solution is free from long lived predecessor radionuclides it can be used directly without further chemical processing to label carrier molecules for e.g. cancer therapy.

The ^{212}Pb precursor isotope source can be associated with a needle, rod or a strip of a material of which ^{212}Pb precursor isotope source is attached to allow diffusion of ^{220}Rn. The source may or may not contain a holder for the radioactive part and a grid or ring or similar surrounding the source to prevent cross contamination when the ^{212}Pb precursor isotope source is withdrawn from the container. In one embodiment it may be attached to a screw cap that can be used to close the container. The ^{212}Pb precursor isotope source can be isolated from the container by withdrawing

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the source into a cover. This will ensure that the source does not cross contaminate the inner walls of the container while the ^{212}Pb is extracted, and also limit risk of exposure to the user of the assembly. It is important that after a period of decay the ^{212}Pb precursor isotope source and the ^{212}Pb adsorbed onto the vial inner surfaces can be separated by withdrawing the ^{212}Pb precursor isotope source form the container, e.g. by replacing the screw cap of which the source is attached by a rod or similar with a standard gas tight screw cap. Thus, [[In]] in one special embodiment is the ^{212}Pb precursor isotope source equipped with a retractable radioactive source that is withdrawn into the cap similar to a "click pen system" or similar for isolating the source from the generator ~~units~~ unit's interior surfaces and thus not require the disassembling and replacement of the cap (e.g. Figures 2 and 4A-4B). Thus, the second part of the assembly can comprise a piston that can be in open and closed positions. The second part of the assembly can also comprise a chamber with a gas tight o-ring seal. In one or more further embodiments the assembly comprises a gas and liquid tight lid or valve in the second part.

The second part of the assembly can, optionally, comprise a needle, rod or strip which may be supplied with a small ball of a material that can absorb radium or thorium including glass wool, quartz wool, mineral wool, metal, paper, cotton, stearate or another fatty acid, metal, cellulose, natural mineral, polymer, ion exchange resin, or other fibrous material. The composition of the holder of the precursor isotope should be chosen with care according to the known affinity of radon for various materials. A material that ^{228}Th and or ^{224}Ra has a good adsorption or absorption to and ^{220}Rn has a low affinity for would be suitable. The container can be made of a glass (including quartz), polymer and or metal, such as a glass vial, with a screw cap or similar, whereby the source is attached to the screw cap. The container (or assembly) can be a glass flask placed up-side down and with for example quartz wool with ^{224}Ra or ^{228}Th placed in the center of the inside of the cap. ^{212}Pb can be produced by unscrewing the flask standing up-side down from the cap with the source, and thereafter washing the interior of the flask with a solution to dissolve ^{212}Pb. The container can have a volume of 1 µl to 10 liters, such as 1 µl to 1 liter, such as 100 µl to 10 ml, such as 100 µl to 100 ml. The volume will depend on the use, where single use generally will be smaller and industrial batch containers will be larger.

Minimizing risk of cross contamination is important and the assembly has to be designed so that the ^{212}Pb precursor isotope source does not come into contact with the inner walls of the container. Thus, in one or more embodiments of the invention the container is substantially free of the ^{212}Pb precursor isotope source on the inner wall of the container. The definition of substantially free depends on use of the ^{212}Pb produced in the assembly. In one or more embodiments of the invention is "substantially free" defined as less than 3 % ^{224}Ra of the ^{212}Pb precursor isotope source, such as less than 1 %, such as less than 0,5 %, as measured as % radioactivity relative to ^{212}Pb. In one or more embodiments of the invention, the substantially free refers to the purity of

^{212}Pb vs ^{224}Ra in a solution from the walls of the container. This purity can be better than 95 %. This purity can be better than 98 %. This purity can be better than 99 %. This purity can be better than 99,5 %. This purity can be better than 99,8 %.

The container is surrounding, but not touching, the ^{212}Pb precursor isotope source. This should be made of an appropriate material, for example glass, plexiglass, metal, ceramics, polymer including polypropylene and Teflon or other materials suitable for allowing deposition of ^{220}Rn and/or ^{212}Pb on its inner walls and allowing ^{212}Pb to be dissolved when washed with a suitable solution for further use in radiolabeling. A solution can be used to wash the inner walls of the container to extract radionuclides, mainly ^{212}Pb and progenies. It may be present during the ^{212}Pb production period in the assembly or be applied after the ^{212}Pb precursor isotope source has been removed or withdrawn. In one embodiment the solution and an acidic or alkaline solution that can be transferred and neutralized before use for administration to a patient. In one embodiment the solution may be water of a suitable purity for pharmaceutical use. Solution volume of 1 ul to 1 liter for single dosing, e.g. 100 ul to 10 ml, and 1 ul to 10 liter or higher for multiple dosing may be used.

The container may or may not contain a surface film on the inner surfaces or some liquid to assist in collecting the diffusion product. This surface film can for example be a coating. Size and volume may be in microliter to ml for single dosing units and in microliters to tens of liters or higher for multiple dosing. The inner walls of the container can be coated. This coating can ensure that ^{212}Pb settles in an optimal way. In one or more embodiments of the invention the inner walls of the container are coated with a compound that comprises a chelator which can complex with ^{212}Pb. It is also possible that the inner walls are coated with one or more compounds where a complex with ^{212}Pb is needed. In one or more embodiments of the invention the inner walls of the container are coated with a chelator capable of chelating ^{212}Pb. This chelator can be TCMC or a variant hereof. The coating may be a film of salt or other suitable material on the inner walls.

In a special embodiment the container is washed directly with the reaction solution containing the complexing agent to yield a radiolabeling solution which after a suitable reaction time can be used directly for therapeutic purposes. In one embodiment the final product solution is autoclaved and or sterile filtered before administration to a subject in need thereof.

In one embodiment the assembly can be attached to a flushing and filtering circuit whereby when the source is retraced from the chamber a reservoir of a solution is connected and an outlet with a sterile filter and a syringe or vacuum pump is attached to flush the chamber and collect the flushing solution, *e.g.*, in similar fashion as for ^{99m}Tc-generators.

In general, surface ratios between precursor source holder and the collector chamber inner surfaces should be optimized so that as much as possible of the generated ^{212}Pb settles on the

collector chamber surfaces. The surfaces may be smooth, or porous or may contain structures to increase surface area relative to the diffusion subunit, container or assembly.

The production can be a production period of 5 hours, 10, hours, 20 hours or more. Afterwards the source may be withdrawn from the chamber into a tube-shaped holder or similar with a gas and liquid tight lid in the bottom that closes when the source is completely withdrawn. This allows for addition of a washing solution, *e.g.*, by a syringe, or activation of a flushing and collecting circuit *e.g.* similar to that of a ^{99m}Tc generator.

In a special embodiment the single chamber diffusion unit has its ^{212}Pb precursor isotope source as a film on the inside surfaces of the assembly and has the ^{212}Pb collector unit (container) inserted into the source covered surfaces without touching these, *i.e.* a reverse configuration compared to what is shown in figure 2.

In another embodiment the diffusion generator is subject to temperature manipulation, either elevated or reduced temperature vs 20 °C.

The use of the invention for includes in the production of radiopharmaceuticals, medical devices and or standardization sources for ^{212}Pb. The assembly of the present invention can be used to generate a ^{212}Pb standard for calibrations.

In one or more embodiments of the invention is the assembly of the present invention comprised in kit with the ^{212}Pb precursor isotope source, and a solution containing a chelator, and a compound that for use in therapy. Such compound can be a nano- or microparticle. In one embodiment such a kit will contain a ^{212}Pb precursor isotope source, a solution for washing the inner walls of the container and a solution or dry form of a carrier compound, for example a chelator, micro- or nanoparticles.

Tables

Table 1. Main radiation properties of the ^{224}Ra series.

Radionuclide (half-life)	Alphas and betas (mean energy in MeV)	X-rays and gammas Energy and % abundance
^{224}Ra (3.6 days)	α 5.6	241 keV, 4.1%
^{220}Rn (55.6 s)	α 6.3	
^{216}Po (145 ms)	α 6.8	
^{212}Pb (10.6 h)	β 0.1	75 keV, 10.3% 77 keV, 17.1% 87 keV, 6.0% 90 keV, 1.5% 239 keV, 43.6% 300 keV, 3.3%
^{212}Bi (1 h)	α 6.1 × 0.36 (2.2 MeV effective[1]) β 0.7 × 0.64 (0.4 MeV effective)	727 keV, 6.7% (4.3% effective)
^{212}Po (299 ns) (64% branch)	α 8.8 (5.6 effective)	
^{208}Tl (3.1 min)	β 0.6 (0.2 MeV effective)	75 keV, 3.4% (1.2% effective)

(36% branch)		511 keV, 22.6% (8.1% effective) 583 keV, 85.0% (30.6% effective) 860 keV, 12.5% (4.5% effective) 2615 keV, 99.8% (35.9% effective)

[1]Average per ^{224}Ra transformation due to branching. Only X-rays or gammas above 1% effective abundance accounted for. Adds up to a total effective energy of approximately 26.5 MeV of alpha of 0.7 MeV of beta per complete decay of a ^{224}Ra atom via progenies to a stable ^{208}Pb atom.

Table 2. A pure ^{212}Pb source with initial 100 MBq ^{212}Pb kept sealed and emptied for ^{212}Pb only once.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	23.1	4.4	0.92	0.192

Table 3. Lead-212 production from a source with initial 100 MBq ^{224}Ra kept sealed and emptied for ^{212}Pb only once.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	70.3	72.9	63.4	53.1
70% extraction recovery (MBq ^{212}Pb) in final product	49.2	51.0	44.4	37.2

Table 4. Lead-212 production from a source with initial 100 MBq ^{224}Ra source emptied for ^{212}Pb every 24 h.

Time	24 h	48 h	72 h	96 h
^{212}Pb (MBq) total	70.3	58.2	48.1	39.8
70% extraction recovery (MBq ^{212}Pb) in final product	49.2	40.7	33.7	27.9

The following figures and examples are provided below to illustrate the present invention. They are intended to be illustrative and are not to be construed as limiting in any way.

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BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows the decay of ^{232}Th to its progenies. The decay type (alpha or beta) is indicated and so is the half-lives. These half-lives are important because they dictate the decay rate and are therefore also key in deciding the optimal mix of isotopes as ^{212}Pb precursor isotope source for the production of ^{212}Pb.

Figure 2A shows a figure of the single chamber container assembly with the container (A), the [[a]] ^{212}Pb precursor isotope source (B) that generates the ^{220}Rn gas which is released into the single chamber container assembly and after decay settled as ^{212}Pb onto the inner walls of the container (C). The upper part of the single chamber container assembly (D) is the second part which comprises the ^{212}Pb precursor isotope source and in this case a cover/cap with a rod attached pointing towards the centre of the container thus enabling ^{212}Pb precursor isotope source release of ^{220}Rn into the container. Figure 2B shows a situation where the ^{212}Pb precursor isotope source (B) has been withdrawn into a gas tight seal that ensures that no ^{220}Rn is released into the container. The ^{212}Pb precursor isotope source can also be removed entirely from the assembly.

Figures 3A-3B show[[s]] pictures of a crude version of the generator system based on a 3 ml v-vial with a[[n]] membrane inserted open top screw cap penetrated by a syringe tip (with position fixed by tape on top of screw cap) and with a strip of laboratory bench paper attached to the syringe tip (left picture shows the ^{212}Pb precursor isotope source and container). The ^{212}Pb precursor isotope source is placed onto the strip by a pipette before the screwcap with the source is carefully attached to the vial (right picture). It is very important that the source is not touching the vial when assembling and disassembling the unit to avoid cross-contamination.

Figures 4A-4B. An example of a single chamber diffusion generator for ^{212}Pb with a retractable source simplifying washout of ^{212}Pb from the inner surfaces by having syringe permeable zones on the lid supplied with septum, a syringe could be used for washing of the interior surfaces without radionuclide cross contamination when the unit is put in closed position (FIG. 4B).

Figures 5A-5B. ~~Top picture~~ Figure 5A shows a 100, 50 and 10 ml generator unit for ^{212}Pb production. ~~Bottom pictures~~ Figure 5B shows the cap with quartz wool in the center of the inner surface. The ^{212}Pb precursor nuclide solution can be placed onto the quartz wool and the flask

mounted for up-side-down storage to produce ^{212}Pb deposited on the flask' inner surface generated via ^{220}Rn diffusion from the precursor source material.

EXAMPLES

Example 1 - Calculation of the relative ^{212}Pb daughter nuclide level at various time points

Background. The development and use of pure ^{212}Pb in therapeutic radiopharmaceuticals is hampered by the short half-life (10.6 h) of the radionuclide making it almost impossible to produce a product in a centralized fashion and shipped to the end user. If ^{224}Ra is used as a short-term generator for ^{212}Pb the level of ^{212}Pb activity can be maintained essentially according to the half-life of ^{224}Ra, which is 3.6 days. The variation in ^{212}Pb level in a sealed source of pure ^{224}Ra is shown.

Method: The ingrowth of ^{212}Pb from a pure ^{224}Ra source were calculated using a universal activity calculator.

Results: Table 2 shows the amount of ^{212}Pb at various time points after the production of a pure (^{224}Ra-free) pharmaceutical solution and storage in a gas tight container. As can be seen the pure ^{212}Pb source rapidly decays and lose more than 75% per 24 h. Table 3 shows the amount of ^{212}Pb present in a sealed source of ^{224}Ra at the same time points. As can be seen the ^{212}Pb activity is maintained at a high level (> 50%) at least up to 96 h.

Table 4 shows the effect of "milking" a ^{224}Ra precursor-based generator for ^{212}Pb several times during a 96-h period.

The data also shows that significant amount of daughter nuclide is present within a relatively short time frame when starting with pure ^{224}Ra. It is noteworthy though that the ratio of ^{212}Pb to ^{224}Ra in the solution reaches 1 after 36 hours and thereafter gradually increases to about 1.1 of which is kept for the rest of the time until complete decay. In conclusion, using ^{224}Ra as a source for ^{212}Pb makes the logistic of centralized production and shipment to end users possible providing an easy way to extract the ^{212}Pb from ^{224}Ra exist.

Example 2 - Preparation of radionuclides and counting of radioactive samples

In the following, all work with the concentrated radioactive preparations including evaporation of solvent etc was performed in a glove-box. A source of ^{228}Th in 1 M HNO3 was acquired from a commercial supplier. Ac-resin was obtained from Eichrom Technologies LLC (Lisle, IL, USA) in the form of a pre-packed cartridge.

Radium-224 was made from ^{228}Th bound to Actinide resin (Eichrom Technologies, LLC) by eluting a column containing actinide resin with immobilized ^{228}Th with 1 M HCl. The eluate was purified on a second Ac-resin column and the eluate evaporated to dryness using an evaporation vial with a cap with gas inlet and outlet placed in a heater block at approximately 110 ◦C and a gentle stream of nitrogen gas to evaporate of the solvent. When the evaporation vial was empty from solvent it was added 0.1 M HCl to dissolve the residue, typically 200-400 µl. Typically, more than 70% of the ^{224}Ra present in the ^{228}Th source could be extracted and purified using the described methods.

Radioactive samples were counted on a Cobra II Autogamma counter (Packard Instruments, Downer Grove, IL, USA). During extraction of ^{224}Ra from the ^{228}Th source, a CRC-25R dose calibrator (Capintec Inc., Ramsey, NJ, USA) was used.

Example 3 - Determining net count rate for ^{212}Pb in a ^{212}Pb/^{224}Ra mixture before radioactive equilibrium has been reached

After more than 3 days, i.e., “equilibrium” a sample kept gas tight will for practical purposes have 1.1 times ^{212}Pb vs ^{224}Ra.

In a gas tight unit regardless of whether ^{212}Pb is at or lower than equilibrium it can be assumed that this is reached after 3 days since surplus ^{212}Pb is reduced by 99% and the ingrowth of ^{212}Pb from ^{224}Ra is practically complete vs. “equilibrium”.

Using the Cobra II Autogamma counter with a counting window setting from 70-80 KeV gives mainly the ^{212}Pb with very little contribution from other radionuclides in the ^{224}Ra series. Radium-224 must be indirectly counted when the initial ^{212}Pb has vanished and equilibrium between ^{224}Ra and ^{212}Pb has been reached (after approximately 3 days). This indirect counting requires the sample to be stored in a relatively gas tight containers as otherwise the ^{220}Rn may escape preventing the radionuclide equilibrium of 1.1 between ^{212}Pb and ^{224}Ra to be reached.

Since sampling and counting may be separated by some time, the net count rate for ^{212}Pb can be adjusted for decay to determine the net ^{212}Pb count rate at the time of sampling. By storing ^{212}Pb samples for a week or longer and remeasure, the amount of ^{224}Ra contaminant can be determined as activity after about 110 hours of storage would not be ^{212}Pb but must be from longer lived precursor isotope.

Example 4 - A simplified single chamber (diffusion chamber generator) assembly for ^{212}Pb production (Figures 3A-3B).

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A 3 ml v-vial with an open top cap. The open top cap was supplied with a membrane permeable by a syringe tip. A syringe tip was pushed through the membrane and fixed with tape on top to lock the position of the tip with regard to the open top cap. On the syringe tip vas placed a strip of absorbent paper about 0.5 X 3 cm by inserting the syringe tip in two holes in the strip. The paper strip was added 2-40 ul ^{224}Ra solution. Thereafter the cap was placed carefully onto the v-vial while the syringe tip and radioactive strip were not to touch the inside of the v-vial. Thereafter the assembly was standing for various time to produce ^{212}Pb via ^{220}Rn diffusion from the strip to the space surrounding the strip. The ^{212}Pb tended to settle on the inner surfaces of the v-vial. Depending on the liquid volumes used for applying the ^{224}Ra source onto the strip, there may be some condensation of liquid due to evaporation/condensation of the liquid applied. Alternatively, the source could be dried before assembling the unit to avoid any solvent condensation on the v-vial inner surfaces.

Example 5A: Production of ^{212}Pb with the ^{212}Pb precursor isotope source absorbed on a paper strip.

Methods: The assembly was assembled with ^{224}Ra placed on the strip of the diffusion subunit inserted in a v-vial according to Figures 3A-3B, and was standing for 17.5 h or more to produce ^{220}Rn and ^{212}Pb. Production of ^{212}Pb evaluation of radiochemical purity of product. At the end of the production period the whole unit was measured on a Capintec dose calibrator. The product was evaluated by separating the source from the container and cap the latter with a gas tight screw cap and measure immediately in the Capintec dose calibrator. The purity of the product was determined by measuring the collector subunit again after a few days when all the ^{212}Pb had decayed but the presence of longer-lived predecessor nuclides ^{224}Ra and ^{228}Th would have been measurable. Results: Highly purified ^{212}Pb was collected in the collector subunit with a relevant yield of 65.6% (range 62.7-69.9% n=4) and with no measurable longer-lived precursor nuclides present (< 0.5%). In conclusion: The assembly was effective in producing and collecting purified ^{212}Pb in an easy manner without need for further purification.

Example 5B: Production of ^{212}Pb with the ^{212}Pb precursor isotope source absorbed on a parafilm strip. The experiment from 5A was repeated except that a parafilm strip was used instead of paper a strip to carry the precursor isotope source.

Results: The yield of ^{212}Pb on the inner surfaces of the collector subunit (vial or container) was found to be only 19.3%. In contrast a unit with paper strip run in parallel with exact same

configuration and emanation period gave a yield of 63.9%. In conclusion, the material used for absorbing and holding the ^{212}Pb precursor isotope source could greatly affect the yield of ^{212}Pb on the collector subunit or container.

Example 6: Dissolving of ^{212}Pb from the container using a solution.

Methods: The collector vial was added 0.3-0.5 ml 0.1 M HCl which was gently swirled to contact the inner surfaces with the liquid and counted in the Capintec dose calibrator. Thereafter the liquid was transferred to an Eppendorf tube and measured in the Capitec dose calibrator. The extraction yield was 74.0 % (range 70.0-76.9%, n=3) when the collector subunit (3 ml v-vial), was washed one single time with 0.3 ml 0.1 M HCl. In conclusion, ^{212}Pb absorbed onto the surfaces of the container was rapidly and with good yield dissolved by a solution useful for radiopharmaceutical processing.

Example 7: Thin layer chromatography analyses

Thin layer chromatography (TLC) was performed using chromatography strips (model # 150-772, Biodex Medical Systems Inc, Shirley, NY, USA). A small beaker with about 0.5 ml of 0.9% NaCl was used to place strips with a sample spot in. To the strip was typically added 1-4 µl of sample at approximately 10% above the bottom of the strip. After the solvent front had moved to about 20% from the top of the strip, the strip was cut in half and each half was placed in a 5 ml test tube for counting. In this system radiolabeled antibody and free radionuclide does not migrate from the bottom half while radionuclide complexed with EDTA migrates to the upper half. A formulation buffer (FB) consisting of 7.5% human serum albumin and 1 mM EDTA in DPBS and adjusted to approximately pH 7 with NaOH was mixed with the radioconjugates in ratio 2:1 for at least 5 minutes before application to the strips to determine free radionuclide. It was verified that in a test solution with free ^{212}Pb was the radionuclide was completely (> 99%) complexed by the EDTA, when mixed with FB, and would travel to the upper half of the TLC strip.

Example 8: In situ chelation of ^{212}Pb in solutions.

Background: The labeling properties of the ^{212}Pb extracted with 0.1 M HCl from the containers was evaluated. Methods: A 10:1 ratio of ^{212}Pb in 0.1 M HCl and 5 M ammonium acetate was used before addition of the chelators, resulting in a pH range of 5 – 6 for the reactions. Reaction times of 15-30 minutes at 37 °C, were tested. For PSMA-617 solutions of 5 µg per 100 µl was labeled with

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good yield of 96.6% as determined by TLC. Also, TCMC-conjugated Herceptin antibody solution of approximately 1.0 mg/ml was labeled with pure ^{212}Pb with a good yield of 98.9%. In conclusion: Lead-212 produced with the assembly was readily complexed with small molecular and large molecular conjugates indicating suitability for use in production of ^{212}Pb based radiopharmaceuticals.

Example 9 - Production of ^{212}Pb from the ^{224}Ra source when unit is kept sealed and emptied only at one time point

Table 3, lower row, shows the example of an output from a diffusion generator emptied after various time points after insertion of the source of 100 MBq of ^{224}Ra into the unit. As shown the generator gives a relatively stable output of ^{212}Pb for up to 96 h.

Example 10 - Production of ^{212}Pb from the ^{224}Ra source when unit is emptied once a day for four days e.g. if used for fractionated radionuclide therapy etc.

Table 4 shows the output when the assembly is "milked" once every 24 h. The combined output is a total of 151.5 MBq of ^{212}Pb when starting with a 100 MBq source. In conclusion, the one chamber assembly is suitable for single dose as well as fractionated dose production.

Example 11 - Example of an assembly with a retractable source (Figure 2 and Figures 4A-4B)

The materials used may be of glass (including quartz), polymer, metal, ceramic or other suitable materials for pharmaceutical containers. The rod in ~~figure~~ Figure 2 (piston in ~~figure~~ Figures 4A-4B) slides in a tube with o rings or similar at the top to secure gas tight seal. The valve at the bottom of the rod is gas and liquid tight in the closed position for the unit.

In the open position the source will be exposed inside the container and emanate ^{220}Rn and cause deposit of ^{212}Pb onto the inner surface. In closed position the source is sealed off from the container (Figure 2B) and the container surfaces can be contacted with a suitable solution to dissolve ^{212}Pb.

In one embodiment where the cap has syringe permeable membrane, a sterile syringe with a sterile solution is used to extract the ^{212}Pb without removing the cap. When such unit has been autoclaved before the extraction of ^{212}Pb, the complete procedure can be performed in an aseptic/sterile fashion.

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Example 12. Precursor nuclide placed onto quartz wool in a ^{212}Pb single chamber generator.

Methods: A flask[[s]] as shown in ~~figure~~ Figures 5A-5B, was used. Flask size could vary and typically 10-100 ml flasks were used. When used as a generator the flask was turned-up-side down. The cap was removed and inside of the center of the cap was placed quarts or glass wool. Radium-224 in solution was placed on the quartz wool and the flask was mounted onto the cap without touching the quartz wool with the flask. The unit was kept tight and stored in up-side-down position for a period of time to produce ^{212}Pb from ingrowth. After typical one to a few days the flask was unscrewed from the cap while being held up-side-down and carefully removed from the cap without touching the quartz wool. The cap with the source was combined with another flask and stored up side down for further ^{212}Pb production. The unscrewed ^{212}Pb containing flask was added a solution of 0.5-2 ml of 0.1 M HCl and the ^{212}Pb extracted from the flask by washing the interior surfaces and collected for use.

Results: Typically, 50-70 percent of the ^{212}Pb activity produced was found in the flask and by carefully washing more than 90% of the ^{212}Pb activity could be collected in the washing solution. The produced ^{212}Pb had a very high purity with ^{224}Ra being as low as 10^{-4} vs ^{212}Pb in newly extracted solutions. The product was very suitable for use in labeling of chelator-containing proteins and small molecules giving very high labeling yields, typically above 97%.

In conclusion, the data showed that quartz wool was very suitable for holding a ^{224}Ra source indicating that quartz/glass/mineral wool, metal wool etc would be suitable for this purpose. It would be possible to use the flask/ quartz wool system in upright position also providing the quartz wool is adhered to the capsule, e.g. with glue, double-sided mounting tape etc. In the current example the flask was used up-side down and the quartz wool was not adhered, but just placed and kept by gravity in position inside the cap.

Example 13. Up-side-down flask system version of single the chamber generator.

Flask based diffusion generator for labeling with ^{212}Pb.

Lead-212 generate therapeutic high-LET radiation as it decays via short-lived alpha emitting daughters resulting in an average of one alpha particle per ^{212}Pb decay. The half-life of ^{212}Pb of 10.6 hours is a limitation to its use and fast and safe production and purification procedures are required. If a ready to use product was to be produced in a centralized production facility and shipped to the end user, the activity level would be reduced to less than 25% in one day. Lead-212 based radioimmunoconjugate has been in clinical testing against peritoneal cancer using ^{212}Pb separated from ^{224}Ra in a cation exchange column and eluted in mineral acid which has to be reconstituted before radiolabeling. This method requires a significant work effort, facilities, and

equipment suitable for evaporation of mineral acids etc to work up the ^{212}Pb from the ^{224}Ra generator material. An alternative generator method was developed and tested based on ^{224}Ra absorbed onto quartz wool and placed inside the centered ring of a removable cap (the generator cap), in a generator chamber. The chamber consists of a glass bottle turned upside down and the removable cap supports the ^{224}Ra labeled quartz wool (Figures 5A-5B). When ^{224}Ra decays, the short-lived ^{220}Rn emanates from the quartz wool and causes absorption of the longer-living decay product, ^{212}Pb, onto the interior surfaces of the flask. The flask can be removed from the cap without the glass coming in contact with the quartz wool. After removing the flask from the generator cap, the flask can be rinsed on the inside with 0.1 M HCl to dissolve the ^{212}Pb deposits whereby a highly purified ^{212}Pb solution is made. The operation and washout of the generator flask is made prior to radiolabeling of NG001. The purity of ^{212}Pb vs ^{224}Ra in the solution is, when the generator is operated in a correct manner (i.e. that the source does not come into contact with the walls), better than 99.8%. The generator can be re-used by attaching a new glass bottle to the generator cap and store for typically 1-2 days for the generation of fresh ^{212}Pb.

In summary, the generator method is easier to use and less time consuming compared with ion exchange-based generators. The generator may be re-used several times (although with a decreasing capacity due to radioactive decay depending of source half-life).

Example 14: Size of collector flask,

The flask sizes of 10, 50 and 100 ml was tested (Figures 5A-5B, upper part). ^{224}Ra was added to quarts wool placed in the cap of flasks placed upside down. The % ^{212}Pb on the flask compared with the theoretical yield varied from about 40% to 60%. It tended to be an advantage to use a larger flask to cap inner surface volume to obtain high yield. In conclusion, flasks with various sizes could be used for generator purposes but a relatively large flask vs. cap seemed to improve ^{212}Pb yield as relatively less would be lost due to absorption on the cap and the source material.

Example 15: Materials for holding the source.

To hold the source material in place inside the generator, e.g., in the inner cap center, Steel wool, glass wool, quartz wool was tested with ^{224}Ra sources. The materials are porous and fluffy and allows for diffusion. A volume of 100-150 microliter of ^{224}Ra in 0.1 M HCl was deposited onto the materials placed inside the caps of 100 ml flasks. After standing for 2-3 days or more, 52-64% of the ^{212}Pb compared to ^{224}Ra present in the generator would have settled on the glass surfaces, so all the three materials would work. i.e., quartz wool averaged of 5 tests, 59.9% (range 52.1-64.4%), glass wool 54.9% and steel wool 64.1% for one test each as compared to ^{224}Ra activity in the

generator. In conclusion, several different materials could be used to hold the source in the one chamber diffusion generator.

Example 16: Sources.

The radionuclides ^{224}Ra and ^{228}Th were used as sources inside the generators. The ^{224}Ra -based generator could be used typically repeatedly up to a few weeks while the ^{228}Th -based unit could be used repeatedly for several months and deliver ^{212}Pb by simply switching the glass flask with an unused one and wash the first flask to produce a ^{212}Pb solution. Yield was not significantly reduced with repeated use except for the decay of the generator radionuclide. As long as the sources are centered inside the cap to avoid contact with the glass bottle, and flasks and caps are kept dry, cross contamination from source to the glass flask was minimal. In conclusion, the single chamber diffusion unit could be used repeatedly for producing ^{212}Pb with both ^{228}Th and ^{224}Ra as the sources. Lead-212 activity on the inner glass surfaces from ^{228}Th a source was found to be on average 49.3% (range 40.9%-66.7%) from four tests.

Example 17: Preparation including heating: To heat up flask before mounting onto the cap with the source material could be a way to produce reduced pressure in the generator. The flask was heated to 90 ^{o}C in a heat chamber for at least 15 minutes and then the flask and cap was screwed tightly together to be gas tight. The generator unit was thereafter stored at room temperature causing reduced inner pressure. After 1-4 days the chamber was opened and the ^{212}Pb activity on the glass flask was measured. The yield from four tests using ^{224}Ra on quartz wool was on average 68.1% (range 60.5%-75.9%, indicating improved yield compared with previous data for normal pressure flasks (average 59.9%). In conclusion, reduced chamber pressure may improve the yield of ^{212}Pb with the one chamber diffusion generator.

Example 18: Yield of ^{212}Pb in the washout solution.

A standard solution of 0.1 M HCl was used for extracting the ^{212}Pb trapped on the inner glass surface of 100 ml flasks. The washing solution was carefully shaken and swirled to cover the inside of the flasks for about 2 minutes and then 80% of the volume was taken out and measured and compared with the total count of the flask before the washing procedure. It was assumed that the 80% volumes should be divided by 0.8 to determine the total activity in the liquid. With 0.6 ml about 85% was extracted and with 1 ml 93% was extracted with similar washing effort. From ^{224}Ra based generator on average 86.1% (range 79.4%-93.4%) for 8 tests was extracted from the glass bottles. From ^{228}Th based generator on average 86.5% (range 84.5%-88.5%) for two tests was extracted

from the glass bottles. In conclusion, ^{212}Pb trapped on the inner glass surfaces in the generators are easily extracted with 0.1 M HCl.

Example 19. Radiolabeling reactivity of solutions:

The TCMC-chelator-based molecule NG001 (Stenberg et al 2020) was used for testing ^{212}Pb labeling with the generator extracted ^{212}Pb. Lead-212 in 0.1 M HCl was added sodium acetate to adjust pH to about 5.5. Thereafter, NG001 was added to 10-20 micrograms per ml. After 30 minutes reaction on 37 °C using a Thermomixer (Eppendorf, Germany), samples were withdrawn and thin layer chromatography (TLC) was performed by mixing the samples 1:2 with 1 mM EDTMP in 7.5 % bovine serum albumin solution and let it stand for 5 minutes. Thereafter 1-5 microliter was applied onto a chromatography strip (model # 150-772, Biodex) and eluted with 0.9% NaCl solution in a beaker. When the liquid front reached the top of the strip, it was cut in two halves, each placed in a tube and counted separately in a Packard Cobra II gamma counter (Packard Instruments Co Inc, USA). The data showed that after 3 hours the activity of the bottom half would make up typically >99% indicating almost quantitative yield. Blind test without the NG001 but all the other compounds would give less than 3 % on the bottom half of the strip indicating good selectivity for the TLC test. In conclusion, the ^{212}Pb extracted from the generator flask showed excellent reactivity, indicating suitability for radiopharmaceutical use.

Example 20. Radiochemical purity of extracted solutions.

Lead-212 solutions were stored for 10 days or more and recounted for measuring ^{224}Ra. The ^{224}Ra activity was decay corrected back to time 0. The ^{224}Ra vs ^{212}Pb was determined to be on average 0.045% (range 0.01%-0.13%). In conclusion, the ^{212}Pb produced from the generator had high radiochemical purity relevant for pharmaceutical use.

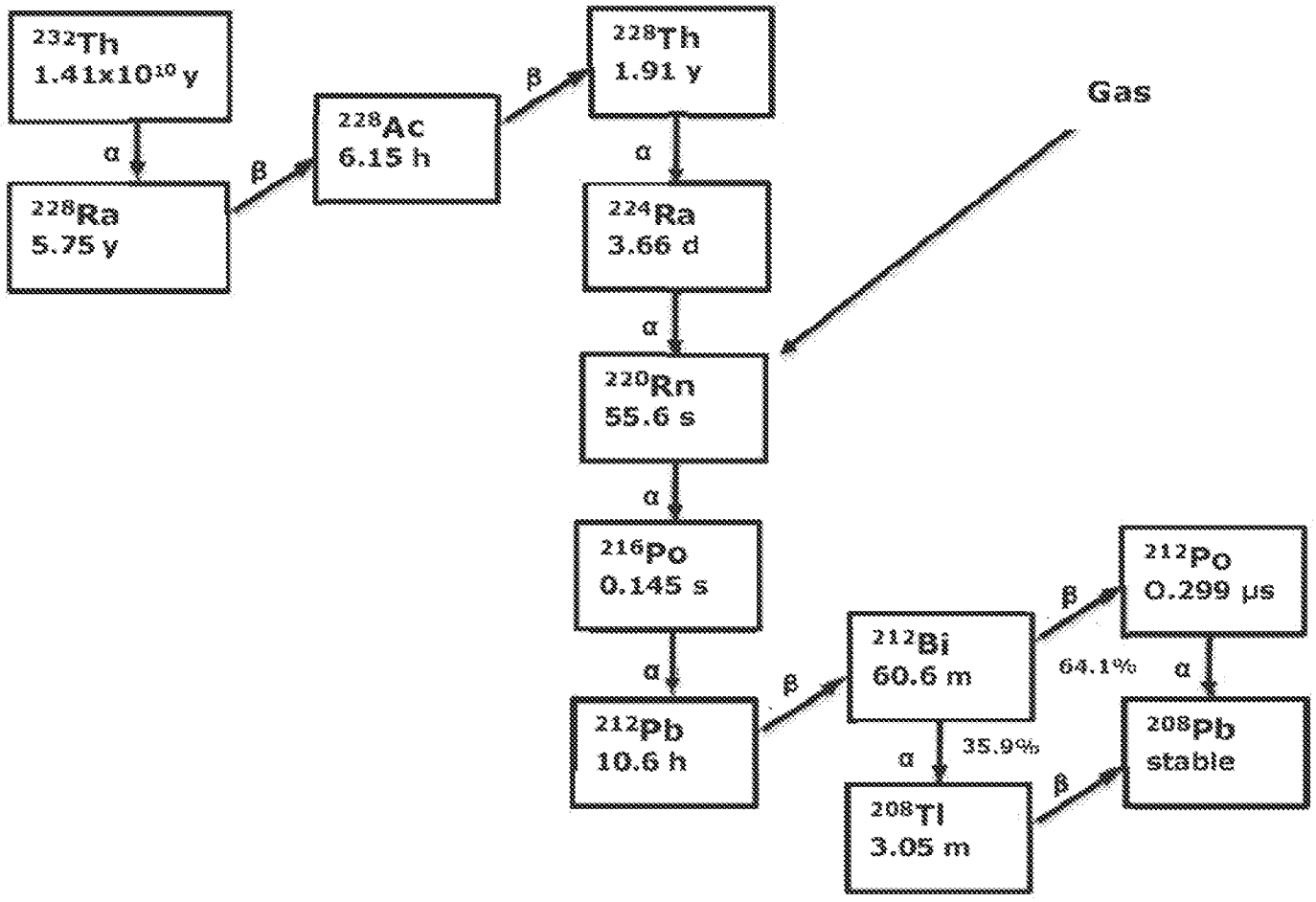

232Th
1.41x10^10 y
α
228Ra
5.75 y
β
228Ac
6.15 h
β
228Th
1.91 y
α
224Ra
3.66 d
α
220Rn
55.6 s
α
216Po
0.145 s
α
212Pb
10.6 h
β
212Bi
60.6 m
64.1%
β
212Po
0.299 µs
α
208Pb
stable
α
35.9%
208Tl
3.05 m
β
Gas

Fig. 1

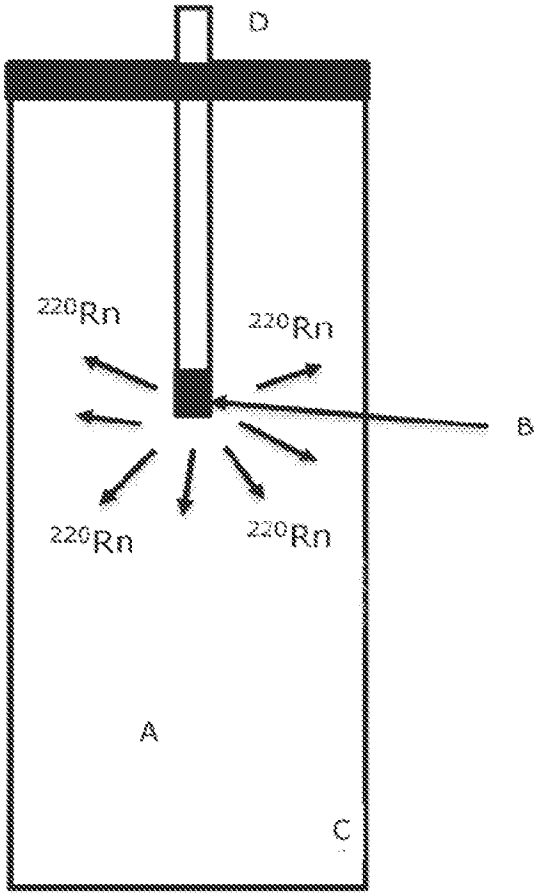


Fig. 2A

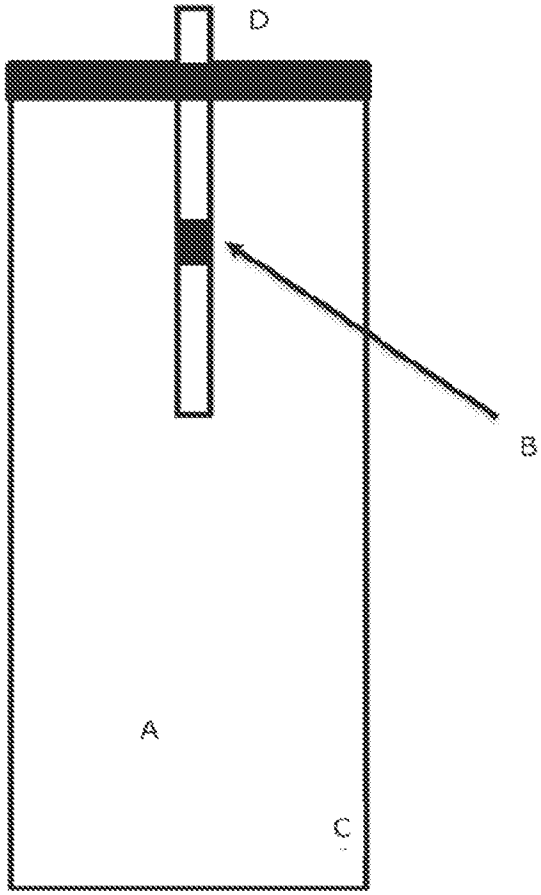


Fig. 2B



Fig. 3A

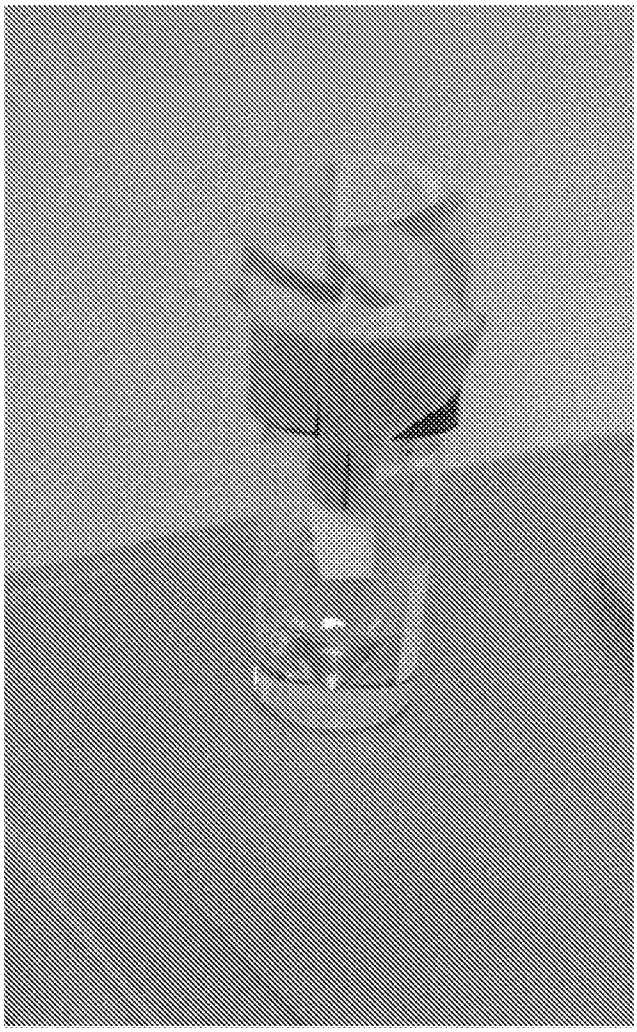


Fig. 3B

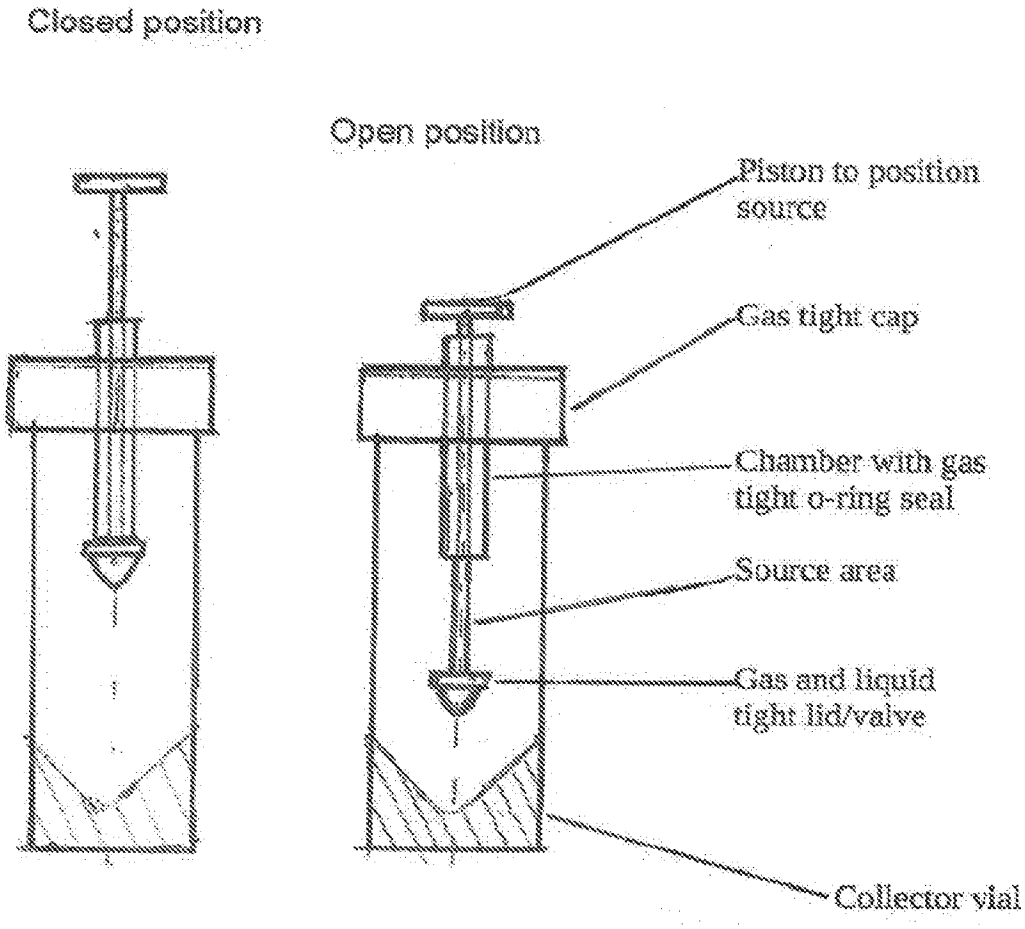

Closed position
Open position
Piston to position source
Gas tight cap
Chamber with gas tight o-ring seal
Source area
Gas and liquid tight lid/valve
Collector vial

Fig. 4A

Fig. 4B

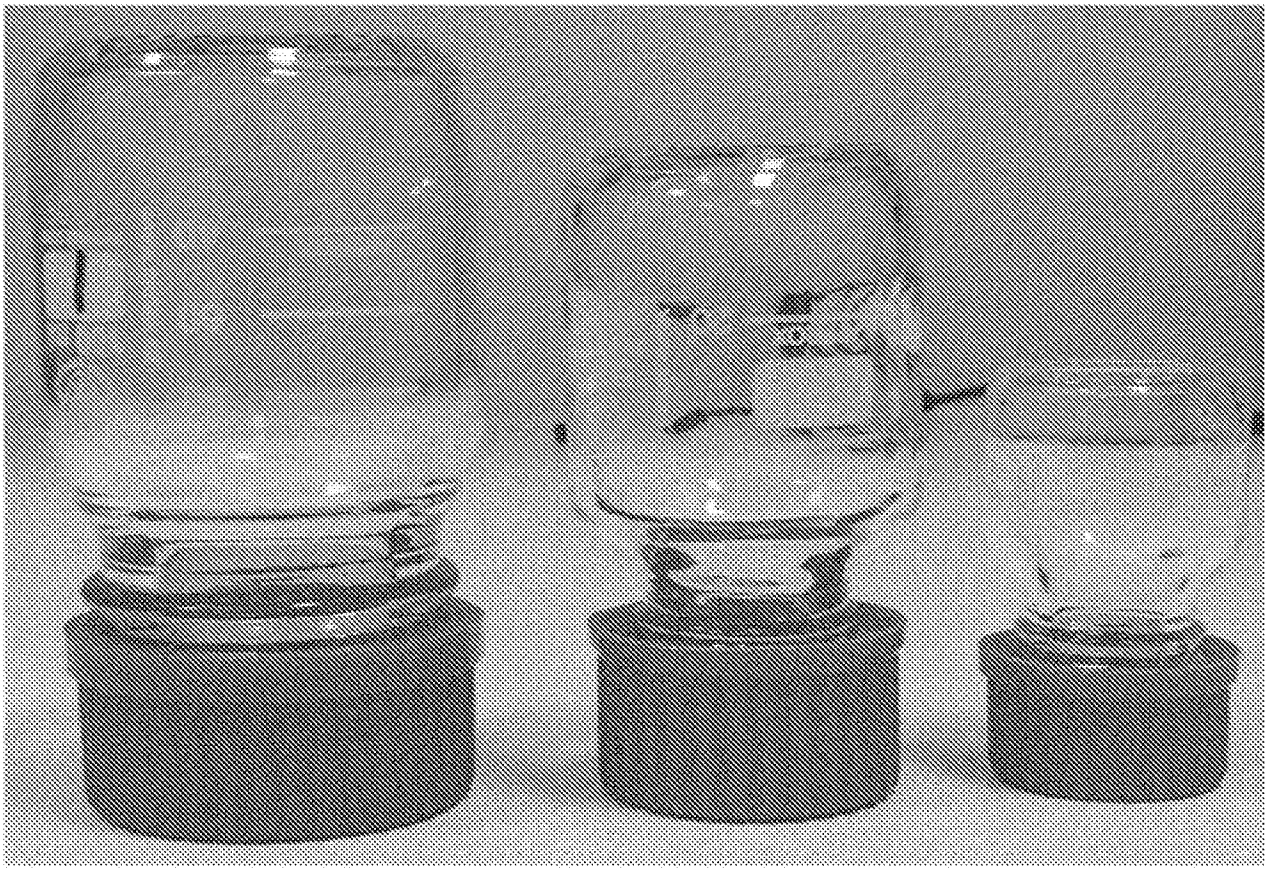


Fig. 5A



Fig. 5B

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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission	

Application Number	18/680,605-Conf. #5167
Filing Date	May 31, 2024
First Named Inventor	Roy H. Larsen
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	A1389.70001US02

ENCLOSURES (*Check all that apply*)

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [x] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53

- [x] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD

Remarks

- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

- Request for Corrected Filing Receipt
- Marked Up Filing Receipt
- Substitute Specification (Clean Copy)
- Substitute Specification (Marked Up Copy)

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	WOLF, GREENFIELD & SACKS, P.C.		
Signature	/Benjamin J. Walsh/		
Printed name	Benjamin J. Walsh		
Date	August 14, 2024	Reg. No.	82,138

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: August 14, 2024 Electronic Signature for Sheryl E. Mackey: /Sheryl E. Mackey/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
18/680,605	05/31/2024		1224	A1389.70001US02	30	2

CONFIRMATION NO. 5167

UPDATED FILING RECEIPT

23628
WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206



Date Mailed: 08/21/2024

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Roy H. Larsen, Oslo, NORWAY;

Applicant(s)

Sciencons AS, Oslo, NORWAY;

Assignment For Published Patent Application

Sciencons AS, Oslo, NORWAY

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 17/756,802 06/02/2022
which is a 371 of PCT/EP2020/084701 12/04/2020

Foreign Applications (You may be eligible to benefit from the Patent Prosecution Highway program at the USPTO. Please see http://www.uspto.gov for more information.)
EUROPEAN PATENT OFFICE (EPO) 20172038.0 04/29/2020 No Access Code Provided
EUROPEAN PATENT OFFICE (EPO) 19213759.4 12/05/2019 No Access Code Provided

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 06/17/2024

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/680,605**

Projected Publication Date: 11/28/2024

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

PRODUCTION OF HIGHLY PURIFIED 212PB

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

AdvanCell - Exhibit 1006 - Page 152

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 18/680,605

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	64		N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	280		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	320		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	30 minus 20 =	* 10	x 40 =	400	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*	x =	0			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	1064		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

Doc Code: TRAN.LET
Document Description: Transmittal Letter

USED IN LIEU OF PTO/SB/21 (07-09)

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission	

Application Number	18/680,605-Conf. #5167
Filing Date	May 31, 2024
First Named Inventor	Roy H. Larsen
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	A1389.70001US02

ENCLOSURES (*Check all that apply*)

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [x] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53

- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
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- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD

Remarks

- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Form PTO-1449
Copy of cited reference

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	WOLF, GREENFIELD & SACKS, P.C.		
Signature	/John Harmon/		
Printed name	John S. Harmon, PhD, PE		
Date	8/21/24	Reg. No.	67,131

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: 8/21/24 Electronic Signature for Timothy Peng: /Timothy Peng/

DOCKET NO.: A1389.70001US02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	Not Yet Assigned
Art Unit:	Not Yet Assigned

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: 8/21/24 Electronic Signature for Timothy Peng: /Timothy Peng/

MAIL STOP AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATEMENT FILED PURSUANT TO THE DUTY OF DISCLOSURE UNDER 37 C.F.R. §§ 1.56, 1.97 AND 1.98

Commissioner:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the undersigned requests consideration of this Information Disclosure Statement.

PART I: Compliance with 37 C.F.R. § 1.97

This Information Disclosure Statement has been filed within three months of the filing date of a national application other than a continued prosecution application under 37 C.F.R. § 1.53(d).

No fee or certification is required.

PART II: Information Cited

The undersigned hereby makes of record in the above-identified application the information listed on the attached form PTO-1449 (modified PTO/SB/08). The order of presentation of the references should not be construed as an indication of the importance of the references.

The undersigned hereby makes the following additional information of record in the above-identified application.

The undersigned would like to bring to the Examiner's attention the following co-pending applications that may contain subject matter related to this application:

Serial No.	Filing Date	Inventor(s)	Docket No.
*17/756,802	06-02-2022	Larsen	A1389.70001US00
*18/680,372	05-31-2024	Larsen	A1389.70001US01

*A copy of this reference is not provided as the Office has waived the requirement under 37 C.F.R. § 1.98(a)(2)(iii) for submitting a copy of a cited U.S. patent application if it is scanned to the Image File Wrapper system and is available on Patent Center.

PART III: Remarks

Documents cited anywhere in the Information Disclosure Statement are enclosed unless otherwise indicated. It is respectfully requested that:

1. The Examiner consider completely the cited information, along with any other information, in reaching a determination concerning the patentability of the present claims;

2. The enclosed form PTO-1449 (modified PTO/SB/08) be signed by the Examiner to evidence that the cited information has been fully considered by the United States Patent and Trademark Office during the examination of this application;

3. The citations for the information be printed on any patent which issues from this application.

By submitting this Information Disclosure Statement, the undersigned makes no representation that a search has been performed, of the extent of any search performed, or that more relevant information does not exist.

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, material to patentability as defined in 37 C.F.R. § 1.56(b).

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, in fact, prior art as defined by 35 U.S.C. § 102, or an admission by Applicant as prior art.

Notwithstanding any statements by the undersigned, the Examiner is urged to form his or her own conclusion regarding the relevance of the cited information.

An early and favorable action is hereby requested.

The Director is hereby authorized to charge any deficiency or credit any overpayment in the fees occasioned by the filing of this Information Disclosure Statement to our Deposit Account No. 23/2825 under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Respectfully submitted,

Electronic signature: /John Harmon/
John S. Harmon, PhD, PE
Registration No.: 67,131
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
617.646.8000

Docket No.: A1389.70001US02
Date: 8/21/24

FORM PTO-1449/A and B (modified PTO/SB/08) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**				APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
				FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
				FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet	1	of	1	GROUP ART UNIT: Not Yet Assigned	EXAMINER: Not Yet Assigned

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		Number	Kind Code		
		10,434,198	B2	Larsen	10-08-2019
		2023-0014219	A1	Larsen	01-19-2023

FOREIGN PATENT DOCUMENTS

Examiner's Initials #	Cite No.	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)
		Office/ Country	Number	Kind Code			

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
		HASSFJELL, A 212Pb generator based on a 228Th source. Appl Radiat Isot. 2001 Oct;55(4):433-9. doi: 10.1016/s0969-8043(00)00372-9.	

[NOTE – No copies of U.S. patents, published U.S. patent applications, or pending, unpublished patent applications stored in the USPTO's Image File Wrapper (IFW) system, are included. See 37 CFR § 1.98 and 1287OG163. Copies of all other patent(s), publication(s), unpublished, pending U.S. patent applications, or other information listed are provided as required by 37 CFR § 1.98 unless 1) such copies were provided in an IDS in an earlier application that complies with 37 CFR § 1.98, and 2) the earlier application is relied upon for an earlier filing date under 35 U.S.C. § 120.]

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**08/21/2024 10:45:21 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Timothy Peng
PATENT CENTER #	66879972	FILING DATE	05/31/2024
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	John Harmon

Documents

TOTAL DOCUMENTS: 4

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
A138970001US02-TRN-JSH.pdf	1	Miscellaneous Incoming Letter	26 KB
A138970001US02-IDSBODY-JSH.pdf	3	Letter specifying the conditions for filing under 37 CFR 1.97	32 KB
HASSFJELL_Appl_Radiat_Isot_2001_v55_p433_NPL.pdf	7	Non Patent Literature	189 KB
A138970001US02-IDS1449-JSH.pdf	1	Information Disclosure Statement (IDS) Form (SB08)	21 KB

Warning: This is not a USPTO supplied IDS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
A138970001US02-TRN-JSH.pdf	739661A6D9F4C04EA438B738703E30D82C83DECF6CDCC477C8B96E3BD98A3B53845758C7AEA8148F70D7400BF9FAD17902EEFE6020F03D45B189AD1A34A81F05
A138970001US02-IDSBODY-JSH.pdf	829B964DE5C637426B5F9DCD2C2B9BE3931F39E92E7ABF01E50D63DE1AF3722909343BB2B984EF3E864455C77EAB065A83E08B796547C2C2881AFB7923711F06
HASSFJELL_Appl_Radiat_Isot_2001_v55_p433_NPL.pdf	448950D8785C8C69F3B577DDCECACB65355A09FF219EB704F79F0A6561A44078A45547658C08E0446AAC1E079389207FB3B9248C8C36DEED8649AB3F9930EE28
A138970001US02-IDS1449-JSH.pdf	84C00BF9A0B7F0251A463DD3124EBAD188A13026D4FFE3E072358A8BB37E1BF4591FA4F923B34F8258378B7C9B8D7AE4CDF25E7A4A9E2F33086CA4DD3CCD2020

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

23628 7590 09/06/2024

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

EXAMINER	
CENTRAL, DOCKET	

ART UNIT	PAPER NUMBER
OPAP	

NOTIFICATION DATE	DELIVERY MODE
09/06/2024	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

Patents_eOfficeAction@WolfGreenfield.com
WGS_eOfficeAction@WolfGreenfield.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 18/680,605	**Applicant(s)** Larsen, Roy H.	
	Examiner FIKIRTE A GEREMEW	**Art Unit** OMBL	**AIA (FITF) Status** Yes

1. THE REQUEST FILED 31 May 2024 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to FIKIRTE GEREMEW at (703) 756-1930. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/FIKIRTE A GEREMEW/ PROGRAM SUPPORT SPECIALIST, OMBL	

Notice of References Cited	Application/Control No. 18/680,605	Applicant(s)/Patent Under Reexamination Larsen, Roy H.	
	Examiner SEAN M LUCK	Art Unit 2881	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-8329122-B1	2012-12-11	Watrous; Matthew G.	G21G1/0005	423/2
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	**Art Unit**
	SEAN M LUCK	2881

CPC						
Symbol					**Type**	**Version**
G21G	/	1	/	0005	F	2013-01-01
G21F	/	5	/	015	I	2013-01-01
G21F	/	5	/	018	I	2013-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

Use images from artifact folder? (•) Yes ( ) No

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	30	
/SEAN M LUCK/ Examiner, Art Unit 2881	19 September 2024	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3b

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	**Art Unit**
	SEAN M LUCK	2881

INTERNATIONAL CLASSIFICATION				
CLAIMED				
G21G	/	1	/	00
G21F	/	5	/	015
G21F	/	5	/	018

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

Use images from artifact folder? (•) Yes ( ) No

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 30	
/SEAN M LUCK/ Examiner, Art Unit 2881 (Primary Examiner)	19 September 2024 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 3b

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	**Art Unit**
	SEAN M LUCK	2881

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19		28								
	2		11		20		29								
	3		12		21		30								
	4		13		22										
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	6		15		24										
	7		16		25										
	8		17		26										
	9		18		27										

Use images from artifact folder? ◉ Yes ○ No

NONE (Assistant Examiner) (Date)		**Total Claims Allowed:** 30
/SEAN M LUCK/ Examiner, Art Unit 2881 (Primary Examiner) (Date)	19 September 2024	O.G. Print Claim(s): 1 / O.G. Print Figure: 3b

AdvanCell - Exhibit 1006 - Page 166

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	Art Unit
	SEAN M LUCK	2881

CPC - Searched*		
Symbol	Date	Examiner
G21G1/0005	09/19/2024	SL
G21F5/015,018	09/19/2024	SL

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Cpc/text/inv/npl/for/applicant/AI/citations/backward-forward/family interference search. See attachment(s) for details.	09/19/2024	SL

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
G21G1/0005		09/19/2024	SL
G21F5/ 015,018		09/19/2024	SL

/SEAN M LUCK/ Examiner, Art Unit 2881	

FORM PTO-1449/A and B (modified PTO/SB/08)	APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
	FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet 1 of 1	GROUP ART UNIT: Not Yet Assigned	EXAMINER: Not Yet Assigned

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document Number	U.S. Patent Document Kind Code	Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		10,434,198	B2	Larsen	10-08-2019
		2023-0014219	A1	Larsen	01-19-2023

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Examiner's Initials #	Cite No.	Foreign Patent Document Office/ Country	Foreign Patent Document Number	Foreign Patent Document Kind Code	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
		HASSFJELL, A 212Pb generator based on a 228Th source. Appl Radiat Isot. 2001 Oct;55(4):433-9. doi: 10.1016/s0969-8043(00)00372-9.	

[NOTE – No copies of U.S. patents, published U.S. patent applications, or pending, unpublished patent applications stored in the USPTO's Image File Wrapper (IFW) system, are included. See 37 CFR § 1.98 and 1287OG163. Copies of all other patent(s), publication(s), unpublished, pending U.S. patent applications, or other information listed are provided as required by 37 CFR § 1.98 unless 1) such copies were provided in an IDS in an earlier application that complies with 37 CFR § 1.98, and 2) the earlier application is relied upon for an earlier filing date under 35 U.S.C. § 120.]

EXAMINER:	DATE CONSIDERED:
/SEAN M LUCK/	09/19/2024

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
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L38	28	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/07/25 04:07 PM
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L47	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L48	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L49	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM

		OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.					
L50	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L51	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L52	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L53	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L54	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM
L55	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L56	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L57	51	L6 AND isotope SAME	(US-PGPUB; USPAT;	OR	ON	ON	2024/08/14

		solid	USOCR)				01:38 PM
L58	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L59	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L60	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L61	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L62	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L63	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 01:38 PM
L64	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L65	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L66	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2024/08/14 01:38 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L67	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L68	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM
L69	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L70	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L71	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM

		(PGPB | USPT | USOC).dbnm.					
L72	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L73	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM
L74	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L75	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L76	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L77	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L78	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L79	1	L64 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:39 PM
L80	8	L64 AND (COLLECT$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:40 PM
L81	1	L64 AND ((PRECURSOR PARENT) SAME (DAUGHTER	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:41 PM

		PROGENY) SAME SOLID SAME GAS$4 SAME ISOTOP$4)					
L82	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:42 PM
L83	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:42 PM
L84	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:43 PM
L85	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$8)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:43 PM
L86	0	L64 AND (SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:45 PM
L87	0	L64 AND ((SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY)))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:45 PM
L88	6	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:45 PM
L89	5	(ISOTOP$8 WITH SOLID WITH (PARENT PRECURSOR)) AND (ISOTOP$8 WITH GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:46 PM
L90	64	L62 L63	(US-PGPUB; USPAT;	OR	ON	ON	2024/08/14

			USOCR)				01:47 PM
L91	0	L90 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:47 PM
L92	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:47 PM
L93	0	L90 AND L89	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:48 PM
L94	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:48 PM
L95	0	("20100224791").pn.	(USPAT)	OR	ON	ON	2024/08/14 01:50 PM
L96	0	"20100224791"	(USPAT)	OR	ON	ON	2024/08/14 01:50 PM
L97	1	"20100224791"	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:50 PM
L98	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:50 PM
L99	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:50 PM
L100	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM
L101	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM

L102	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM
L103	1	"20070158271"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM
L104	0	(11/610574).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM
L105	0	("2007/0158271").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM
L106	36	(Artificial Intelligence) More like doc: US-20070158271-A1 Text: (WO-2009003290-A1 OR EP-2179423-A1 OR AU-2006345883-A1 OR WO-2008004028-A2 OR EP-2011126-A2 OR US-20080093564-A1 OR CA-2631712-C OR CA-2631712-A1 OR CA-2692514-A1 OR US-7700926-B2 OR EP-2492920-A2 OR US-20100224791-A1 OR EP-2011126-B1 OR JP-2008139272-A OR WO-2008004028-A3 OR EP-2492920-A3 OR US-20240249856-A1 OR CN-110917658-A OR CN-110917658-B OR US-20180209921-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:52 PM
L107	1	(11/773022).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM
L108	52	("3576998" | "3655981" | "3749556" | "3774035" | "3882315" | "3920995" | "3946238" | "4020351" | "4039835" | "4084097" | "4144461" | "4160910" | "4280053" | "4286169" | "4387303" | "4414145" | "4782231" | "5109160" | "5186913" | "5397902" | "5831271" | "5834788" | "6157036" | "6781142" | "6998052" | "7060998" | "7091494" | "7163031" | "20030219366" | "20050104016" | "20050116186" | "20050253085" | "20060023829").pn. OR ("7700926").urpn. AND	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM

		(PGPB | USPT | USOC).dbnm.					
L109	0	L64 AND (COLLECT$4 SAME CERAMIC SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:59 PM
L110	2	L64 AND (COLLECT$4 SAME CERAMIC)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:59 PM
L111	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L112	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L113	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L114	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L115	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 09:28 PM
L116	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L117	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L118	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2024/08/14 09:28 PM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L119	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L120	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L121	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L122	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		AND (PGPB | USPT | USOC).dbnm.					
L123	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L124	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L125	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L126	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L127	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L128	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L129	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L130	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L131	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L132	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L133	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L134	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	ON	2024/08/14 09:28 PM

			DERWENT)				
L135	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L136	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L137	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L138	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2024/08/14 09:28 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L139	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L140	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L141	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L142	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L143	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L144	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO,	OR	ON	ON	2024/08/14 09:28 PM

		EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L145	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L146	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L147	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L148	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L149	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L150	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L151	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L152	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L153	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L154	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 09:28 PM
L155	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM

L156	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L157	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L158	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L159	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK,	OR	ON	ON	2024/08/14 09:28 PM

		JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L160	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L161	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L162	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L163	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L164	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L165	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

L166	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L167	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L168	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L169	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L170	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L171	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L172	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L173	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 09:28 PM
L174	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L175	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L176	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2024/08/14 09:28 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L177	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L178	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L179	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L180	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT |	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		USOC).dbnm.					
L181	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L182	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L183	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L184	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L185	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L186	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L187	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L188	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L189	1	L64 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L190	8	L64 AND (COLLECT$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM

L191	1	L64 AND ((PRECURSOR PARENT) SAME (DAUGHTER PROGENY) SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L192	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L193	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L194	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L195	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$8)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L196	0	L64 AND (SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L197	0	L64 AND ((SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY)))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L198	6	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L199	5	(ISOTOP$8 WITH SOLID WITH (PARENT PRECURSOR)) AND (ISOTOP$8 WITH	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		GAS$6 WITH (DAUGHTER PROGENY))					
L200	64	L62 L63	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L201	0	L90 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L202	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L203	0	L90 AND L89	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L204	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L205	0	("20100224791").pn.	(USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L206	0	"20100224791"	(USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L207	1	"20100224791"	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L208	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L209	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L210	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14

							09:28 PM
L211	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L212	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L213	1	"20070158271"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L214	0	(11/610574).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L215	0	("2007/0158271").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L216	36	(Artificial Intelligence) More like doc: US-20070158271-A1 Text: (WO-2009003290-A1 OR EP-2179423-A1 OR AU-2006345883-A1 OR WO-2008004028-A2 OR EP-2011126-A2 OR US-20080093564-A1 OR CA-2631712-C OR CA-2631712-A1 OR CA-2692514-A1 OR US-7700926-B2 OR EP-2492920-A2 OR US-20100224791-A1 OR EP-2011126-B1 OR JP-2008139272-A OR WO-2008004028-A3 OR EP-2492920-A3 OR US-20240249856-A1 OR CN-110917658-A OR CN-110917658-B OR US-20180209921-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L217	1	(11/773022).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L218	52	("3576998" | "3655981" | "3749556" | "3774035" | "3882315" | "3920995" | "3946238" | "4020351" | "4039835" | "4084097" | "4144461" | "4160910" | "4280053" | "4286169" | "4387303" | "4414145" | "4782231" | "5109160" | "5186913" | "5397902" | "5831271" | "5834788" | "6157036" | "6781142" | "6998052" | "7060998" | "7091494" | "7163031" | "20030219366" |	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		"20050104016" | "20050116186" | "20050253085" | "20060023829").pn. OR ("7700926").urpn. AND (PGPB | USPT | USOC).dbnm.					
L219	0	L64 AND (COLLECT$4 SAME CERAMIC SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L220	2	L64 AND (COLLECT$4 SAME CERAMIC)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L221	2	("10434198" "20230014219").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:09 PM
L222	0	"18680372"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:34 PM
L223	0	("18680372").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:34 PM
L224	0	"18680605"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:36 PM
L225	0	"18680605"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:33 PM
L226	0	"18680372"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:33 PM
L227	2	L174 AND ((seal$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4))	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:34 PM
L228	11	("4280053" | "4859431" | "4980093" | "4990787" | "5617860" | "5860295" | "6202440" | "7023000" | "7302812" | "7531150" | "20050044886").pn. OR ("8329122").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:35 PM
L229	34	(Artificial Intelligence) More like doc: US-8329122-B1 Text: (WO-2004105049-A1 OR US-7023000-B2 OR US-20060022127-A1 OR FR-3044426-A1 OR US-20230411033-A1 OR JP-2023550075-A OR CA-2576907-C OR CA-2576907-A1 OR EP-1774536-A1 OR EA-009820-B1 OR CA-3198969-A1 OR AU-2021376899-A1 OR WO-2022101500-A1	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:36 PM

		OR EP-4244874-A1 OR US-20230420153-A1 OR EP-4002392-A1 OR DE-69719962-T2 OR US-20210158987-A1 OR CA-2360721-C OR JP-S615000-A).did.					
L230	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L231	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L232	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L233	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L234	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L235	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L236	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L237	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2024/09/18 04:37 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L238	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L239	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L240	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L241	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L242	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L243	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L244	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L245	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L246	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L247	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L248	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L249	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L250	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L251	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L252	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L253	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L254	6265	G21G1/0005.cpc.	(US-PGPUB; USPAT;	OR	ON	ON	2024/09/18

		G21F5/015,018.cpc.	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				04:37 PM
L255	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L256	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L257	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2024/09/18 04:37 PM

			WO); FPRS; EPO; JPO)				
L258	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L259	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L260	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L261	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L262	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L263	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO;	OR	ON	ON	2024/09/18 04:37 PM

		2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	JPO; DERWENT; IBM_TDB)				
L264	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L265	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L266	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L267	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L268	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L269	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L270	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L271	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L272	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L273	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L274	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L275	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2024/09/18 04:37 PM

			CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L276	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L277	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L278	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM

		B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.					
L279	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L280	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L281	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L282	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L283	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L284	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L285	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L286	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L287	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L288	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L289	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L290	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L291	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L292	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L293	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L294	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L295	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE,	OR	ON	ON	2024/09/18 04:37 PM

			SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L296	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L297	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L298	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L299	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L300	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L301	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L302	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L303	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L304	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L305	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L306	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L307	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L308	1	L64 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L309	8	L64 AND (COLLECT$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L310	1	L64 AND ((PRECURSOR PARENT) SAME (DAUGHTER PROGENY) SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

L311	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L312	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L313	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L314	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$8)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L315	0	L64 AND (SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L316	0	L64 AND ((SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY)))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L317	7	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L318	5	(ISOTOP$8 WITH SOLID WITH (PARENT PRECURSOR)) AND (ISOTOP$8 WITH GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L319	64	L62 L63	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L320	0	L90 AND (CERAMIC SAME SOLID SAME	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

		GAS$4 SAME ISOTOP$4)					
L321	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L322	0	L90 AND L89	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L323	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L324	0	("20100224791").pn.	(USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L325	0	"20100224791"	(USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L326	1	"20100224791"	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L327	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L328	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L329	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L330	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L331	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L332	1	"20070158271"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L333	0	(11/610574).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L334	0	("2007/0158271").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L335	34	(Artificial Intelligence) More like doc: US-20070158271-A1 Text: (WO-2009003290-A1 OR EP-2179423-A1 OR AU-2006345883-A1 OR WO-2008004028-A2 OR EP-2011126-A2 OR US-20080093564-A1 OR CA-2631712-C OR CA-2631712-A1 OR CA-2692514-A1 OR US-7700926-B2 OR EP-2492920-A2 OR US-20100224791-A1 OR EP-2011126-B1 OR JP-2008139272-A OR WO-2008004028-A3 OR EP-2492920-A3 OR US-20240249856-A1 OR DE-2826833-A1 OR US-4160910-A OR CA-1093223-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L336	1	(11/773022).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L337	52	("3576998" | "3655981" | "3749556" | "3774035" | "3882315" | "3920995" | "3946238" | "4020351" | "4039835" | "4084097" | "4144461" | "4160910" | "4280053" | "4286169" | "4387303" | "4414145" | "4782231" | "5109160" | "5186913" | "5397902" | "5831271" | "5834788" | "6157036" | "6781142" | "6998052" | "7060998" | "7091494" | "7163031" | "20030219366" | "20050104016" | "20050116186" | "20050253085" | "20060023829").pn. OR ("7700926").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L338	0	L64 AND (COLLECT$4 SAME CERAMIC SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

L339	2	L64 AND (COLLECT$4 SAME CERAMIC)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L340	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L341	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L342	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L343	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L344	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L345	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L346	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L347	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE,	OR	ON	ON	2024/09/18 04:37 PM

			SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L348	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L349	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L350	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L351	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L352	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L353	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L354	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L355	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L356	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L357	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L358	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L359	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L360	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L361	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L362	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L363	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L364	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2024/09/18 04:37 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L365	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L366	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L367	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L368	31	(Artificial Intelligence) More like doc:	(US-PGPUB; USPAT; USOCR; FIT (AU, AP,	OR	ON	ON	2024/09/18 04:37 PM

		US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L369	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L370	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L371	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L372	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L373	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM

		10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.					
L374	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L375	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L376	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L377	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L378	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L379	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L380	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L381	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L382	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L383	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L384	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L385	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV,	OR	ON	ON	2024/09/18 04:37 PM

			MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L386	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L387	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L388	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM

		AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.					
L389	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L390	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L391	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L392	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L393	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L394	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L395	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L396	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L397	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L398	1	"17756802"	(US-PGPUB; USPAT;	OR	ON	ON	2024/09/18

			USOCR)				04:37 PM
L399	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L400	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L401	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L402	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L403	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L404	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L405	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO;	OR	ON	ON	2024/09/18 04:37 PM

			JPO)				
L406	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L407	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L408	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L409	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L410	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L411	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L412	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L413	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L414	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L415	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L416	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
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L421	1	L64 AND ((PRECURSOR PARENT) SAME	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

		SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)					
L422	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
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L427	7	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
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L429	64	L62 L63	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
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L431	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
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PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp

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N4	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 03:48 PM
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N7	24	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
N8	45	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
N9	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
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N29	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
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FORM PTO-1449/A and B (modified PTO/SB/08)				APPLICATION NO.: Not Yet Assigned	ATTY. DOCKET NO.: A1389.70001US02
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				FILING DATE: Concurrently Herewith	CONFIRMATION NO.: Not Yet Assigned
				FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet	1	of	1	GROUP ART UNIT: Not Yet Assigned	EXAMINER: Not Yet Assigned

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		Number	Kind Code		
		3,453,196		Sporek	07-01-1969
		7,476,370	B2	Mitsugashira et al.	01-13-2009
		2006-0022127	A1	Zyuzin	02-02-2006
		2015-0170776	A1	Torgue et al.	06-18-2015
		2018-0047474	A1	O'Hara	02-15-2018

FOREIGN PATENT DOCUMENTS

Examiner's Initials #	Cite No.	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)
		Office/ Country	Number	Kind Code			
	*	EP	0 466 290	A1	Brunswick Corporation	01-15-1992	

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
	*	International Search Report for PCT Application No. PCT/EP2020/084701 dated February 17, 2021.	

[NOTE – No copies of U.S. patents, published U.S. patent applications, or pending, unpublished patent applications stored in the USPTO's Image File Wrapper (IFW) system, are included. See 37 CFR § 1.98 and 1287OG163. Copies of all other patent(s), publication(s), unpublished, pending U.S. patent applications, or other information listed are provided as required by 37 CFR § 1.98 unless 1) such copies were provided in an IDS in an earlier application that complies with 37 CFR § 1.98, and 2) the earlier application is relied upon for an earlier filing date under 35 U.S.C. § 120.]

EXAMINER: /SEAN M LUCK/	DATE CONSIDERED: 09/19/2024

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

*a copy of this reference is not provided as it was previously cited by or submitted to the office in a prior application, Serial No. 17/756,802, filed June 2, 2022, and relied upon for an earlier filing date under 35 U.S.C. 120 (continuation, continuation-in-part, and divisional applications).

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

Bibliographic Data

Application No: 18/680,605

Foreign Priority claimed: (●) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /SEAN M LUCK/ Examiner's Signature | Initials

Title: PRODUCTION OF HIGHLY PURIFIED 212PB

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
05/31/2024	376	2881	A1389.70001US02
RULE			

APPLICANTS

Sciencons AS, Oslo, NORWAY

INVENTORS

Roy H. Larsen,

CONTINUING DATA

This application is a CON of 17756802 06/02/2022

17756802 is a 371 of PCT/EP2020/084701 12/04/2020

FOREIGN APPLICATIONS

EPO EP19213759.4 12/05/2019

EPO EP20172038.0 04/29/2020

IF REQUIRED, FOREIGN LICENSE GRANTED**

06/17/2024

** SMALL ENTITY **

STATE OR COUNTRY

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UNITED STATES

FILING FEE RECEIVED

$2,960

DOCKET NO.: A1389.70001US02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	Not Yet Assigned
Confirmation No.:	Not Yet Assigned
Filed:	Concurrently Herewith
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	Not Yet Assigned
Art Unit:	Not Yet Assigned

MAIL STOP AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATEMENT FILED PURSUANT TO THE DUTY OF DISCLOSURE UNDER 37 C.F.R. §§ 1.56, 1.97 AND 1.98

Commissioner:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the undersigned requests consideration of this Information Disclosure Statement.

PART I: Compliance with 37 C.F.R. § 1.97

This Information Disclosure Statement has been filed within three months of the filing date of a national application other than a continued prosecution application under 37 C.F.R. § 1.53(d).

No fee or certification is required.

PART II: Information Cited

The undersigned hereby makes of record in the above-identified application the information listed on the attached form PTO-1449 (modified PTO/SB/08). The order of presentation of the references should not be construed as an indication of the importance of the references.

The undersigned hereby makes the following additional information of record in the above-identified application.

AdvanCell - Exhibit 1006 - Page 231

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

The undersigned would like to bring to the Examiner's attention the enclosed search report or other communication from a corresponding or related International or Foreign National Application:

Serial No.	Date of Mailing	Type(s) of Communication	Docket No.
PCT/EP2020/084701	**02-17-2021**	***International Search Report and Written Opinion**	**n/a**

*a copy of this reference is not provided as it was previously cited by or submitted to the office in a prior application, Serial No. 17/756,802, filed June 2, 2022, and relied upon for an earlier filing date under 35 U.S.C. 120 (continuation, continuation-in-part, and divisional applications).

PART III: Remarks

Documents cited anywhere in the Information Disclosure Statement are enclosed unless otherwise indicated. It is respectfully requested that:

1. The Examiner consider completely the cited information, along with any other information, in reaching a determination concerning the patentability of the present claims;

2. The enclosed form PTO-1449 (modified PTO/SB/08) be signed by the Examiner to evidence that the cited information has been fully considered by the United States Patent and Trademark Office during the examination of this application;

3. The citations for the information be printed on any patent which issues from this application.

By submitting this Information Disclosure Statement, the undersigned makes no representation that a search has been performed, of the extent of any search performed, or that more relevant information does not exist.

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, material to patentability as defined in 37 C.F.R. § 1.56(b).

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, in fact, prior art as defined by 35 U.S.C. § 102, or an admission by Applicant as prior art.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

Notwithstanding any statements by the undersigned, the Examiner is urged to form his or her own conclusion regarding the relevance of the cited information.

An early and favorable action is hereby requested.

The Director is hereby authorized to charge any deficiency or credit any overpayment in the fees occasioned by the filing of this Information Disclosure Statement to our Deposit Account No. 23/2825 under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Respectfully submitted,

Electronic signature: /Jeffrey C. Harrigan/
Jeffrey C. Harrigan
Registration No.: 79,725
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
617.646.8000

Docket No.: A1389.70001US02
Date: May 31, 2024

/SEAN M LUCK/

09/19/2024

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

23628 7590 09/25/2024

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

EXAMINER	
LUCK, SEAN M	
ART UNIT	**PAPER NUMBER**
2881	

DATE MAILED: 09/25/2024

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

TITLE OF INVENTION: PRODUCTION OF HIGHLY PURIFIED 212PB

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0.00	$0.00	$480	12/26/2024

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

AdvanCell - Exhibit 1006 - Page 234

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23628 7590 09/25/2024
WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

TITLE OF INVENTION: PRODUCTION OF HIGHLY PURIFIED 212PB

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0.00	$0.00	$480	12/26/2024

EXAMINER	ART UNIT	CLASS-SUBCLASS
LUCK, SEAN M	2881	376-202000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via the USPTO patent electronic filing system ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

❑ Applicant asserting small entity status. See 37 CFR 1.27

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

❑ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

23628 7590 09/25/2024

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

EXAMINER	
LUCK, SEAN M	
ART UNIT	PAPER NUMBER
2881	

DATE MAILED: 09/25/2024

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

AdvanCell - Exhibit 1006 - Page 236

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013).
https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf

Routine uses of the information in this record may include disclosure to:

1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
2) a federal, state, local, or international agency, in response to its request;
3) a contractor of the USPTO having need for the information in order to perform a contract;
4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c));
9) the Office of Personnel Management (OPM) for personnel research purposes; and
10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

Notice of Allowability	Application No. 18/680,605	Applicant(s) Larsen, Roy H.	
	Examiner SEAN M LUCK	Art Unit 2881	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 08/21/2024.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-30 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☑ All b) ☐ Some* c) ☐ None of the:

   1. ☑ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/SEAN M LUCK/
Examiner, Art Unit 2881

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Reasons for Allowance

2. The following is an examiner's statement of reasons for allowance: The prior art in general discloses the decay of solid precursor isotopes in a collection container in general, but does not provide adequate detail to address the inventive features of exposing the collector surface to gaseous progeny isotopes to deposit solid progeny isotopes. The information provided in the prior art does not address these features, or provide a basis for a person of ordinary skill in the art to arrive at them without relying on improper hindsight reasoning or inappropriate claim interpretation.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SEAN M LUCK whose telephone number is (571)272-6493. The examiner can normally be reached 8-5 M-F.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robert Kim can be reached on (571)272-2293. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SEAN M LUCK/
Examiner, Art Unit 2881

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 18/680,605	Filing Date 05/31/2024	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $40 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $192 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	11/13/2024	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 38	Minus	** 30	= 8		x $40 =	320
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $192 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	320

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/MARCUS A PRIDGEN/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Bibliographic data

Publication
RU2742138 C1 [2021-02-02]
Application
RU2020117908 [2020-05-20]

Classifications
IPC
G21G4/08
CPC
G21G1/0005; G21G4/08

Priorities
RU2020117908 [2020-05-20]

Inventors
Мокров Юрий Геннадьевич; Mokrov Yurij Gennadevich

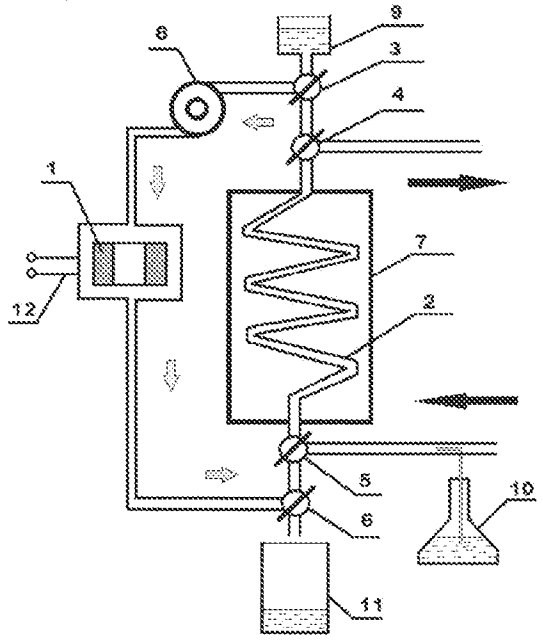
Assignees
Федеральное государственное унитарное предприятие "Производственное объединение "Маяк";
Federalnoe gosudarstvennoe unitarnoe predpriyatie "Proizvodstvennoe obedinenie "Mayak"

Titles
[EN]
METHOD OF OBTAINING 211PB/211BI FOR NUCLEAR MEDICINE
[RU]
Способ получения 211Pb/211Bi для ядерной медицины

Abstract

RU	EN

RU	EN
Изобретение относится к технологии получения свинца-211/висмута-211 (^{211}Pb/^{211}Bi) для ядерной медицины. Способ основан на использовании эффекта эманации радона-219 (^{219}Rn) источником, содержащим препарат радий-223 (^{223}Ra). Источник изготавливают путем создания на поверхности пористого/волоконного материала с развитой внешней поверхностью тонкого сухого твердого слоя препарата. Источник размещают в установке, состоящей из герметичного газового контура с принудительной циркуляцией газового потока и коллектора для осаждения газообразного ^{219}Rn. Предварительно на внутренних стенках коллектора создают ледяной слой путем его охлаждения и одновременного инжектирования водного аэрозоля в контур. Осаждение ^{219}Rn и накопление продуктов его распада, содержащих целевой продукт, проводят на поверхности слоя льда коллектора, а извлечения ^{211}Pb/^{211}Bi проводят путем нагрева стенок коллектора и сбора образующейся талой воды. Изобретение позволяет упростить технологию получения ^{211}Pb/^{211}Bi, повысить выход и обеспечить высокую радиохимическую чистоту целевого радионуклида. 11 з.п. ф-лы, 1 ил.	FIELD: nuclear medicine. SUBSTANCE: invention relates to a technology for producing lead-211 / bismuth-211 (^{211}Pb / ^{211}Bi) for nuclear medicine. The method is based on the use of the effect of radon-219 (^{219}Rn) emanation by a source containing radium-223 (^{223}Ra). The source is made by creating a thin dry solid layer of radium-223 on the surface of a porous / fibrous material with an outer surface. The source is placed in an installation consisting of a sealed gas loop with forced circulation of a gas flow and a collector for the deposition of gaseous ^{219}Rn. It's necessary to create an ice layer on the inner walls of the collector by cooling it and simultaneously injecting a water aerosol into the collector. The deposition of ^{219}Rn and the accumulation of its decay products containing the target product are carried out on the surface of the ice layer of the collector, and the extraction of ^{211}Pb / ^{211}Bi is carried out by heating the walls of the collector and collecting the formed melt water. EFFECT: invention makes it possible to simplify technology of obtaining ^{211}Pb / ^{211}Bi, to increase yield and to ensure high radiochemical purity of the target radionuclide. 12 cl, 1 dwg



Принципиальная схема установки (генератора) для получения ^{211}Pb/^{211}Bi

Claims

[RU]	[MT]
1. Способ получения свинца-211/висмута-211 (^{211}Pb/^{211}Bi) для ядерной медицины, включающий: приготовление препарата из материала, содержащего радий-223 (^{223}Ra), изготовление источника испускания радона-219 (^{219}Rn) путем нанесения препарата на подложку, размещение источника в герметичной установке, создание условий для интенсификации выхода ^{219}Rn из источника в газовый объем установки, размещение в установке коллектора для осаждения газообразного ^{219}Rn, накопление на стенках коллектора продуктов радиоактивного распада ^{219}Rn, содержащих целевой продукт, в течение не менее 2 часов, извлечение из коллектора целевого продукта в виде раствора и использование установки для повторного цикличного получения целевого продукта, отличающийся тем, что препарат изготавливают в виде водного раствора соединений ^{223}Ra, в качестве подложки источника используют пористый материал с развитой внешней поверхностью, источник изготавливают путем создания на поверхности материала тонкого сухого твердого слоя препарата толщиной несколько молекулярных слоев, источник помещают в емкость объемом V_1, оборудованную системой нагрева, коллектор изготавливают в виде емкости объемом V_2, оборудованной системой охлаждения и нагревания, установка состоит из вспомогательного, рабочего и промывного контуров, соединенных трубками и отделяемых запорными вентилями, вспомогательный контур используют на предварительной стадии для создания на внутренних стенках коллектора ледяного слоя, накопление целевого продукта проводят на поверхности ледяного слоя в рабочем контуре, состоящем из объемов V_1 и V_2, объема соединительных трубок V_3 и насоса для принудительной циркуляции газа с расходом Q, а промывной контур используют в режиме извлечения целевого продукта путем нагрева стенок коллектора и сбора образующейся талой воды.	1. A method for producing lead-211 / bismuth-211 (^{211} Pb / ^{211} Bi) for nuclear medicine, including: preparing a preparation from a material containing radium-223 (^{223} Ra), making a source of emission of radon-219 (^{219} Rn) by applying preparation on a substrate, placing the source in a sealed unit, creating conditions for intensifying the output of ^{219} Rn from the source into the gas volume of the unit, placing a collector in the unit for deposition of gaseous ^{219} Rn, accumulation of ^{219} Rn radioactive decay products containing the target product on the collector walls during not less than 2 hours, extraction of the target product from the collector in the form of a solution and use of an installation for repeated cyclic production of the target product, characterized in that the preparation is made in the form of an aqueous solution of ^{223} Ra compounds, a porous material with a developed outer surface is used as a source substrate, source made by creating a thin dry solid on the surface of the material th layer of the drug with a thickness of several molecular layers, the source is placed in a container with a volume of V_1, equipped with a heating system, the collector is made in the form of a container with a volume of V_2, equipped with a cooling and heating system, the installation consists of an auxiliary, working and flushing circuits connected by tubes and separated by shut-off valves, the auxiliary circuit is used at a preliminary stage to create an ice layer on the inner walls of the collector, the accumulation of the target product is carried out on the surface of the ice layer in a working circuit consisting of volumes V_1 and V_2, the volume of connecting pipes V_3 and a pump for forced gas circulation with flow rate Q, and the flushing circuit is used in the mode of extracting the target product by heating the manifold walls and collecting the formed melt water.
2. Способ по п. 1, отличающийся тем, что для получения препарата используют растворимые в воде соединения ^{223}Ra, которые в сухом виде хорошо выделяют радон, например хлориды, и/или бромиды, и/или окиси.	2. The method according to claim 1, characterized in that for the preparation of the preparation, water-soluble compounds of ^{223} Ra are used, which in dry form release radon well, for example, chlorides and / or bromides and / or oxides.

3. Способ по п. 1, отличающийся тем, что в качестве пористого материала используют волоконный материал из ультратонких волокон, например из ткани Петрянова, и/или стекловолокна, и/или углеродного волокна, а нанесение препарата на материал проводят методом накалывания и/или смачивания раствором препарата с последующим высушиванием.	3. The method according to claim 1, characterized in that the porous material is a fiber material made of ultra-thin fibers, for example from Petryanov's fabric, and / or glass fiber, and / or carbon fiber, and the preparation is applied to the material by the method of pricking and / or wetting with a solution of the drug, followed by drying.
4. Способ по п. 1, отличающийся тем, что создание на внутренних стенках коллектора слоя льда проводят путем замораживания водного аэрозоля, например, на основе дистиллированной воды или физиологического раствора, который принудительно вводят в объем коллектора, например, с использованием инжектора.	4. The method according to claim 1, characterized in that the creation of an ice layer on the inner walls of the collector is carried out by freezing an aqueous aerosol, for example, based on distilled water or saline, which is forcibly introduced into the collector volume, for example, using an injector.
5. Способ по п. 1, отличающийся тем, что в режиме накопления целевого продукта интенсификацию выхода ^{219}Rn из источника в газовый объем проводят путем нагрева источника до температуры более 100°С.	5. The method according to claim. 1, characterized in that in the mode of accumulation of the target product the intensification of the output of ^{219} Rn from the source to the gas volume is carried out by heating the source to a temperature of more than 100 ° C.
6. Способ по п. 1, отличающийся тем, что материал препарата содержит торий-227 (^{227}Th) или смесь ^{227}Th и ^{223}Ra и допускает присутствие примесей ^{224}Ra и ^{226}Ra.	6. The method according to claim 1, characterized in that the preparation material contains thorium-227 (^{227} Th) or a mixture of ^{227} Th and ^{223} Ra and allows the presence of impurities ^{224} Ra and ^{226} Ra.
7. Способ по п. 1, отличающийся тем, что принудительную циркуляцию газового потока в замкнутом контуре установки проводят, например с использованием перистальтического насоса, а в качестве газовой среды используют сухой воздух и/или углекислый газ.	7. The method according to claim 1, characterized in that the forced circulation of the gas flow in a closed circuit of the installation is carried out, for example, using a peristaltic pump, and dry air and / or carbon dioxide is used as the gaseous medium.
8. Способ по п. 1, отличающийся тем, что значения Q, V_1, V_2 и V_3 выбирают таким образом, чтобы: (V_1/Q) <0,25 с; (V_2/Q) ~20-25 с, а (V_3/Q) - минимально возможным.	8. The method according to claim 1, characterized in that the values of Q, V_1 , V_2 and V_3 are chosen so that: (V_1 / Q) <0.25 s; (V_2 / Q) ~ 20-25 s, a (V_3 / Q) - the minimum possible.
9. Способ по п. 1, отличающийся тем, что в режиме накопления целевого продукта, охлаждение стенок коллектора проводят до температуры ниже -71°С с использованием «сухого льда» (двуокиси углерода CO_2) и/или специального ультранизкотемпературного холодильника.	9. The method according to claim 1, characterized in that in the mode of accumulation of the target product, the cooling of the collector walls is carried out to a temperature below -71 ° C using "dry ice" (carbon dioxide CO_2) and / or a special ultra-low-temperature refrigerator.

10. Способ по п. 1, отличающийся тем, что извлечение целевого продукта из промывного контура проводят путем нагревания внешних стенок коллектора горячей водой и/или с использованием специального нагревателя, а после сбора талой воды, при необходимости, проводят дополнительную промывку коллектора.	10. The method according to claim 1, characterized in that the extraction of the target product from the flushing circuit is carried out by heating the outer walls of the collector with hot water and / or using a special heater, and after collecting melted water, if necessary, additional washing of the collector is carried out.
11. Способ по пп. 1 и 3, отличающийся тем, что для изготовления источника используют фильтрующий материал ФПА-15-2,0 в виде фильтров АФА-РМА, которые собирают в пакет, или в виде ленты, которую наматывают в рулон на катушку.	11. The method according to PP. 1 and 3, characterized in that for the manufacture of the source the filter material FPA-15-2.0 is used in the form of AFA-PMA filters, which are collected in a bag, or in the form of a tape, which is wound into a roll on a reel.
12. Способ по п. 11, отличающийся тем, что газовый поток в объеме V_1 направляют параллельно плоскости фильтрующих слоев материала источника.	12. The method according to claim 11, characterized in that the gas flow in the volume $V_{1\,is}$ directed parallel to the plane of the filter layers of the source material.

Description

[RU]	[MT]
Изобретение относится к технологии получения радионуклидов для ядерной медицины.	The invention relates to a technology for producing radionuclides for nuclear medicine.
В настоящее время одним из наиболее перспективных направлений в радиационной терапии онкологических заболеваний является метод таргетной (target - мишень) терапии, основанный на использовании в качестве источника внутреннего облучения короткоживущих альфа-излучающих радионуклидов (КАИР) с характерным периодом полураспада десятки минут. Малый период полураспада ($T_{1/2}$) КАИР предопределяет необходимость получения их в медицинской клинике для экспрессного изготовления соответствующих радиофармпрепаратов (РФП).	At present, one of the most promising directions in radiation therapy of oncological diseases is the method of targeted (target) therapy, based on the use of short-lived alpha-emitting radionuclides (CAIR) with a characteristic half-life of tens of minutes as a source of internal irradiation. The short half-life ($T_{1/2}$) of CAIR determines the need to obtain them in a medical clinic for the express preparation of the corresponding radiopharmaceuticals (RP).
Для получения КАИР в онкологических центрах принято использовать специальные радиохимические методы, основанные на отделении КАИР от более долгоживущих материнских радионуклидов (МР) по принципу работы изотопных генераторов (ИГ). Такие ИГ должны обеспечить многократное выделение КАИР и удовлетворять следующим требованиям: высокая радиологическая эффективность получаемых РФП; доступность МР; низкая стоимость; высокая радиохимическая чистота КАИР (минимальное содержание сопутствующих радионуклидов и примесных веществ); радиационная безопасность при использовании и транспортировке; возможность автоматизации процесса эксплуатации и др.	To obtain CAIR in oncology centers, it is customary to use special radiochemical methods based on the separation of CAIR from more long-lived parent radionuclides (MP) according to the principle of operation of isotope generators (IG). Such IGs should provide multiple isolation of CAIR and meet the following requirements: high radiological efficiency of the received RP; MP availability; low cost; high radiochemical purity of CAIR (minimum content of associated radionuclides and impurity substances); radiation safety during use and transportation; the ability to automate the operation process, etc.
В качестве одного из возможных КАИР рассматривают ^{211}Pb и ^{211}Bi [Л.И. Гусева. Радиоизотопные генераторы короткоживущих α-излучающих радионуклидов, перспективных для использования в ядерной медицине. Радиохимия, 2014, т. 56, №5, с. 385-399], которые образуются в результате радиоактивного распада ^{227}Ac по следующей цепочке:	^{211} Pb and ^{211} Bi are considered as one of the possible CAIR [L.I. Gusev. Radioisotope generators of short-lived α-emitting radionuclides, promising for use in nuclear medicine. Radiochemistry, 2014, v. 56, No. 5, p. 385-399], which are formed as a result of the radioactive decay of ^{227} Ac along the following chain:
^{227}Ac (21,6 лет) → ^{227}Th (18 сут) → ^{223}Ra (11 сут) → ^{219}Rn (3,96 с) → ⋯ → ^{211}Pb (36 мин) → ^{211}Bi (2,2 мин) →⋯	^{227} Ac (21.6 years) → ^{227} Th (18 days) → ^{223} Ra (11 days) → ^{219} Rn (3.96 s) →⋯ → ^{211} Pb (36 min) → ^{211} Bi (2.2 min) → ...

До настоящего времени не известны эффективные способы получения $^{211}Pb/^{211}Bi$ в необходимом количестве, что сдерживает широкое использование этих нуклидов для ядерной медицины. Но если будет предложен простой, эффективный и безопасный способ получения высокочистого $^{211}Pb/^{211}Bi$ в требуемых объемах, то это откроет новые перспективы его использования.	Until now, no effective methods are known for producing ^{211} Pb / ^{211} Bi in the required amount, which hinders the widespread use of these nuclides for nuclear medicine. But if a simple, effective and safe way of obtaining high-purity ^{211} Pb / ^{211} Bi in the required volumes is proposed, this will open up new prospects for its use.
Известно всего несколько способов получения $^{211}Pb/^{211}Bi$ на радиоизотопных генераторах с использованием ионообменных, экстракционных и дистилляционных технологий [Л.И. Гусева. Радиоизотопные генераторы короткоживущих α-излучающих радионуклидов, перспективных для использования в ядерной медицине. Радиохимия, 2014, т. 56, №5, с. 385-399].	There are only a few methods of obtaining ^{211} Pb / ^{211} Bi on radioisotope generators using ion exchange, extraction and distillation technologies [L.I. Gusev. Radioisotope generators of short-lived α-emitting radionuclides, promising for use in nuclear medicine. Radiochemistry, 2014, v. 56, No. 5, p. 385-399].
Основным общим недостатком всех ионообменных и экстракционных технологий, основанных на использовании высокомолекулярных органических сорбентов, является радиационная деструкция таких материалов, что приводит ухудшению качества целевого продукта и ограничению срока эксплуатации ИГ.	The main common drawback of all ion-exchange and extraction technologies based on the use of high-molecular-weight organic sorbents is the radiation destruction of such materials, which leads to a deterioration in the quality of the target product and a limitation of the IG service life.
Специфической особенностью МР - ^{223}Ra ($T_{1/2}$=11,4 сут) является образование в процессе его распада инертного короткоживущего радиоактивного газа радона ^{219}Rn ($T_{1/2}$=3,96 с), что предопределяет теоретическую возможность создания технологий, основанных на использовании эффекта эманации радона. Единственный известный пример применения такой технологии для получения $^{211}Pb/^{211}Bi$ приведен в статье [Atcher, R.W., Friedman, A.M., Huzenga, J.R., Spencer, R.P.: A radionuclide generator for production of ^{211}Pb and its daughter. J. Radioanal. Nucl. Chem. Lett. 135, 215-221 (1989)], которая и принята за прототип.	A specific feature of MP - ^{223} Ra ($T_{1/2}$ = 11.4 days) is the formation during its decay of an inert short-lived radioactive gas radon ^{219} Rn ($T_{1/2}$ = 3.96 s), which predetermines the theoretical possibility of creating technologies based on on the use of the effect of radon emanation. The only known example of the application of this technology for the production of ^{211} Pb / ^{211} Bi is given in the article [Atcher, RW, Friedman, AM, Huzenga, JR, Spencer, RP: A radionuclide generator for production of ^{211} Pb and its daughter. J. Radioanal. Nucl. Chem. Lett. 135, 215-221 (1989)], which is taken as a prototype.
Этот способ предполагает выполнение следующих операций:	This method involves performing the following operations:
- в платиновом тигле изготавливают препарат на основе стеарата бария, содержащий в качестве материнского нуклида ^{223}Ra;	- in a platinum crucible a preparation is made based on barium stearate containing ^{223} Ra as a parent nuclide;

- изготавливают источник эманации ^{219}Rn, путем осаждения препарата на дно платинового тигля (подложку) в виде тонкого слоя, локализующего ^{223}Ra, но относительно прозрачного для выхода газообразного ^{219}Rn;	- a source of emanation ^{219} Rn is made by depositing the preparation on the bottom of a platinum crucible (substrate) in the form of a thin layer that localizes ^{223} Ra, but relatively transparent for the outlet of gaseous ^{219} Rn;
- изготавливают герметичную установку (генератор) в виде трубы диаметром 3 см, соединенную с вакуумным насосом;	- a sealed installation (generator) is made in the form of a pipe with a diameter of 3 cm, connected to a vacuum pump;
- размещают в установке источник и коллектор, предназначенный для сбора ^{219}Rn и накопления продуктов его распада;	- a source and a collector are placed in the installation, designed to collect ^{219} Rn and accumulate products of its decay;
- высушивают в течение нескольких часов стеарат бария на подложке источника путем охлаждения коллектора до температуры жидкого азота;	- drying the barium stearate on the source substrate for several hours by cooling the collector to the temperature of liquid nitrogen;
- создают в установке вакуум с давлением менее 50 мкм ртутного столба для интенсификации выхода ^{219}Rn из источника в газовый объем установки;	- create a vacuum in the installation with a pressure of less than 50 microns of mercury to intensify the output of ^{219} Rn from the source into the gas volume of the installation;
- охлаждают коллектор до температуры жидкого азота;	- cool the collector to the temperature of liquid nitrogen;
- осаждают на стенках коллектора ^{219}Rn и продукты его радиоактивного распада в течение времени, необходимого для установления равновесной активности ^{211}Pb (около 2 часов);	- ^{219} Rn and the products of its radioactive decay are deposited on the walls of the collector during the time required to establish the equilibrium activity of ^{211} Pb (about 2 hours);
- выделяют ^{211}Pb/211Bi со стенок коллектора, путем смыва слабой кислотой.	- ^{211} Pb / 211Bi is isolated from the walls of the collector, by flushing with a weak acid.
Основным преимуществом этого способа является уникально высокая радиохимическая чистота получаемого целевого продукта.	The main advantage of this method is the uniquely high radiochemical purity of the obtained target product.
К недостаткам способа относят: низкий выход целевого продукта (около 10%); сложность реализации (использование платинового тигля, глубокого вакуума и жидкого азота); радиолитическое повреждение материала источника (стеарата бария), содержащего ^{223}Ra, которое приводит к снижению срока эксплуатации ИГ.	The disadvantages of this method include: low yield of the target product (about 10%); the complexity of implementation (using a platinum crucible, high vacuum and liquid nitrogen); radiolytic damage to the source material (barium stearate) containing ^{223} Ra, which leads to a decrease in the life of the IG.

Задачами предлагаемого технического решения являются: существенное увеличение выхода целевого продукта, упрощение технологии получения и увеличение срока эксплуатации ИГ, при одновременном сохранении преимуществ способа по прототипу. Решение указанных задач достигается путем использования нового типа материала-источника для размещения ^{223}Ra и дополнительных технологических процессов и операций, которые ранее не применялись.	The objectives of the proposed technical solution are: a significant increase in the yield of the target product, simplification of the production technology and increase in the service life of IG, while maintaining the advantages of the prototype method. The solution to these problems is achieved by using a new type of source material to accommodate ^{223} Ra and additional technological processes and operations that were not previously used.
Ядро ^{219}Rn может покинуть поверхность твердого тела (материала-источника) или за счет энергии отдачи, которую оно получает при радиоактивном распаде ^{223}Ra, или за счет диффузионных процессов. При комнатной температуре скорость диффузии атомов внутри твердого тела очень мала, поэтому, для короткоживущего ^{219}Rn выход в газовую фазу по этому механизму маловероятен.	The ^{219} Rn nucleus can leave the surface of a solid (source material) either due to the recoil energy that it receives during the radioactive decay of ^{223} Ra, or due to diffusion processes. At room temperature, the diffusion rate of atoms inside a solid is very low; therefore, for the short-lived ^{219} Rn, the exit into the gas phase by this mechanism is unlikely.
Энергия ядра отдачи (^{219}Rn) при распаде ^{223}Ra составляет ~0,12 МэВ, а длина пробега L ~ (10-20) нм [Несмеянов А.Н. Радиохимия. - 2-е изд., М.: Химия, 1978. - 560 с.]. Поэтому основным механизмом выхода ^{219}Rn из твердого тела в газовую фазу является эффект ядер отдачи. Образование ядер ^{219}Rn происходит во всем объеме материала-источника, а выход радона в газовую фазу возможен только из тонкого поверхностного слоя. Для достижения максимального выхода радона, близкого к теоретически возможному (100%), необходимо, чтобы эффективная толщина слоя материала-источника - h, равная отношению его объема к площади, была сопоставима с L (h ~ L). Решить такую задачу можно, например, путем использования вместо плоской подложки - пористого материала с развитой внешней поверхностью. Таким материалом может быть, например, волокнистые материалы, применяемые для улавливания аэрозольных частиц на основе ультратонких полимерных волокон (ткань Петрянова) или на основе стекловолокна, углеволокна (графена) и др.	The energy of the recoil nucleus (^{219} Rn) in the decay of ^{223} Ra is ~ 0.12 MeV, and the path length is L ~ (10-20) nm [Nesmeyanov A.N. Radiochemistry. - 2nd ed., M .: Chemistry, 1978. - 560 p.]. Therefore, the main mechanism for the release of ^{219} Rn from the solid into the gas phase is the effect of recoil nuclei. The formation of ^{219} Rn nuclei occurs in the entire volume of the source material, and the release of radon into the gas phase is possible only from a thin surface layer. To achieve the maximum radon yield close to the theoretically possible (100%), it is necessary that the effective thickness of the source material layer - h, equal to the ratio of its volume to area, be comparable to L (h ~ L). This problem can be solved, for example, by using instead of a flat substrate - a porous material with a developed outer surface. Such a material can be, for example, fibrous materials used to trap aerosol particles based on ultra-thin polymer fibers (Petryanov cloth) or based on glass fiber, carbon fiber (graphene), etc.

Изготовление источника проводят, например, путем нанесения на поверхность волоконного материала раствора соединений ^{223}Ra с последующим высушиванием. Для получения водного раствора ^{223}Ra используют легко растворимые в воде соединения, которые в сухом виде хорошо выделяют ^{219}Rn, например, хлориды, бромиды, окиси и др. [Пруткина М.И., Шашкин В.Л. Справочник по радиометрической разведке и радиометрическому анализу. М., Атомиздат, 1975, с. 248].	The source is made, for example, by applying a solution of compounds ^{223} Ra to the surface of the fiber material, followed by drying. To obtain an aqueous solution of ^{223} Ra, readily water-soluble compounds are used, which in dry form well emit ^{219} Rn, for example, chlorides, bromides, oxides, etc. [Prutkina MI, Shashkin V.L. A Handbook of Radiometric Survey and Radiometric Analysis. M., Atomizdat, 1975, p. 248].
Такое техническое решение позволяет увеличить выход газообразного ^{219}Rn из материала источника, отказаться от использования стеарата бария и, таким образом, полностью исключить радиолитическое разрушение органического материала-источника и продлить срок службы ИГ без ухудшения качества целевого продукта.	This technical solution makes it possible to increase the yield of gaseous ^{219} Rn from the source material, to abandon the use of barium stearate and, thus, to completely exclude radiolytic destruction of the organic source material and to extend the service life of the IG without deteriorating the quality of the target product.
Установку изготавливают в виде герметичного замкнутого контура, состоящего из соединенных между объема V_1, где размещают материал источника и происходит генерация ^{219}Rn, сорбционного устройства (коллектора) объемом V_2, где осуществляется осаждение и накопление ^{219}Rn и продуктов его распада и объема соединительных трубок V_3. В контуре установки организуют принудительную циркуляцию газового потока. Объемы V_1, V_2 и V_3, а также расход газа в контуре установки Q выбирают таким образом, чтобы время нахождения газового потока в объеме источника V_1 и в объеме V_3 было минимальным (не более 0,5 с), а время нахождения газового потока в объеме V_2 должно быть не менее 4-5 периодов полураспада ^{219}Rn, то есть около 15-25 с. При одновременном выполнение этих условий основная часть образующихся продуктов распада ^{219}Rn будет накапливаться на стенках коллектора с объемом V_2.	The installation is made in the form of a sealed closed loop, consisting of interconnected volumes V_1, where the source material is placed and the generation of ^{219} Rn occurs, a sorption device (collector) with volume V_2, where the deposition and accumulation of ^{219} Rn and its decay products and the volume of connecting tubes V_3. Forced circulation of the gas flow is organized in the unit circuit. The volumes V_1, V_2 and V_3, as well as the gas flow rate in the circuit of the installation Q, are selected so that the residence time of the gas flow in the volume of the source V_1 and in the volume $V_{3\,is}$ minimal (no more than 0.5 s), and the time finding the gas flow in the volume V_2 should be at least 4-5 half-lives of ^{219} Rn, that is, about 15-25 s. If these conditions are met simultaneously, the bulk of the formed ^{219} Rn decay products will accumulate on the walls of the reservoir with a volume of V_2.
Для исключения возможности попадания посторонних веществ в герметичный контур установки, циркуляцию газового потока проводят с использованием перистальтического насоса.	To exclude the possibility of foreign substances entering the sealed circuit of the installation, the gas flow is circulated using a peristaltic pump.

Известно [Пруткина М.И., Шашкин В.Л. Справочник по радиометрической разведке и радиометрическому анализу. М., Атомиздат, 1975, с. 248], что сорбция радона на любых твердых поверхностях сильно зависит от температуры. При понижении температуры ниже комнатной, сорбция возрастает, а полная конденсация радона на поверхности происходит при температуре ниже температуры замерзания жидкого радона, которая равна -71°С. Поэтому температуру коллектора поддерживают на возможно низком уровне (предпочтительно ниже -71°С).	It is known [Prutkina MI, Shashkin V.L. A Handbook of Radiometric Survey and Radiometric Analysis. M., Atomizdat, 1975, p. 248] that the sorption of radon on any solid surface strongly depends on temperature. When the temperature drops below room temperature, sorption increases, and complete condensation of radon on the surface occurs at a temperature below the freezing point of liquid radon, which is -71 ° C. Therefore, the collector temperature is kept as low as possible (preferably below -71 ° C).
В качестве газовой среды можно использовать воздух или углекислый газ (двуокись углерода). При использовании углекислого газа он будет частично вымораживаться на стенках коллектора, что приведет к понижению давления в газовом контуре и к увеличению выхода радона из материала источника.	Air or carbon dioxide (carbon dioxide) can be used as a gaseous medium. When carbon dioxide is used, it will partially freeze out on the walls of the collector, which will lead to a decrease in pressure in the gas circuit and to an increase in the release of radon from the source material.
Содержание влаги в материале источника нежелательно, поскольку водяная пленка на поверхности и в капиллярах микрокристалликов препарата может существенно затруднить выход ^{219}Rn в газовую среду. Поэтому материал-источника нагревают до температуры выше 100°С, что позволяет дополнительно сократить «паразитную» сорбцию ^{219}Rn на конструкционных материалах источника. Выделяющийся водяной пар вымораживают на стенках коллектора.	The moisture content in the source material is undesirable, since a water film on the surface and in the capillaries of the preparation microcrystals can significantly hinder the release of ^{219} Rn into the gaseous environment. Therefore, the source material is heated to a temperature above 100 ° C, which makes it possible to further reduce the "parasitic" sorption of ^{219} Rn on the structural materials of the source. The released water vapor is frozen on the walls of the collector.
Такое техническое решение позволит отказаться от использования сложной вакуумной техники, применяемой в способе по прототипу.	This technical solution will allow to abandon the use of complex vacuum technology used in the prototype method.

Короткий период полураспада ^{211}Pb (36 мин) требует применения экспрессных и эффективных методов выделения целевого продукта из коллектора (без использования химических реактивов), что позволит до минимума сократить время проведения всех операций и снизить потери ^{211}Pb на радиоактивный распад при выделении. Достижение этой цели осуществляют следующим образом. На предварительной стадии эксплуатации установки (до организации циркуляции газа по контуру), на внутренней поверхности коллектора создают тонкий ледяной слой в виде изморози. Быстрое создание такого слоя возможно, например, путем охлаждения стенок коллектора до отрицательной температуры при одновременной подаче в объем коллектора водного аэрозоля дистиллированной воды, например, с использованием инжектора.	The short half-life of ^{211} Pb (36 min) requires the use of rapid and effective methods for isolating the target product from the reservoir (without using chemical reagents), which will minimize the time for all operations and reduce the loss of ^{211} Pb to radioactive decay during isolation. This goal is achieved as follows. At the preliminary stage of plant operation (prior to the organization of gas circulation along the circuit), a thin ice layer in the form of frost is created on the inner surface of the collector. The rapid creation of such a layer is possible, for example, by cooling the walls of the collector to a negative temperature while simultaneously supplying distilled water to the collector volume with an aqueous aerosol, for example, using an injector.
В рабочем режиме (при циркуляции газа) осаждение ^{219}Rn и накопление продуктов его распада осуществляют на поверхности созданного ледяного слоя, а извлечение целевого продукта проводят путем нагрева стенок коллектора до температуры плавления льда и сбора талой воды.	In the operating mode (with gas circulation), the deposition of ^{219} Rn and the accumulation of its decay products are carried out on the surface of the created ice layer, and the extraction of the target product is carried out by heating the collector walls to the melting point of ice and collecting melt water.
Для увеличения продолжительности эксплуатации ИГ в материал источника вводят соединения торий-227 (^{227}Th) и/или смесь соединений ^{227}Th и ^{223}Ra.	To increase the duration of IG operation, thorium-227 (^{227} Th) compounds and / or a mixture of ^{227} Th and ^{223} Ra compounds are introduced into the source material.
Присутствие в материале источника примесей других альфа-излучающих изотопов радия (^{224}Ra и/или ^{226}Ra), в схеме радиоактивного распада которых присутствуют аналоги целевого радионуклида - изотопы ^{212}Pb/^{212}Bi и/или ^{214}Pb/^{214}Bi, допустимо, поскольку изотопы-аналоги обладают сходными терапевтическими свойствами, а их накопление на коллекторе за 2 часа будет незначительным.	The presence in the material of the source of impurities of other alpha-emitting isotopes of radium (^{224} Ra and / or ^{226} Ra), in the radioactive decay scheme of which there are analogues of the target radionuclide - isotopes ^{212} Pb / ^{212} Bi and / or ^{214} Pb / ^{214} Bi, is permissible, since the isotopes - analogs have similar therapeutic properties, and their accumulation on the collector in 2 hours will be negligible.
Принципиальная схема такой установки показана на фиг.	A schematic diagram of such an installation is shown in Fig.

Установка включает три контура (вспомогательный, рабочий и промывной) и состоит из источника (1), коллектора (2), запорных вентилей (3-6), холодильника/нагревателя (7), насоса (8), бака с промывным раствором (9), инжектора для подачи водного аэрозоля в объем V_2 из сосуда с дистиллированной водой (10), емкости для сбора целевого продукта (11) и устройства для электрического нагрева источника и контроля температуры (12). Для упрощения схемы вентили (3-6) на рисунке показаны как трехходовые краны.	The installation includes three circuits (auxiliary, working and flushing) and consists of a source (1), a manifold (2), shut-off valves (3-6), a refrigerator / heater (7), a pump (8), a tank with a flushing solution (9), an injector for supplying an aqueous aerosol into volume V_2 from a vessel with distilled water (10), a container for collecting the target product (11) and a device for electric heating of the source and temperature control (12). To simplify the diagram, the valves (3-6) are shown in the figure as three-way valves.
Эксплуатация установки осуществляется циклично, а каждый цикл включает следующие этапы:	The unit is operated cyclically, and each cycle includes the following stages:
1. На начальном этапе используют вспомогательный контур для создания на внутренней поверхности стенок коллектора ледяного слоя в виде изморози (наледи).	1. At the initial stage, an auxiliary contour is used to create an ice layer on the inner surface of the collector walls in the form of rime (ice).
Для этого источник отсоединяют от коллектора с использованием вентилей (3 и 6). С использованием холодильника (7) проводят охлаждение стенок коллектора до отрицательной температуры (ниже 0°С), оптимальной для образования наледи. Открывают вентили (4 и 5) и организуют циркуляцию воздуха по укороченному (негерметичному) контуру. С использованием инжектора подают в контур водный аэрозоль из емкости с дистиллированной водой (10). После создания на внутренней поверхности коллектора ледяного слоя, закрывают вентили (4 и 5), отключают инжектор и прекращают подачу водного аэрозоля в установку. Холодильник (7) переводят в рабочий режим с пониженной температурой стенок коллектора (2), оптимальной для осаждения ^{219}Rn и накопление продуктов его распада на поверхности созданного ледяного слоя.	For this, the source is disconnected from the collector using valves (3 and 6). Using the refrigerator (7), the collector walls are cooled to a negative temperature (below 0 ° C), which is optimal for the formation of ice. Open valves (4 and 5) and organize air circulation along the shortened (leaky) circuit. Using an injector, a water aerosol is fed into the circuit from a container with distilled water (10). After creating an ice layer on the inner surface of the collector, close the valves (4 and 5), turn off the injector and stop the supply of water aerosol to the installation. The refrigerator (7) is switched to an operating mode with a lowered temperature of the walls of the collector (2), which is optimal for the deposition of ^{219} Rn and the accumulation of its decay products on the surface of the created ice layer.

2. На втором этапе, организуют циркуляцию воздуха по рабочему контуру установки путем последовательного выполнения следующих операций: включают электрический нагрев источника (12) до температуры выше 100°С, соединяют объемы источника и коллектора путем открытия вентилей (3 и 6) и включают насос (8). Выделяющийся из материала-источника газообразный ^{219}Rn поступает в объем коллектора, где происходит его осаждение на покрытых льдом стенках коллектора и затем радиоактивный распад с образованием целевого продукта. Накопление продуктов распада проводят в течение ~2 часов.	2. At the second stage, air circulation is organized along the operating circuit of the installation by sequentially performing the following operations: turn on the electrical heating of the source (12) to a temperature above 100 ° C, connect the volumes of the source and the collector by opening valves (3 and 6) and turn on the pump (8). The gaseous ^{219} Rn released from the source material enters the reservoir volume, where it is deposited on the ice-covered reservoir walls and then radioactive decay with the formation of the target product. The accumulation of decomposition products is carried out for ~ 2 hours.
3. На третьем этапе используют промывной контур для выделения накопленных в коллекторе продуктов распада ^{219}Rn, содержащих целевой продукт. Для этого, закрывают вентили (3 и 6) и тем самым отсоединяют источник (1) от коллектора (2), выключают нагрев объема источника (12), выключают насос (8), переключают холодильник (7) в режим нагрева и производят сбор талой воды в накопительную емкость (11). При необходимости проводят окончательную промывку коллектора водой из бака (9). Полученный раствор используют для изготовления РФП.	3. At the third stage, a flushing circuit is used to separate the ^{219} Rn decomposition products accumulated in the collector and containing the target product. To do this, close the valves (3 and 6) and thereby disconnect the source (1) from the collector (2), turn off the heating of the source volume (12), turn off the pump (8), switch the refrigerator (7) to heating mode and collect the thawed water into the storage tank (11). If necessary, carry out the final flushing of the collector with water from the tank (9). The resulting solution is used for the manufacture of RFP.
Ниже приведены примеры, демонстрирующие возможность изготовления генератора для получения ^{211}Pb/^{211}Bi с начальной активностью $1 \cdot 10^8$ Бк (100 МБк).	Below are examples demonstrating the possibility of manufacturing a generator for producing ^{211} Pb / ^{211} Bi with an initial activity of $1 \cdot 10^8$ Bq (100 MBq).
В качестве препарата используют, например, раствор соли бромида ^{223}Ra с активностью 200 МБк, объемом 10 мл и с суммарной концентрацией солей 1 г/л.	As a preparation, for example, a solution of a salt of bromide ^{223} Ra with an activity of 200 MBq, a volume of 10 ml and a total salt concentration of 1 g / l is used.
Мощность эквивалентной дозы на расстоянии 1 м от такого сосуда с раствором ^{223}Ra (в геометрии точечного источника) составит ~100 мкЗв/час. Дополнительную радиационную опасность представляет ингаляция выделяющегося ^{219}Rn и продуктов его распада. Поэтому все работы по изготовлению источника необходимо проводить в герметичном боксе радиохимического предприятия (лаборатории), оборудованном системой вентиляции и защитой от внешнего гамма-излучения.	The equivalent dose rate at a distance of 1 m from such a vessel with a ^{223} Ra solution (in the geometry of a point source) will be ~ 100 μSv / h. An additional radiation hazard is posed by inhalation of the emitted ^{219} Rn and its decay products. Therefore, all work on the manufacture of the source must be carried out in a sealed box of a radiochemical enterprise (laboratory) equipped with a ventilation system and protection from external gamma radiation.

Продолжительность эксплуатации генератора T примем равной ~22 суток, а время транспортировки генератора до медицинской клиники - 2 суток.	The operating time of the generator T is assumed to be ~ 22 days, and the time for transporting the generator to a medical clinic is 2 days.
Пример 1 демонстрирует возможный процесс изготовления источника.	Example 1 demonstrates a possible source fabrication process.
В качестве материала-источника используют, например, волокнистый материал типа ФПА-15-2,0 на основе ацетилцеллюлозы, который применяется для изготовления аналитических аэрозольных фильтров АФА-РМА. Этот материал обладает следующими свойствами [А.К. Будыка, Н.Б. Борисов Волокнистые фильтры для контроля загрязнения воздушной среды. М., ИздАТ, 2008, - 360 с]: средний диаметр волокон 1,5 мкм, объемная доля волокон в материале (плотность упаковки) α=5%, поверхностная масса σ_F=3,5 мг/см^2, хорошо смачивается водой (гидрофилен), устойчивый к слабым кислотам, термоустойчив при температурах до 150°С.	As a source material, for example, a fibrous material of the FPA-15-2.0 type based on cellulose acetate is used, which is used for the manufacture of analytical aerosol filters AFA-PMA. This material has the following properties [A.K. Budyk, N.B. Borisov Fiber filters for air pollution control. M., IzdAT, 2008, - 360 s]: the average fiber diameter is 1.5 μm, the volume fraction of fibers in the material (packing density) α = 5%, surface weight σ_F = 3.5 mg / cm^2, well wetted with water (hydrophilic), resistant to weak acids, heat resistant at temperatures up to 150 ° C.
Для изготовления источника используют материал ФПА-15-2,0 в виде готовых фильтров АФА-РМА или в виде ленты, что предпочтительнее, поскольку в этом случае процесс изготовления более технологичен и легче поддается автоматизации.	For the manufacture of the source, material FPA-15-2.0 is used in the form of ready-made AFA-PMA filters or in the form of a tape, which is preferable, since in this case the manufacturing process is more technological and easier to automate.
По центральной оси ленты наносят раствор соли ^{223}Ra в виде серии последовательных отдельных капель таким образом, чтобы диаметр образующегося после растекания капли пятна не превышал ширины ленты, а расстояние между каплями не превышало диаметра пятна и одновременно высушивают, например под термолампой. Подсушенную ленту наматывают в рулон на катушку в виде кассеты.	Along the central axis of the tape, a solution of ^{223}Ra salt is applied in the form of a series of successive individual drops so that the diameter of the spot formed after the drop spreads does not exceed the width of the tape, and the distance between the drops does not exceed the diameter of the spot and is simultaneously dried, for example, under a thermal lamp. The dried tape is wound into a roll on a reel in the form of a cassette.
Такой процесс изготовления источника легко автоматизировать даже в условиях герметичного бокса по принципу работы пленочного фотоаппарата, когда лента последовательно прокручивается с одной («чистой») кассеты на другую, в виде готового источника, а нанесение раствора на ленту соответствует изготовлению фотоснимка.	Such a source manufacturing process is easy to automate even in a sealed box according to the principle of a film camera, when the tape is sequentially scrolled from one ("clean") cassette to another, in the form of a ready source, and the application of the solution to the tape corresponds to the production of a photograph.

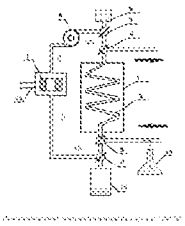
Используют ленту с шириной, например 50 мм. Объем одной капли задают микро-дозатором ~0,1 мл, после растекания капли диаметр образующегося пятна составит ~40 мм, а площадь одного пятна ~12,5 $см^2$. Тогда на ленту необходимо нанести ~100 капель, а длина ленты будет равна ~400 см. Общая поверхность высушенных капель составит ~1250 $см^2$. При этом поверхностная активность ^{223}Ra на рабочем слое ленты будет σ_A=160 кБк/$см^2$, а поверхностная плотность соли σ_s=8 мкг/$см^2$. При внутреннем диаметре жесткой втулки кассеты источника ~10 см, лента будет намотана в ~14 слоев с суммарной толщиной слоя ~50 мг/$см^2$ (менее 2 мм).	Use a tape with a width of, for example, 50 mm. The volume of one drop is set with a micro-dispenser ~ 0.1 ml, after the drop spreads, the diameter of the formed spot will be ~ 40 mm, and the area of one spot is ~ 12.5 cm^2. Then it is necessary to apply ~ 100 drops to the tape, and the length of the tape will be ~ 400 cm. The total surface of the dried drops will be ~ 1250 cm^2. In this case, the surface activity of ^{223} Ra on the working layer of the tape will be σ_A = 160 kBq / cm^2, and the surface density of the salt σ_s = 8 μg / cm^2. With the inner diameter of the source cassette rigid sleeve ~ 10 cm, the tape will be wound in ~ 14 layers with a total layer thickness of ~ 50 mg / cm^2 (less than 2 mm).
При нанесении раствора бромида ^{223}Ra на ткань ФПА-15-2,0 происходит смачивание гидрофильных волокон ацетилцеллюлозы, а при высушивании раствора на поверхности волокон образуется тонкий слой соли толщина которого существенно меньше диаметра волокон и соизмерима с длиной пробега ядра ^{219}Rn в соли.	When a solution of bromide ^{223} Ra is applied to FPA-15-2.0 fabric, the hydrophilic fibers of cellulose acetate are wetted, and when the solution is dried, a thin layer of salt forms on the surface of the fibers, the thickness of which is significantly less than the diameter of the fibers and is commensurate with the run length of the ^{219} Rn core in salt.
Пример 2 демонстрирует оценку радиационной стойкости материала источника.	Example 2 demonstrates an assessment of the radiation resistance of a source material.
Сведения о радиационной стойкости материалов ФПА и фильтров АФА-РМ к облучению альфа-частицами крайне ограничены.	Information on the radiation resistance of FPA materials and AFA-RM filters to alpha-particle irradiation is extremely limited.
На стр. 170 монографии [А.К. Будыка, Н.Б. Борисов Волокнистые фильтры для контроля загрязнения воздушной среды. М., ИздАТ, 2008, - 360 с] указано, что «Все фильтры АФА-РМ обладают радиационной стойкостью по отношению к «горячим» аэрозольным частицам. Разрушение фильтрующего слоя наступает, например, при активности аэрозольных частиц, содержащих ^{210}Po, свыше $3 \cdot 10^{-6}$ Ки (110 кБк)».	On page 170 of the monograph [A.K. Budyk, N.B. Borisov Fiber filters for air pollution control. M., IzdAT, 2008, - 360 p.] It is stated that "All AFA-RM filters have radiation resistance in relation to" hot "aerosol particles. The destruction of the filtering layer occurs, for example, when the activity of aerosol particles containing ^{210} Po exceeds $3 \cdot 10^{-6}$ Ci (110 kBq) ".
Это означает, что допустимая активность одной «горячей» частицы ^{210}Po, с характерным размером ~1 мкм, на фильтре АФА-РМ (110 кБк), примерно соответствует активности ^{223}Ra, равномерно нанесенной на 1 $см^2$ ленты (160 кБк). Радиационные характеристики ^{210}Po и ^{223}Ra примерно одинаковы, поэтому можно считать, что радиационная стойкость материала ФПА за время эксплуатации генератора будет обеспечена.	This means that the permissible activity of one "hot" ^{210} Po particle, with a characteristic size of ~ 1 μm, on an AFA-RM filter (110 kBq), approximately corresponds to the activity of ^{223} Ra, uniformly applied to 1 $cm^{2\,of}$ tape (160 kBq). The radiation characteristics of ^{210} Po and ^{223} Ra are approximately the same, therefore, it can be assumed that the radiation resistance of the FPA material during the operation of the generator will be provided.

Пример 3 демонстрирует расчет оптимальных значений объемов V_1, V_2, V_3 и расхода газа в рабочем контуре Q.	Example 3 shows the calculation of the optimal values of the volumes V_1, V_2, V_3 and the gas flow rate in the working circuit Q.
Кассета с лентой вставляется в картридж. Картридж источника изготавливают в виде разборного жесткого цилиндра внутри которого находится герметичная полость в форме цилиндрического кольцевого зазора с внутренним диаметром d_1 и наружным d_2. С торцов цилиндра полость соединена с подводящими трубками для прокачки газа. Высота цилиндрической полости соответствует ширине ленты, а размер цилиндрического зазора выбирают исходя из толщины намотанных слоев ленты. Реальная толщина фильтра АФА-РМ менее 0,1 мм, поэтому для 14 слоев ленты толщину зазора можно принять 2 мм.	The tape cassette is inserted into the cartridge. The source cartridge is made in the form of a collapsible rigid cylinder inside which there is a sealed cavity in the form of a cylindrical annular gap with an inner diameter d_1 and an outer diameter d_2. At the ends of the cylinder, the cavity is connected to supply pipes for pumping gas. The height of the cylindrical cavity corresponds to the width of the tape, and the size of the cylindrical gap is selected based on the thickness of the wound layers of the tape. The real thickness of the AFA-RM filter is less than 0.1 mm, therefore, for 14 layers of tape, the gap thickness can be taken as 2 mm.
Поток газа направляют по кольцевому зазору параллельно плоскости слоев ленты. Внутренний газовый объем цилиндрической полости (при d_2-d_1=4 мм) будет V_1 ~30 см^3, а с учетом объемной доли волокон в материале ленты, ~28 см^3. Объемный расход газа Q задают таким образом, чтобы время нахождения газа в объеме V_1 было минимальным и не превышало, например, t_1 ~0,25 с. При заданных параметрах значение $Q=V_1/t_1$ ~120 мл/с (7,2 л/мин.). При таком расходе в объеме V_1 будет распадаться ~4% от образующихся ядер ^{219}Rn. Если время нахождения газа в объеме V_2 будет, например, равно t_2 ~20 с (в 5 раз больше периода полураспада ^{219}Rn), то основная часть продуктов распада ^{219}Rn (~97%) будет образовываться в объеме V_2. Тогда значение $V_2=Q*t_2$ ~2400 мл (2,4 л). Дальнейшее увеличение объема V_2 нецелесообразно, поскольку при этом будет возрастать и площадь поверхности коллектора (объема V_2), что может затруднить извлечение накопленного ^{211}Pb из коллектора.	The gas flow is directed along the annular gap parallel to the plane of the tape layers. The internal gas volume of the cylindrical cavity (at d_2 -d_1 = 4 mm) will be V_1 ~ 30 cm^3, and taking into account the volume fraction of fibers in the tape material, ~ 28 cm^3. The volumetric gas flow rate Q is set in such a way that the residence time of the gas in the volume V_1 is minimal and does not exceed, for example, t_1 ~ 0.25 s. With the given parameters, the value of $Q = V_1 / t_1$ ~ 120 ml / s (7.2 L / min.). With such a flow rate, ~ 4% of the ^{219}Rn nuclei formed will decay in the volume V_1. If the residence time of the gas in the volume V_2 is, for example, t_2 ~ 20 s (5 times the half-life of ^{219}Rn), then the main part of the decay products of ^{219}Rn (~ 97%) will be formed in the volume V_2. Then the value of $V_2 = Q * t_2$ ~ 2400 ml (2.4 L). A further increase in the volume V_2 is impractical, since in this case the surface area of the reservoir (volume V_2) will also increase, which can make it difficult to extract the accumulated ^{211}Pb from the reservoir.
Для повышения эффективности генератора, время нахождения ^{219}Rn в соединительной трубке объемом V_3 снижают до минимально-возможного значения.	To increase the efficiency of the generator, the residence time of ^{219}Rn in the connecting tube of volume V_3 is reduced to the minimum possible value.
Пример 4 демонстрирует расчет активности ^{211}Pb/^{211}Bi накапливаемой на коллекторе генератора.	Example 4 shows the calculation of the ^{211}Pb / ^{211}Bi activity accumulated on the generator manifold.

Накопление активности ^{211}Pb на стенках коллектора проводят за время не более 4-5 периодов полураспада ^{211}Pb, так как, уже за 2,5 часа на стенках коллектора накопится ~95% от максимально возможного значения равновесной активности.	The accumulation of activity of ^{211} Pb on the walls of the reservoir is carried out for no more than 4-5 half-lives of ^{211} Pb, since already in 2.5 hours ~ 95% of the maximum possible value of the equilibrium activity will accumulate on the walls of the reservoir.
Конструкция картриджа должна предусматривать нагрев ленты в рабочем состоянии до температуры более 100°С, но менее допустимой для фильтра АФА-РМ (150°С). Такая температура позволяет сократить сорбцию ^{219}Rn на материалах картриджа и необходима для удаления влаги из материала источника, поскольку наличие водяной пленки на поверхности и в капиллярах кристалликов соли может затруднить выход ^{219}Rn в газовую среду.	The design of the cartridge should provide for heating the tape in working order to a temperature of more than 100 ° C, but less than the permissible temperature for the AFA-RM filter (150 ° C). This temperature makes it possible to reduce the sorption of ^{219} Rn on the cartridge materials and is necessary to remove moisture from the source material, since the presence of a water film on the surface and in the capillaries of salt crystals can hinder the release of ^{219} Rn into the gaseous environment.
Для охлаждения стенок коллектора до температуры ниже -71°С используют, например, «сухой лед» (температуры замерзания двуокиси углерода, -78°С) или специальный ультранизкотемпературный холодильник. Такая температура позволяет повысить сорбцию газообразного ^{219}Rn на ледяных стенках коллектора, удалить пары воды и часть углекислого газа из объема рабочего контура путем их вымораживания на стенках коллектора, что приведет к понижению давления в контуре и увеличению выхода радона из материала источника.	To cool the walls of the collector to temperatures below -71 ° C, use, for example, "dry ice" (freezing point of carbon dioxide, -78 ° C) or a special ultra-low-temperature refrigerator. This temperature makes it possible to increase the sorption of gaseous ^{219} Rn on the ice walls of the collector, to remove water vapor and part of carbon dioxide from the volume of the working circuit by freezing them on the walls of the collector, which will lead to a decrease in the pressure in the circuit and an increase in the release of radon from the source material.
В режиме извлечения продуктов распада ^{219}Rn из коллектора, его внешние стенки нагревают до температуры выше +90°С с использованием, например, горячей воды и/или электрического нагревателя. Сливают талую воду (вместе с кусочками льда), содержащую основную часть продуктов распада ^{219}Rn, из коллектора в накопительную емкость. При необходимости емкость коллектора дополнительно промывают дистиллированной водой. Продолжительность размораживания конденсата не превысит 10 минут.	In the mode of extracting decomposition products of ^{219} Rn from the collector, its outer walls are heated to a temperature above + 90 ° C using, for example, hot water and / or an electric heater. Melted water (together with pieces of ice), containing the main part of the decomposition products of ^{219} Rn, is drained from the collector into the storage tank. If necessary, the collector tank is additionally rinsed with distilled water. Condensate defrosting time will not exceed 10 minutes.
Общие потери ^{211}Pb, в долях от равновесной активности, не превысят 30% и определяются:	The total losses of ^{211} Pb, in fractions of the equilibrium activity, will not exceed 30% and are determined by:
- доля оставшегося ^{219}Rn в соли бромида ^{223}Ra, менее 10%;	- the proportion of the remaining ^{219} Rn in the bromide salt of ^{223} Ra, less than 10%;
- «паразитной» сорбцией (за пределами коллектора), не более 5%;	- "parasitic" sorption (outside the collector), no more than 5%;

- распад за время размораживания конденсата, не более 8%;	- decomposition during condensate defrosting, no more than 8%;
- остаточной сорбцией на стенках коллектора и распадом при смыве, менее 5%.	- residual sorption on the walls of the collector and decomposition during flushing, less than 5%.
Таким образом, активность первой порции целевого продукта, с учетом распада ^{223}Ra за время транспортировки кассеты с источником до медицинской клиники (~12%), составит ~120 МБк.	Thus, the activity of the first portion of the target product, taking into account the decay of ^{223}Ra during the transport of the cassette with the source to the medical clinic (~ 12%), will be ~ 120 MBq.
Общие временные затраты на один цикл работы генератора составят 3 часа, что позволяет получить 8 порций целевого продукта в сутки.	The total time spent on one cycle of the generator operation will be 3 hours, which makes it possible to obtain 8 portions of the target product per day.

Images



РОССИЙСКАЯ ФЕДЕРАЦИЯ

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(56) Список документов, цитированных в отчете о поиске: L.I.GUSEVA et al.Optimization of Conditions for Isolation of Short-Lived 211Pb Using a Cation Exchanger and Aqueous-Organic HCl Solutions as Eluents. A 223Ra-211Pb Generator,Radiochemistry (46) 2, january 2004, p.168-171. RU 2373589 C1, 20.11.2009. RU 2498434 C1, 10.11.2013. US 20180047474 A1, 15.02.2018.

(54) Способ получения ^{211}Pb/^{211}Bi для ядерной медицины

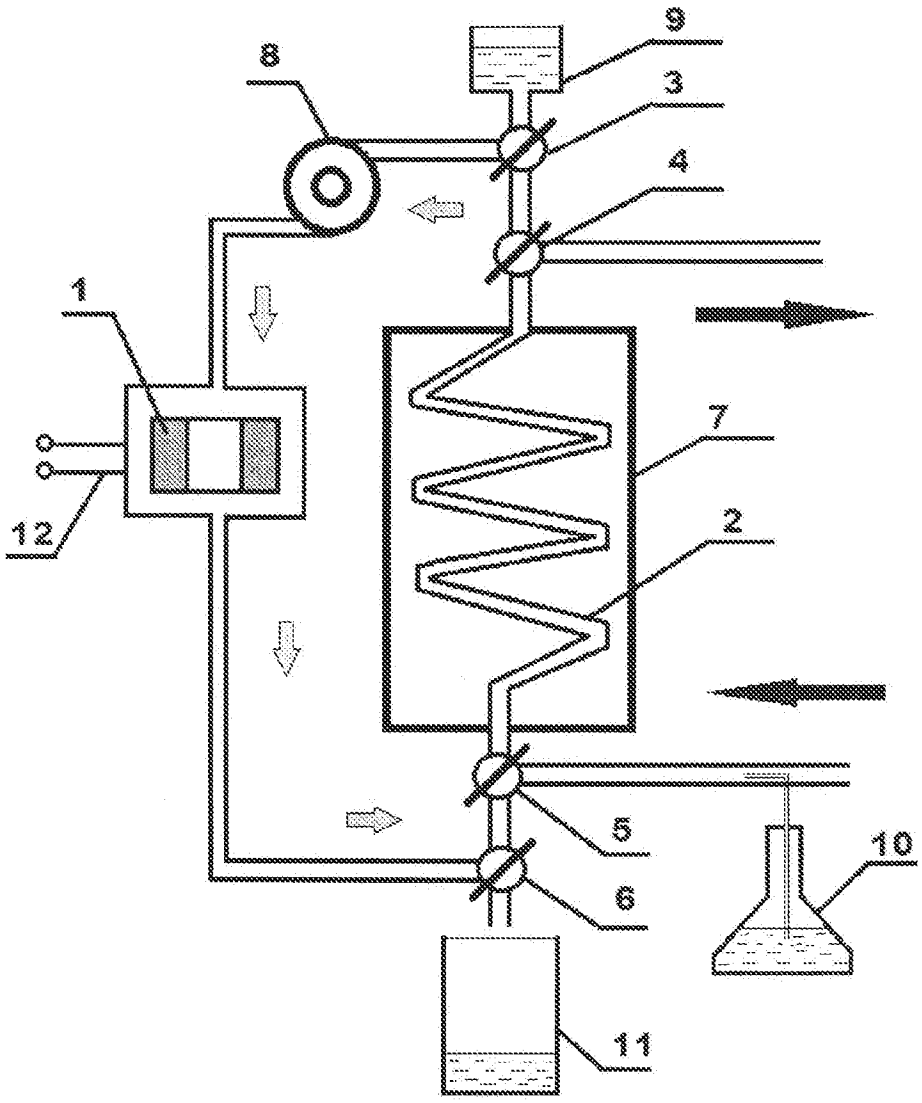
(57) Реферат:

Изобретение относится к технологии получения свинца-211/висмута-211 (^{211}Pb/^{211}Bi) для ядерной медицины. Способ основан на использовании эффекта эманации радона-219 (^{219}Rn) источником, содержащим препарат радий-223 (^{223}Ra). Источник изготавливают путем создания на поверхности пористого/волоконного материала с развитой внешней поверхностью тонкого сухого твердого слоя препарата. Источник размещают в установке, состоящей из герметичного газового контура с принудительной циркуляцией газового потока и коллектора для осаждения газообразного ^{219}Rn. Предварительно на внутренних стенках коллектора создают ледяной слой путем его охлаждения и одновременного инжектирования водного аэрозоля в контур. Осаждение ^{219}Rn и накопление продуктов его распада, содержащих целевой продукт, проводят на поверхности слоя льда коллектора, а извлечения ^{211}Pb/^{211}Bi проводят путем нагрева стенок коллектора и сбора образующейся талой воды. Изобретение позволяет упростить технологию получения ^{211}Pb/^{211}Bi, повысить выход и обеспечить высокую радиохимическую чистоту целевого радионуклида. 11 з.п. ф-лы, 1 ил.

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Принципиальная схема установки (генератора) для получения $^{211}Pb/^{211}Bi$

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(54) METHOD OF OBTAINING ^{211}PB/^{211}BI FOR NUCLEAR MEDICINE

(57) Abstract:

FIELD: nuclear medicine.

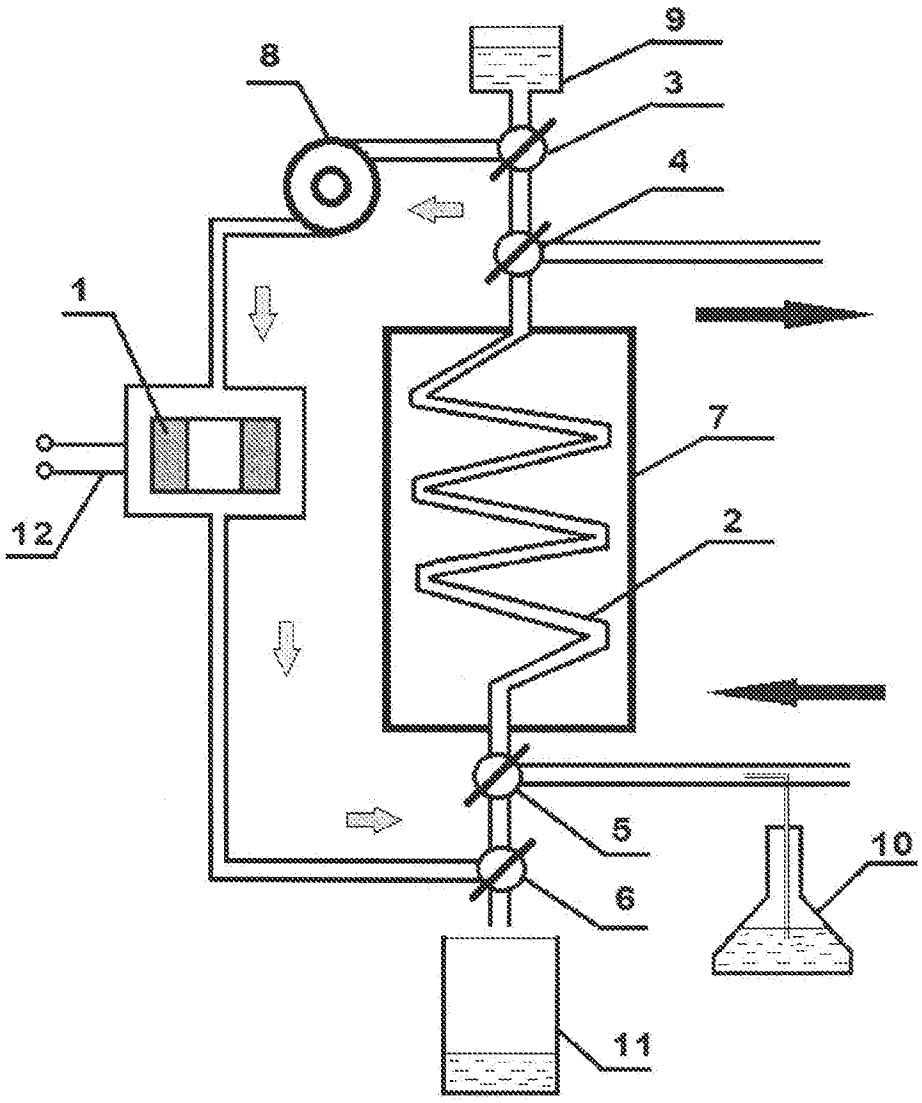
SUBSTANCE: invention relates to a technology for producing lead-211 / bismuth-211 (^{211}Pb / ^{211}Bi) for nuclear medicine. The method is based on the use of the effect of radon-219 (^{219}Rn) emanation by a source containing radium-223 (^{223}Ra). The source is made by creating a thin dry solid layer of radium-223 on the surface of a porous / fibrous material with an outer surface. The source is placed in an installation consisting of a sealed gas loop with forced circulation of a gas flow and a collector for the deposition of gaseous ^{219}Rn. It's necessary to create an ice layer on the inner walls of the collector by cooling it and simultaneously injecting a water aerosol into the collector. The deposition of ^{219}Rn and the accumulation of its decay products containing the target product are carried out on the surface of the ice layer of the collector, and the extraction of ^{211}Pb / ^{211}Bi is carried out by heating the walls of the collector and collecting the formed melt water.

EFFECT: invention makes it possible to simplify technology of obtaining ^{211}Pb / ^{211}Bi, to increase yield and to ensure high radiochemical purity of the target radionuclide.

12 cl, 1 dwg

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Принципиальная схема установки (генератора) для получения $^{211}Pb/^{211}Bi$

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Изобретение относится к технологии получения радионуклидов для ядерной медицины.

В настоящее время одним из наиболее перспективных направлений в радиационной терапии онкологических заболеваний является метод таргетной (target - мишень) терапии, основанный на использовании в качестве источника внутреннего облучения короткоживущих альфа-излучающих радионуклидов (КАИР) с характерным периодом полураспада десятки минут. Малый период полураспада ($T_{1/2}$) КАИР предопределяет необходимость получения их в медицинской клинике для экспрессного изготовления соответствующих радиофармпрепаратов (РФП).

Для получения КАИР в онкологических центрах принято использовать специальные радиохимические методы, основанные на отделении КАИР от более долгоживущих материнских радионуклидов (МР) по принципу работы изотопных генераторов (ИГ). Такие ИГ должны обеспечить многократное выделение КАИР и удовлетворять следующим требованиям: высокая радиологическая эффективность получаемых РФП; доступность МР; низкая стоимость; высокая радиохимическая чистота КАИР (минимальное содержание сопутствующих радионуклидов и примесных веществ); радиационная безопасность при использовании и транспортировке; возможность автоматизации процесса эксплуатации и др.

В качестве одного из возможных КАИР рассматривают ^{211}Pb и ^{211}Bi [Л.И. Гусева. Радиоизотопные генераторы короткоживущих α-излучающих радионуклидов, перспективных для использования в ядерной медицине. Радиохимия, 2014, т. 56, №5, с. 385-399], которые образуются в результате радиоактивного распада ^{227}Ac по следующей цепочке:

^{227}Ac (21,6 лет) → ^{227}Th (18 сут) → ^{223}Ra (11 сут) → ^{219}Rn (3,96 с) → … → ^{211}Pb (36 мин) → ^{211}Bi (2,2 мин) →…

До настоящего времени не известны эффективные способы получения ^{211}Pb/^{211}Bi в необходимом количестве, что сдерживает широкое использование этих нуклидов для ядерной медицины. Но если будет предложен простой, эффективный и безопасный способ получения высокочистого ^{211}Pb/^{211}Bi в требуемых объемах, то это откроет новые перспективы его использования.

Известно всего несколько способов получения ^{211}Pb/^{211}Bi на радиоизотопных генераторах с использованием ионообменных, экстракционных и дистилляционных технологий [Л.И. Гусева. Радиоизотопные генераторы короткоживущих α-излучающих радионуклидов, перспективных для использования в ядерной медицине. Радиохимия, 2014, т. 56, №5, с. 385-399].

Основным общим недостатком всех ионообменных и экстракционных технологий, основанных на использовании высокомолекулярных органических сорбентов, является радиационная деструкция таких материалов, что приводит ухудшению качества целевого продукта и ограничению срока эксплуатации ИГ.

Специфической особенностью МР - ^{223}Ra ($T_{1/2}$=11,4 сут) является образование в процессе его распада инертного короткоживущего радиоактивного газа радона ^{219}Rn ($T_{1/2}$=3,96 с), что предопределяет теоретическую возможность создания технологий, основанных на использовании эффекта эманации радона. Единственный известный пример применения такой технологии для получения ^{211}Pb/^{211}Bi приведен в статье

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[Atcher, R.W., Friedman, A.M., Huzenga, J.R., Spencer, R.P: A radionuclide generator for production of ^{211}Pb and its daughter. J. Radioanal. Nucl. Chem. Lett. 135, 215-221 (1989)], которая и принята за прототип.

Этот способ предполагает выполнение следующих операций:

- в платиновом тигле изготавливают препарат на основе стеарата бария, содержащий в качестве материнского нуклида ^{223}Ra;
- изготавливают источник эманации ^{219}Rn, путем осаждения препарата на дно платинового тигля (подложку) в виде тонкого слоя, локализующего ^{223}Ra, но относительно прозрачного для выхода газообразного ^{219}Rn;
- изготавливают герметичную установку (генератор) в виде трубы диаметром 3 см, соединенную с вакуумным насосом;
- размещают в установке источник и коллектор, предназначенный для сбора ^{219}Rn и накопления продуктов его распада;
- высушивают в течение нескольких часов стеарат бария на подложке источника путем охлаждения коллектора до температуры жидкого азота;
- создают в установке вакуум с давлением менее 50 мкм ртутного столба для интенсификации выхода ^{219}Rn из источника в газовый объем установки;
- охлаждают коллектор до температуры жидкого азота;
- осаждают на стенках коллектора ^{219}Rn и продукты его радиоактивного распада в течение времени, необходимого для установления равновесной активности ^{211}Pb (около 2 часов);
- выделяют ^{211}Pb/211Bi со стенок коллектора, путем смыва слабой кислотой.

Основным преимуществом этого способа является уникально высокая радиохимическия чистота получаемого целевого продукта.

К недостаткам способа относят: низкий выход целевого продукта (около 10%); сложность реализации (использование платинового тигля, глубокого вакуума и жидкого азота); радиолитическое повреждение материала источника (стеарата бария), содержащего ^{223}Ra, которое приводит к снижению срока эксплуатации ИГ.

Задачами предлагаемого технического решения являются: существенное увеличение выхода целевого продукта, упрощение технологии получения и увеличение срока эксплуатации ИГ, при одновременном сохранении преимуществ способа по прототипу. Решение указанных задач достигается путем использования нового типа материала-источника для размещения ^{223}Ra и дополнительных технологических процессов и операций, которые ранее не применялись.

Ядро ^{219}Rn может покинуть поверхность твердого тела (материала-источника) или за счет энергии отдачи, которую оно получает при радиоактивном распаде ^{223}Ra, или за счет диффузионных процессов. При комнатной температуре скорость диффузии атомов внутри твердого тела очень мала, поэтому, для короткоживущего ^{219}Rn выход в газовую фазу по этому механизму маловероятен.

Энергия ядра отдачи (^{219}Rn) при распаде ^{223}Ra составляет ~0,12 МэВ, а длина пробега L ~ (10-20) нм [Несмеянов А.Н. Радиохимия. - 2-е изд., М.: Химия, 1978. - 560 с.]. Поэтому основным механизмом выхода ^{219}Rn из твердого тела в газовую фазу является эффект

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ядер отдачи. Образование ядер ^{219}Rn происходит во всем объеме материала-источника, а выход радона в газовую фазу возможен только из тонкого поверхностного слоя. Для достижения максимального выхода радона, близкого к теоретически возможному (100%), необходимо, чтобы эффективная толщина слоя материала-источника - h, равная отношению его объема к площади, была сопоставима с L (h ~ L). Решить такую задачу можно, например, путем использования вместо плоской подложки - пористого материала с развитой внешней поверхностью. Таким материалом может быть, например, волокнистые материалы, применяемые для улавливания аэрозольных частиц на основе ультратонких полимерных волокон (ткань Петрянова) или на основе стекловолокна, угле-волокна (графена) и др.

Изготовление источника проводят, например, путем нанесения на поверхность волоконного материала раствора соединений ^{223}Ra с последующим высушиванием. Для получения водного раствора ^{223}Ra используют легко растворимые в воде соединения, которые в сухом виде хорошо выделяют ^{219}Rn, например, хлориды, бромиды, окиси и др. [Пруткина М.И., Шашкин В.Л. Справочник по радиометрической разведке и радиометрическому анализу. М., Атомиздат, 1975, с. 248].

Такое техническое решение позволяет увеличить выход газообразного ^{219}Rn из материала источника, отказаться от использования стеарата бария и, таким образом, полностью исключить радиолитическое разрушение органического материала-источника и продлить срок службы ИГ без ухудшения качества целевого продукта.

Установку изготавливают в виде герметичного замкнутого контура, состоящего из соединенных между объема V_1, где размещают материал источника и происходит генерация ^{219}Rn, сорбционного устройства (коллектора) объемом V_2, где осуществляется осаждение и накопление ^{219}Rn и продуктов его распада и объема соединительных трубок V_3. В контуре установки организуют принудительную циркуляцию газового потока. Объемы V_1, V_2 и V_3, а также расход газа в контуре установки Q выбирают таким образом, чтобы время нахождения газового потока в объеме источника V_1 и в объеме V_3 было минимальным (не более 0,5 с), а время нахождения газового потока в объеме V_2 должно быть не менее 4-5 периодов полураспада ^{219}Rn, то есть около 15-25 с. При одновременном выполнение этих условий основная часть образующихся продуктов распада ^{219}Rn будет накапливаться на стенках коллектора с объемом V_2.

Для исключения возможности попадания посторонних веществ в герметичный контур установки, циркуляцию газового потока проводят с использованием перистальтического насоса.

Известно [Пруткина М.И., Шашкин В.Л. Справочник по радиометрической разведке и радиометрическому анализу. М., Атомиздат, 1975, с. 248], что сорбция радона на любых твердых поверхностях сильно зависит от температуры. При понижении температуры ниже комнатной, сорбция возрастает, а полная конденсация радона на поверхности происходит при температуре ниже температуры замерзания жидкого радона, которая равна -71°С. Поэтому температуру коллектора поддерживают на возможно низком уровне (предпочтительно ниже -71°С).

В качестве газовой среды можно использовать воздух или углекислый газ (двуокись углерода). При использовании углекислого газа он будет частично вымораживаться

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на стенках коллектора, что приведет к понижению давления в газовом контуре и к увеличению выхода радона из материала источника.

Содержание влаги в материале источника нежелательно, поскольку водяная пленка на поверхности и в капиллярах микрокристалликов препарата может существенно затруднить выход ^{219}Rn в газовую среду. Поэтому материал-источника нагревают до температуры выше 100°С, что позволяет дополнительно сократить «паразитную» сорбцию ^{219}Rn на конструкционных материалах источника. Выделяющийся водяной пар вымораживают на стенках коллектора.

Такое техническое решение позволит отказаться от использования сложной вакуумной техники, применяемой в способе по прототипу.

Короткий период полураспада ^{211}Pb (36 мин) требует применения экспрессных и эффективных методов выделения целевого продукта из коллектора (без использования химических реактивов), что позволит до минимума сократить время проведения всех операций и снизить потери ^{211}Pb на радиоактивный распад при выделении. Достижение этой цели осуществляют следующим образом. На предварительной стадии эксплуатации установки (до организации циркуляции газа по контуру), на внутренней поверхности коллектора создают тонкий ледяной слой в виде изморози. Быстрое создание такого слоя возможно, например, путем охлаждения стенок коллектора до отрицательной температуры при одновременной подаче в объем коллектора водного аэрозоля дистиллированной воды, например, с использованием инжектора.

В рабочем режиме (при циркуляции газа) осаждение ^{219}Rn и накопление продуктов его распада осуществляют на поверхности созданного ледяного слоя, а извлечение целевого продукта проводят путем нагрева стенок коллектора до температуры плавления льда и сбора талой воды.

Для увеличения продолжительности эксплуатации ИГ в материал источника вводят соединения торий-227 (^{227}Th) и/или смесь соединений ^{227}Th и ^{223}Ra.

Присутствие в материале источника примесей других альфа-излучающих изотопов радия (^{224}Ra и/или ^{226}Ra), в схеме радиоактивного распада которых присутствуют аналоги целевого радионуклида - изотопы $^{212}Pb/^{212}Bi$ и/или $^{214}Pb/^{214}Bi$, допустимо, поскольку изотопы-аналоги обладают сходными терапевтическими свойствами, а их накопление на коллекторе за 2 часа будет незначительным.

Принципиальная схема такой установки показана на фиг.

Установка включает три контура (вспомогательный, рабочий и промывной) и состоит из источника (1), коллектора (2), запорных вентилей (3-6), холодильника/нагревателя (7), насоса (8), бака с промывным раствором (9), инжектора для подачи водного аэрозоля в объем V_2 из сосуда с дистиллированной водой (10), емкости для сбора целевого продукта (11) и устройства для электрического нагрева источника и контроля температуры (12). Для упрощения схемы вентили (3-6) на рисунке показаны как трехходовые краны.

Эксплуатация установки осуществляется циклично, а каждый цикл включает следующие этапы:

1. На начальном этапе используют вспомогательный контур для создания на внутренней поверхности стенок коллектора ледяного слоя в виде изморози (наледи).

Для этого источник отсоединяют от коллектора с использованием вентилей (3 и 6). С использованием холодильника (7) проводят охлаждение стенок коллектора до

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отрицательной температуры (ниже 0°С), оптимальной для образования наледи. Открывают вентили (4 и 5) и организуют циркуляцию воздуха по укороченному (негерметичному) контуру. С использованием инжектора подают в контур водный аэрозоль из емкости с дистиллированной водой (10). После создания на внутренней поверхности коллектора ледяного слоя, закрывают вентили (4 и 5), отключают инжектор и прекращают подачу водного аэрозоля в установку. Холодильник (7) переводят в рабочий режим с пониженной температурой стенок коллектора (2), оптимальной для осаждения ^{219}Rn и накопление продуктов его распада на поверхности созданного ледяного слоя.

2. На втором этапе, организуют циркуляцию воздуха по рабочему контуру установки путем последовательного выполнения следующих операций: включают электрический нагрев источника (12) до температуры выше 100°С, соединяют объемы источника и коллектора путем открытия вентилей (3 и 6) и включают насос (8). Выделяющийся из материала-источника газообразный ^{219}Rn поступает в объем коллектора, где происходит его осаждение на покрытых льдом стенках коллектора и затем радиоактивный распад с образованием целевого продукта. Накопление продуктов распада проводят в течение ~2 часов.

3. На третьем этапе используют промывной контур для выделения накопленных в коллекторе продуктов распада ^{219}Rn, содержащих целевой продукт. Для этого, закрывают вентили (3 и 6) и тем самым отсоединяют источник (1) от коллектора (2), выключают нагрев объема источника (12), выключают насос (8), переключают холодильник (7) в режим нагрева и производят сбор талой воды в накопительную емкость (11). При необходимости проводят окончательную промывку коллектора водой из бака (9). Полученный раствор используют для изготовления РФП.

Ниже приведены примеры, демонстрирующие возможность изготовления генератора для получения ^{211}Pb/^{211}Bi с начальной активностью $1 \cdot 10^8$ Бк (100 МБк).

В качестве препарата используют, например, раствор соли бромида ^{223}Ra с активностью 200 МБк, объемом 10 мл и с суммарной концентрацией солей 1 г/л.

Мощность эквивалентной дозы на расстоянии 1 м от такого сосуда с раствором ^{223}Ra (в геометрии точечного источника) составит ~100 мкЗв/час. Дополнительную радиационную опасность представляет ингаляция выделяющегося ^{219}Rn и продуктов его распада. Поэтому все работы по изготовлению источника необходимо проводить в герметичном боксе радиохимического предприятия (лаборатории), оборудованном системой вентиляции и защитой от внешнего гамма-излучения.

Продолжительность эксплуатации генератора Т примем равной ~22 суток, а время транспортировки генератора до медицинской клиники - 2 суток.

Пример 1 демонстрирует возможный процесс изготовления источника.

В качестве материала-источника используют, например, волокнистый материал типа ФПА-15-2,0 на основе ацетилцеллюлозы, который применяется для изготовления аналитических аэрозольных фильтров АФА-РМА. Этот материал обладает следующими свойствами [А.К. Будыка, Н.Б. Борисов Волокнистые фильтры для контроля загрязнения воздушной среды. М., ИздАТ, 2008, - 360 с]: средний диаметр волокон 1,5 мкм, объемная доля волокон в материале (плотность упаковки) α=5%, поверхностная масса σ_P=3,5 мг/см^2, хорошо смачивается водой (гидрофилен), устойчивый к слабым кислотам, термоустойчив при температурах до 150°С.

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Для изготовления источника используют материал ФПА-15-2,0 в виде готовых фильтров АФА-РМА или в виде ленты, что предпочтительнее, поскольку в этом случае процесс изготовления более технологичен и легче поддается автоматизации.

По центральной оси ленты наносят раствор соли ^{223}Ra в виде серии последовательных отдельных капель таким образом, чтобы диаметр образующегося после растекания капли пятна не превышал ширины ленты, а расстояние между каплями не превышало диаметра пятна и одновременно высушивают, например под термолампой. Подсушенную ленту наматывают в рулон на катушку в виде кассеты.

Такой процесс изготовления источника легко автоматизировать даже в условиях герметичного бокса по принципу работы пленочного фотоаппарата, когда лента последовательно прокручивается с одной («чистой») кассеты на другую, в виде готового источника, а нанесение раствора на ленту соответствует изготовлению фотоснимка.

Используют ленту с шириной, например 50 мм. Объем одной капли задают микродозатором ~0,1 мл, после растекания капли диаметр образующегося пятна составит ~40 мм, а площадь одного пятна ~12,5 см^2. Тогда на ленту необходимо нанести ~100 капель, а длина ленты будет равна ~400 см. Общая поверхность высушенных капель составит ~1250 см^2. При этом поверхностная активность ^{223}Ra на рабочем слое ленты будет σ_A=160 кБк/см^2, а поверхностная плотность соли σ_s=8 мкг/см^2. При внутреннем диаметре жесткой втулки кассеты источника ~10 см, лента будет намотана в ~14 слоев с суммарной толщиной слоя ~50 мг/см^2 (менее 2 мм).

При нанесении раствора бромида ^{223}Ra на ткань ФПА-15-2,0 происходит смачивание гидрофильных волокон ацетилцеллюлозы, а при высушивании раствора на поверхности волокон образуется тонкий слой соли толщина которого существенно меньше диаметра волокон и соизмерима с длиной пробега ядра ^{219}Rn в соли.

Пример 2 демонстрирует оценку радиационной стойкости материала источника.

Сведения о радиационной стойкости материалов ФПА и фильтров АФА-РМ к облучению альфа-частицами крайне ограничены.

На стр. 170 монографии [А.К. Будыка, Н.Б. Борисов Волокнистые фильтры для контроля загрязнения воздушной среды. М., ИздАТ, 2008, - 360 с] указано, что «Все фильтры АФА-РМ обладают радиационной стойкостью по отношению к «горячим» аэрозольным частицам. Разрушение фильтрующего слоя наступает, например, при активности аэрозольных частиц, содержащих ^{210}Po, свыше $3\cdot10^{-6}$ Ки (110 кБк)».

Это означает, что допустимая активность одной «горячей» частицы ^{210}Po, с характерным размером ~1 мкм, на фильтре АФА-РМ (110 кБк), примерно соответствует активности ^{223}Ra, равномерно нанесенной на 1 см^2 ленты (160 кБк). Радиационные характеристики ^{210}Po и ^{223}Ra примерно одинаковы, поэтому можно считать, что радиационная стойкость материала ФПА за время эксплуатации генератора будет обеспечена.

Пример 3 демонстрирует расчет оптимальных значений объемов V_1, V_2, V_3 и расхода газа в рабочем контуре Q.

Кассета с лентой вставляется в картридж. Картридж источника изготавливают в виде разборного жесткого цилиндра внутри которого находится герметичная полость в форме цилиндрического кольцевого зазора с внутренним диаметром d_1 и наружным d_2. С торцов цилиндра полость соединена с подводящими трубками для прокачки газа.

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Высота цилиндрической полости соответствует ширине ленты, а размер цилиндрического зазора выбирают исходя из толщины намотанных слоев ленты. Реальная толщина фильтра АФА-РМ менее 0,1 мм, поэтому для 14 слоев ленты толщину зазора можно принять 2 мм.

Поток газа направляют по кольцевому зазору параллельно плоскости слоев ленты. Внутренний газовый объем цилиндрической полости (при d_2-d_1=4 мм) будет V_1 ~30 $см^3$, а с учетом объемной доли волокон в материале ленты, ~28 $см^3$. Объемный расход газа Q задают таким образом, чтобы время нахождения газа в объеме V_1 было минимальным и не превышало, например, t_1 ~0,25 с. При заданных параметрах значение $Q=V_1/t_1$ ~120 мл/с (7,2 л/мин.). При таком расходе в объеме V_1 будет распадаться ~4% от образующихся ядер ^{219}Rn. Если время нахождения газа в объеме V_2 будет, например, равно t_2 ~20 с (в 5 раз больше периода полураспада ^{219}Rn), то основная часть продуктов распада ^{219}Rn (~97%) будет образовываться в объеме V_2. Тогда значение $V_2=Q*t_2$ ~2400 мл (2,4 л). Дальнейшее увеличение объема V_2 нецелесообразно, поскольку при этом будет возрастать и площадь поверхности коллектора (объема V_2), что может затруднить извлечение накопленного ^{211}Pb из коллектора.

Для повышения эффективности генератора, время нахождения ^{219}Rn в соединительной трубке объемом V_3 снижают до минимально-возможного значения.

Пример 4 демонстрирует расчет активности $^{211}Pb/^{211}Bi$ накапливаемой на коллекторе генератора.

Накопление активности ^{211}Pb на стенках коллектора проводят за время не более 4-5 периодов полураспада ^{211}Pb, так как, уже за 2,5 часа на стенках коллектора накопится ~95% от максимально возможного значения равновесной активности.

Конструкция картриджа должна предусматривать нагрев ленты в рабочем состоянии до температуры более 100°С, но менее допустимой для фильтра АФА-РМ (150°С). Такая температура позволяет сократить сорбцию ^{219}Rn на материалах картриджа и необходима для удаления влаги из материала источника, поскольку наличие водяной пленки на поверхности и в капиллярах кристалликов соли может затруднить выход ^{219}Rn в газовую среду.

Для охлаждения стенок коллектора до температуры ниже -71°С используют, например, «сухой лед» (температуры замерзания двуокиси углерода, -78°С) или специальный ультранизкотемпературный холодильник. Такая температура позволяет повысить сорбцию газообразного ^{219}Rn на ледяных стенках коллектора, удалить пары воды и часть углекислого газа из объема рабочего контура путем их вымораживания на стенках коллектора, что приведет к понижению давления в контуре и увеличению выхода радона из материала источника.

В режиме извлечения продуктов распада ^{219}Rn из коллектора, его внешние стенки нагревают до температуры выше +90°С с использованием, например, горячей воды и/или электрического нагревателя. Сливают талую воду (вместе с кусочками льда), содержащую основную часть продуктов распада ^{219}Rn, из коллектора в накопительную емкость. При необходимости емкость коллектора дополнительно промывают

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дистиллированной водой. Продолжительность размораживания конденсата не превысит 10 минут.

Общие потери ^{211}Pb, в долях от равновесной активности, не превысят 30% и определяются:

- доля оставшегося ^{219}Rn в соли бромида ^{223}Ra, менее 10%;
- «паразитной» сорбцией (за пределами коллектора), не более 5%;
- распад за время размораживания конденсата, не более 8%;
- остаточной сорбцией на стенках коллектора и распадом при смыве, менее 5%.

Таким образом, активность первой порции целевого продукта, с учетом распада ^{223}Ra за время транспортировки кассеты с источником до медицинской клиники (~12%), составит ~120 МБк.

Общие временные затраты на один цикл работы генератора составят 3 часа, что позволяет получить 8 порций целевого продукта в сутки.

(57) Формула изобретения

1. Способ получения свинца-211/висмута-211 (^{211}Pb/^{211}Bi) для ядерной медицины, включающий: приготовление препарата из материала, содержащего радий-223 (^{223}Ra), изготовление источника испускания радона-219 (^{219}Rn) путем нанесения препарата на подложку, размещение источника в герметичной установке, создание условий для интенсификации выхода ^{219}Rn из источника в газовый объем установки, размещение в установке коллектора для осаждения газообразного ^{219}Rn, накопление на стенках коллектора продуктов радиоактивного распада ^{219}Rn, содержащих целевой продукт, в течение не менее 2 часов, извлечение из коллектора целевого продукта в виде раствора и использование установки для повторного цикличного получения целевого продукта, отличающийся тем, что препарат изготавливают в виде водного раствора соединений ^{223}Ra, в качестве подложки источника используют пористый материал с развитой внешней поверхностью, источник изготавливают путем создания на поверхности материала тонкого сухого твердого слоя препарата толщиной несколько молекулярных слоев, источник помещают в емкость объемом V_1, оборудованную системой нагрева, коллектор изготавливают в виде емкости объемом V_2, оборудованной системой охлаждения и нагревания, установка состоит из вспомогательного, рабочего и промывного контуров, соединенных трубками и отделяемых запорными вентилями, вспомогательный контур используют на предварительной стадии для создания на внутренних стенках коллектора ледяного слоя, накопление целевого продукта проводят на поверхности ледяного слоя в рабочем контуре, состоящем из объемов V_1 и V_2, объема соединительных трубок V_3 и насоса для принудительной циркуляции газа с расходом Q, а промывной контур используют в режиме извлечения целевого продукта путем нагрева стенок коллектора и сбора образующейся талой воды.

2. Способ по п. 1, отличающийся тем, что для получения препарата используют растворимые в воде соединения ^{223}Ra, которые в сухом виде хорошо выделяют радон, например хлориды, и/или бромиды, и/или окиси.

3. Способ по п. 1, отличающийся тем, что в качестве пористого материала используют волоконный материал из ультратонких волокон, например из ткани Петрянова, и/или стекловолокна, и/или углеродного волокна, а нанесение препарата на материал проводят

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методом накалывания и/или смачивания раствором препарата с последующим высушиванием.

4. Способ по п. 1, отличающийся тем, что создание на внутренних стенках коллектора слоя льда проводят путем замораживания водного аэрозоля, например, на основе дистиллированной воды или физиологического раствора, который принудительно вводят в объем коллектора, например, с использованием инжектора.

5. Способ по п. 1, отличающийся тем, что в режиме накопления целевого продукта интенсификацию выхода ^{219}Rn из источника в газовый объем проводят путем нагрева источника до температуры более 100°С.

6. Способ по п. 1, отличающийся тем, что материал препарата содержит торий-227 (^{227}Th) или смесь ^{227}Th и ^{223}Ra и допускает присутствие примесей ^{224}Ra и ^{226}Ra.

7. Способ по п. 1, отличающийся тем, что принудительную циркуляцию газового потока в замкнутом контуре установки проводят, например с использованием перистальтического насоса, а в качестве газовой среды используют сухой воздух и/или углекислый газ.

8. Способ по п. 1, отличающийся тем, что значения Q, V_1, V_2 и V_3 выбирают таким образом, чтобы: $(V_1/Q) < 0{,}25$ с; $(V_2/Q) \sim 20\text{-}25$ с, а (V_3/Q) - минимально возможным.

9. Способ по п. 1, отличающийся тем, что в режиме накопления целевого продукта, охлаждение стенок коллектора проводят до температуры ниже -71°С с использованием «сухого льда» (двуокиси углерода CO_2) и/или специального ультранизкотемпературного холодильника.

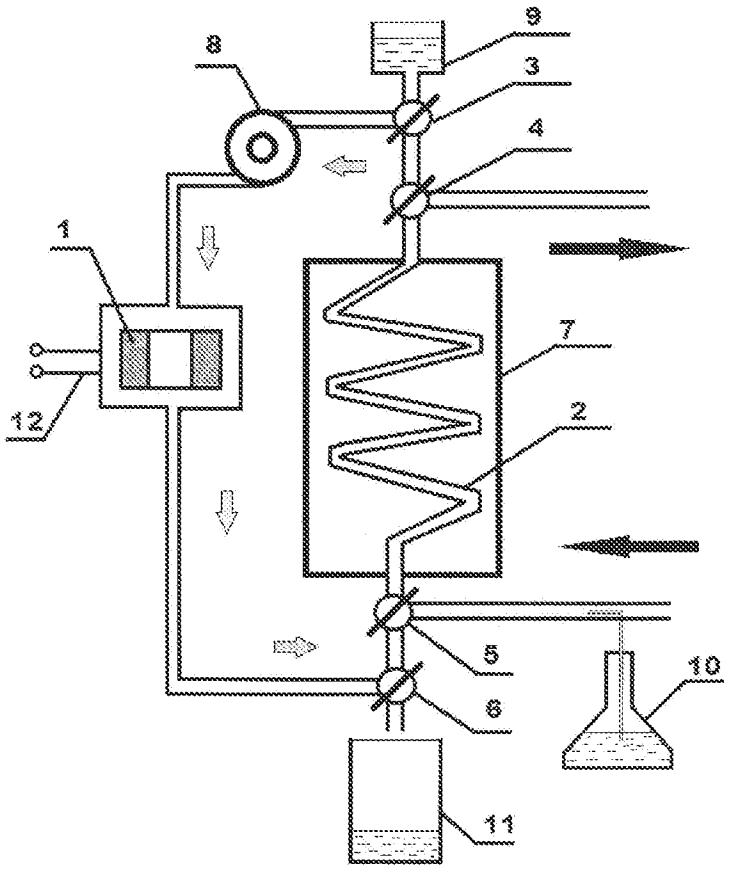
10. Способ по п. 1, отличающийся тем, что извлечение целевого продукта из промывного контура проводят путем нагревания внешних стенок коллектора горячей водой и/или с использованием специального нагревателя, а после сбора талой воды, при необходимости, проводят дополнительную промывку коллектора.

11. Способ по пп. 1 и 3, отличающийся тем, что для изготовления источника используют фильтрующий материал ФПА-15-2,0 в виде фильтров АФА-РМА, которые собирают в пакет, или в виде ленты, которую наматывают в рулон на катушку.

12. Способ по п. 11, отличающийся тем, что газовый поток в объеме V_1 направляют параллельно плоскости фильтрующих слоев материала источника.

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1



Принципиальная схема установки (генератора) для получения $^{211}Pb/^{211}Bi$

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Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	18/680,605-Conf. #5167
Filing Date	May 31, 2024
First Named Inventor	Roy H. Larsen
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	A1389.70001US02

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8,1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. [ ] Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. [ ] Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      ii. [ ] Other _____

   b. [X] Enclosed

      i. [X] Amendment/Reply

      ii. [ ] Affidavit(s)/ Declaration(s)

      iii. [X] Information Disclosure Statement (IDS)

      iv. [X] Other Form PTOL-1449 and Cited References

2. Miscellaneous

   a. [ ] Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. [ ] Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. [X] The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 23/2825 .

      i. [X] RCE fee required under 37 CFR 1.17(e)

      ii. [ ] Extension of time fee (37 CFR 1.136 and 1.17)

      iii. [ ] Other _____

   b. [ ] Check in the amount of $ _____ enclosed

   c. [X] Payment by credit card ~~(Form PTO-2038 enclosed)~~

   d. [ ] Payment by USPTO patent electronic filing system.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/John Harmon/	Date	11/13/24
Name (Print/Type)	John S. Harmon, PhD, PE	Registration No.	67,131

~~CERTIFICATE OF MAILING OR TRANSMISSION~~

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Dated: November 13, 2024 Electronic Signature for Sheryl E. Mackey: /Sheryl E. Mackey/

FORM PTO-1449/A and B (modified PTO/SB/08)	APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
	FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet 1 of 2	GROUP ART UNIT: 2881	EXAMINER: S. M. Luck

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		Number	Kind Code		
		5,038,046		Norman et al.	08-06-1991
		9,202,600	B2	Ravn et al.	12-01-2015
		12,125,603	B2	Larsen	10-22-2024

FOREIGN PATENT DOCUMENTS

Examiner's Initials #	Cite No.	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)
		Office/ Country	Number	Kind Code			
		RU	2742138	C1	FED GOSUDARSTVENNOE UNITARNOE PREDPRIYATIE PROIZVODSTVENNOE OBEDINENIE MAYAK	02-02-2021	Y – Machine Translation

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
		ATCHER et al., A radionuclide generator for the production of 211Pb and its daughters. J Radioanalyt Nucl Chem. 1989 Feb;135:215-21.	
		ATCHER et al., An improved generator for the production of 212Pb and 212Bi from 224Ra. Int J Rad Appl Instrum A. 1988;39(4):283-6. doi: 10.1016/0883-2889(88)90016-0.	
		BOLDYREV et al., 212Pb/212Bi Generator for nuclear medicine. Atomic Energy. 2012 Mar 23;111:422-7.	
		CHAPPELL et al., Synthesis, characterization, and evaluation of a novel bifunctional chelating agent for the lead isotopes 203Pb and 212Pb. Nucl Med Biol. 2000 Jan;27(1):93-100. doi: 10.1016/s0969-8051(99)00086-4.	
		HASSFJELL et al., A generator for production of 212Pb and 212Bi. Appl Radiat Isot. 1994 Oct;45(10):1021-5.	
		KNAPP et al., Availability of Alpha-Emitting Radioisotopes by Reactor and Accelerator Production and via Decay of Naturally Occurring Parents. In: Radiopharmaceuticals for Therapy. 2016. Knapp et al., Eds. Chapter 8:159-66.	
		KOZEMPEL, Radon Nuclides and Radon Generators. In: Radon. 2017. Adrovic, Ed. Chapter 2:7-23.	

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

FORM PTO-1449/A and B (modified PTO/SB/08) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**				APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
				FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
				FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet	2	of	2	GROUP ART UNIT: 2881	EXAMINER: S. M. Luck

		RUTHERFORD, A radio-active substance emitted from thorium compounds. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science. 1900 Jan;49(296):1-14.	
		RUTHERFORD, The Succession of Changes in Radioactive Bodies. Phil Trans Roy Soc A. 1905;204:169-219.	
		WRASIDLO et al., Generation of lead-212 and radioimmunoconjugates for use in cancer therapy and the 'emanating power' of stearates. Coll Surf A Physiochem Eng Aspects. 2001 Jul 31;186(1-2):123-8.	

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EXAMINER:	DATE CONSIDERED:

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Docket No.: A1389.70001US02
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	S. M. Luck
Art Unit:	2881

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I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: November 13, 2024 Electronic Signature for Sheryl E. Mackey: /Sheryl E. Mackey/

SECOND PRELIMINARY AMENDMENT UNDER 37 C.F.R. § 1.115

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

INTRODUCTORY COMMENTS

Prior to examination on the merits, please amend the above-identified U.S. patent application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this amendment.

Remarks/Arguments begin on page 7 of this amendment.

AMENDMENTS TO THE CLAIMS

Applicant submits below a complete listing of the current claims, including marked-up claim(s) with insertions indicated by underlining and deletions indicated by strikeouts and/or double bracketing. This listing of claims replaces all prior versions, and listings, of claims in the application:

1. (Original) A radioisotope generator comprising:

a solid precursor isotope source configured to emanate one or more gaseous progeny isotopes, the solid precursor isotope source comprising a precursor isotope; and

wherein the solid precursor isotope source is configured to be fluidly coupled to a volume including a collector surface with a gas tight seal, and wherein the solid precursor isotope source and the collector surface are configured such that the one or more gaseous progeny isotopes deposit one or more solid progeny isotopes on the collector surface.

2. (Original) The radioisotope generator of claim 1, further comprising a flushing circuit configured to flush the collector surface.

3. (Original) The radioisotope generator of claim 1, further comprising a valve associated with the solid precursor isotope source.

4. (Original) The radioisotope generator of claim 1, further comprising a vacuum pump attached to the volume.

5. (Original) The radioisotope generator of claim 1, wherein the solid precursor isotope source comprises a porous material configured to retain the precursor isotope.

6. (Original) The radioisotope generator of claim 5, wherein the precursor isotope is absorbed, adsorbed, and/or encapsulated by the porous material.

7. (Original) The radioisotope generator of claim 1, wherein the precursor isotope comprises a thorium 228 isotope (^{228}Th) and/or a radium 224 isotope (^{224}Ra), the one or more gaseous progeny isotopes comprises a radon 220 isotope (^{220}Rn), and the one or more solid progeny isotopes comprises a lead 212 isotope (^{212}Pb).

8. (Original) The radioisotope generator of claim 1, wherein the collector surface is an interior surface of a container, and wherein the volume is an internal volume of the container.

9. (Original) The radioisotope generator of claim 8, wherein the solid precursor isotope source is configured to be connected to an opening of the container.

10. (Original) The radioisotope generator of claim 8, further comprising the container.

11. (Currently Amended) The radioisotope generator of claim 10, wherein the container is configured to removably connect[[ed]] to the solid precursor isotope source.

12. (Original) The radioisotope generator of claim 10, further comprising a chelator disposed on the interior surface, the chelator configured to chelate the one or more solid progeny isotopes.

13. (Original) The radioisotope generator of claim 12, wherein the chelator comprises TCMC.

14. (Original) The radioisotope generator of claim 1, wherein the volume is configured to receive a solvent configured to dissolve the one or more solid progeny isotopes from the interior surface.

15. (Original) The radioisotope generator of claim 1, wherein the radioisotope generator is configured to be converted from a first configuration in which the collector surface is not in fluid communication with the solid precursor isotope source, and a second configuration in which the collector surface is in fluid communication with the solid precursor isotope source.

16. (Original) A method of generating a progeny radioisotope, the method comprising:

allowing one or more gaseous progeny isotopes to emanate from a solid precursor isotope source, the solid precursor isotope source comprising a precursor isotope;

fluidly coupling a volume including a collector surface to the solid precursor isotope source using a gas tight seal; and

allowing one or more solid progeny isotopes of the one or more gaseous progeny isotopes to deposit on the collector surface.

17. (Original) The method of claim 16, further comprising flushing the collector surface.

18. (Original) The method of claim 16, wherein fluidly coupling the volume to the solid precursor isotope comprises opening a valve associated with the solid precursor isotope source.

19. (Original) The method of claim 16, further comprising drawing a vacuum in the volume.

20. (Original) The method of claim 16, wherein the solid precursor isotope source comprises a porous material configured to retain the precursor isotope.

21. (Original) The method of claim 20, wherein the precursor isotope is absorbed, adsorbed, and/or encapsulated by the porous material.

22. (Original) The method of claim 16, wherein the precursor isotope comprises a thorium 228 isotope (^{228}Th) and/or a radium 224 isotope (^{224}Ra), the one or more gaseous progeny isotopes comprises a radon 220 isotope (^{220}Rn), and the one or more solid progeny isotopes comprises a lead 212 isotope (^{212}Pb).

23. (Original) The method of claim 16, wherein the collector surface is an interior surface of a container, and wherein the volume is an internal volume of the container.

24. (Original) The method of claim 23, further comprising connecting the solid precursor isotope source to an opening of the container.

25. (Original) The method of claim 23, further comprising removably connecting the solid precursor isotope to the container.

26. (Original) The method of claim 23, further comprising chelating the one or more solid progeny isotopes using a chelator disposed on the interior surface.

27. (Original) The method of claim 26, wherein the chelator comprises TCMC.

28. (Original) The method of claim 23, further comprising receiving a solvent in the volume, and dissolving the one or more solid progeny isotopes from the interior surface in the solvent.

29. (Original) The method of claim 16, wherein fluidly coupling the volume to the solid precursor isotope source comprises converting a radioisotope generator from a first configuration in which the collector surface is not in fluid communication with the solid precursor isotope source to a second configuration in which the collector surface is in fluid communication with the solid precursor isotope source.

30. (Original) The method of claim 16, further comprising forming a radiopharmaceutical using the one or more solid progeny isotopes.

31. (New) The method of claim 18, further comprising closing the valve to isolate the volume from the solid precursor isotope source.

32. (New) The method of claim 16, wherein the solid precursor isotope is bound to a non-radioactive material.

33. (New) The method of claim 32, wherein the non-radioactive material is a ceramic.

34. (New) The method of claim 23, forming at least a portion of a single chamber with the solid precursor isotope source and the container.

35. (New) The radioisotope generator of claim 3, wherein the valve is configured to isolate the solid precursor isotope from the volume in a closed position.

36. (New) The radioisotope generator of claim 1, wherein the solid precursor isotope is bound to a non-radioactive material.

37. (New) The radioisotope generator of claim 36, wherein the non-radioactive material is a ceramic.

38. (New) The radioisotope generator of claim 1, wherein the solid precursor isotope source and the container form at least a portion of a single chamber when fluidly coupled.

REMARKS

Claims 1-30 were previously pending in this application. Claim 11 has been amended. New claims 31-38 have been added. As a result, claims 1-38 are pending for examination with claims 1 and 16 being independent claims. No new matter has been added.

The pending application is believed to be in condition for substantive examination.

Please charge our Credit Card in the amount of $320.00 covering the fee set forth in 37 C.F.R. § 1.16(i). The Director is hereby authorized to charge any deficiency in the fees filed, asserted to be filed or which should have been filed with this Amendment to our Deposit Account No. 23/2825, under Docket No. A1389.70001US02.

Dated: 11/13/24

Respectfully submitted,

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Doc Code: TRAN.LET
Document Description: Transmittal Letter

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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission	

Application Number	18/680,605-Conf. #5167
Filing Date	May 31, 2024
First Named Inventor	Roy H. Larsen
Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned
Attorney Docket Number	A1389.70001US02

ENCLOSURES (*Check all that apply*)

- [x] Fee Transmittal Form
  - [ ] Fee Attached
- [x] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [x] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53

- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD

Remarks

- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):
  - PTO Form 1449
  - Cited References
  - Request for Continued Examination Transmittal

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	WOLF, GREENFIELD & SACKS, P.C.		
Signature	/John Harmon/		
Printed name	John S. Harmon, PhD, PE		
Date	11/13/24	Reg. No.	67,131

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**11/13/2024 03:43:46 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Timothy Peng
PATENT CENTER #	67850726	AUTHORIZED BY	John Harmon
CUSTOMER #	23628	FILING DATE	05/31/2024
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Roy H. Larsen

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 8543	**E2024ACF46489971**	**Sheryl Mackey**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
232825	**37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2801	REQUEST FOR CONTINUED EXAMINATION (RCE) - 1ST REQUEST (SEE 37 CFR 1.114)	544.00	1	544.00
2202	EACH CLAIM IN EXCESS OF 20	40.00	8	320.00
			TOTAL AMOUNT:	**$864.00**

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New Applications Under 35 U.S.C. 111

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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
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PATENT CENTER #	67850726	FILING DATE	05/31/2024
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	John Harmon

Documents

TOTAL DOCUMENTS: 19

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
Boldyrev_et_al_Atomic_Energy_2012_v11_p422_NPL_QC.pdf	6	Non Patent Literature	139 KB
Knapp_et_al_Radiopharm_Therapy_2016_ch8_p159_NPL_QC.pdf	8	Non Patent Literature	276 KB
Chappell_et_al_Nuclear_Med_Biology_2000_v27_p93_NPL_QC.pdf	8	Non Patent Literature	324 KB
HASSFJELL_et_al_Appl_Radiat_Isot_1994_v45_p1021_NPL.pdf	5	Non Patent Literature	582 KB
KOZEMPEL_Radon_2017_ch2_p7_NPL.pdf	20	Non Patent Literature	837 KB

RU2742138C1_w_MT_FOR.pdf		33	Foreign Reference	1546 KB
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RUTHERFORD_Phil_Trans_Roy_Soc_A_1905_v204_p169_NPL.pdf		52	Non Patent Literature	18262 KB
A138970001US02-TRN-JSH.pdf		1	Miscellaneous Incoming Letter	26 KB
A138970001US02-FEE-JSH.pdf		1	Fee Worksheet (SB06)	34 KB
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A138970001US02-PAMN-JSH-CLM.pdf	(2-6)	5	Claims	49 KB
A138970001US02-PAMN-JSH-REM.pdf	(7-7)	1	Applicant Arguments/Remarks Made in an Amendment	21 KB
A138970001US02-IDSBODY-JSH.pdf		3	Letter specifying the conditions for filing under 37 CFR 1.97	29 KB
A138970001US02-IDS1449-JSH.pdf		2	Information Disclosure Statement (IDS) Form (SB08)	28 KB

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A138970001US02-IDSBODY-JSH.pdf	E652CE93F5915E8285CAC2B5AACEF0A3BBC20733389B243BDF69526578001A0A63F3E2F484347F9D75D9B540DA187D0B294B0675C7080A9F9AA8D58F55E3B70C
A138970001US02-IDS1449-JSH.pdf	AD502D0443E0EB9BEFC9719AF7F22B22D7CCB1A218E0615741F84184F1BA4E704AEA2003737A16DC653129E12A54778CF1396CCAB563120D7792527555005299

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

FEE TRANSMITTAL

Complete if known	
Application Number	18/680,605-Conf. #5167
Filing Date	May 31, 2024
First Named Inventor	Roy H. Larsen
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Practitioner Docket No.	A1389.70001US02

[x] Applicant asserts small entity status. See 37 CFR 1.27.

[ ] Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

TOTAL AMOUNT OF PAYMENT ($)864.00

METHOD OF PAYMENT (check all that apply)

[ ] Check [x] Credit Card [ ] Money Order [ ] None [ ] Other (please identify): _____

[x] Deposit Account Deposit Account Number: 23/2825 Deposit Account Name: Wolf, Greenfield & Sacks, P.C.

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

[ ] Charge fee(s) indicated below

[ ] Charge fee(s) indicated below, **except for the filing fee**

[x] Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17, **except for any excess claims fees or multiple dependent claim fee**

[ ] Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17

[x] Credit any overpayment of fee(s)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

	FILING FEES			SEARCH FEES			EXAMINATION FEES			
Application Type	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**Fees Paid ($)**
Utility	320	128*	64	700	280	140	800	320	160	
Design	220	88	44	160	64	32	640	256	128	
Plant	220	88	44	440	176	88	660	264	132	
Reissue	320	128	64	700	280	140	2,320	928	464	
Provisional	300	120	60	0	0	0	0	0	0	

* The $128 small entity status filing fee for a utility application is further reduced to $64 for a small entity applicant who files the application via Patent Center or EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	**Undiscounted Fee ($)**	**Small Entity Fee ($)**	**Micro Entity Fee ($)**
Each claim over 20 (including Reissues)	100	40	20
Each independent claim over 3 (including Reissues)	480	192	96
Multiple dependent claims	860	344	172

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
38	- 30 or HP =	8	x 40.00	=	320.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
2	- 3 or HP =		x	=	

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	
Fee ($)	**Fee Paid ($)**

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $420 ($168 for small entity) ($84 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**	**Fee ($)**	**Fee Paid ($)**
	- 100 =		/50 =	(round **up** to a whole number) x		=

4. OTHER FEE(S)

	Fees Paid ($)
Non-English specification, $140 fee ($56 small entity) ($28 for micro entity)	
Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, $400 fee ($200 small or micro entity)	
Other (e.g., late filing surcharge): 2801 Request for continued examination (RCE) - 1st ...	544.00

SUBMITTED BY

Signature	/John Harmon/	Registration No. (Attorney/Agent)	67,131	Telephone	617.646.8000
Name (Print/Type)	John S. Harmon, PhD, PE			Date	11/13/24

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: November 13, 2024 Electronic Signature for Sheryl E. Mackey: /Sheryl E. Mackey/

DOCKET NO.: A1389.70001US02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	S. M. Luck
Art Unit:	2881

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: November 13, 2024 Electronic Signature for Sheryl E. Mackey: /Sheryl E. Mackey/

MAIL STOP RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATEMENT FILED PURSUANT TO THE DUTY OF DISCLOSURE UNDER 37 C.F.R. §§ 1.56, 1.97 AND 1.98

Commissioner:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the undersigned requests consideration of this Information Disclosure Statement.

PART I: Compliance with 37 C.F.R. § 1.97

This Information Disclosure Statement has been filed before the mailing of a first Office Action after the filing of a Request for Continued Examination under 37 C.F.R. § 1.114.

No fee or certification is required.

PART II: Information Cited

The undersigned hereby makes of record in the above-identified application the information listed on the attached form PTO-1449 (modified PTO/SB/08). The order of presentation of the references should not be construed as an indication of the importance of the references.

PART III: Remarks

Documents cited anywhere in the Information Disclosure Statement are enclosed unless otherwise indicated. It is respectfully requested that:

1. The Examiner consider completely the cited information, along with any other information, in reaching a determination concerning the patentability of the present claims;

2. The enclosed form PTO-1449 (modified PTO/SB/08) be signed by the Examiner to evidence that the cited information has been fully considered by the United States Patent and Trademark Office during the examination of this application;

3. The citations for the information be printed on any patent which issues from this application.

By submitting this Information Disclosure Statement, the undersigned makes no representation that a search has been performed, of the extent of any search performed, or that more relevant information does not exist.

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, material to patentability as defined in 37 C.F.R. § 1.56(b).

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, in fact, prior art as defined by 35 U.S.C. § 102, or an admission by Applicant as prior art.

Notwithstanding any statements by the undersigned, the Examiner is urged to form his or her own conclusion regarding the relevance of the cited information.

An early and favorable action is hereby requested.

The Director is hereby authorized to charge any deficiency or credit any overpayment in the fees occasioned by the filing of this Information Disclosure Statement to our Deposit Account No. 23/2825 under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Respectfully submitted,

Electronic signature: /John Harmon/
John S. Harmon, PhD, PE
Registration No.: 67,131
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
617.646.8000

Docket No.: A1389.70001US02
Date: 11/13/24

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**11/22/2024 04:19:59 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Timothy Peng
PATENT CENTER #	68092738	FILING DATE	05/31/2024
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	John Harmon

Documents

TOTAL DOCUMENTS: 4

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
A138970001US02-IDSBODY-JSH.pdf	3	Letter specifying the conditions for filing under 37 CFR 1.97	32 KB
A138970001US02-TRN-JSH.pdf	1	Miscellaneous Incoming Letter	26 KB
A138970001US02-IDS1449-JSH.pdf	1	Information Disclosure Statement (IDS) Form (SB08)	21 KB
Warning: This is not a USPTO supplied IDS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.			
STENBERG_et_al_J_Labelled_Comp_Radiopharm_2020_v63_p129_NPL.pdf	15	Non Patent Literature	1075 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
A138970001US02-IDSBODY-JSH.pdf	DE47373F960A297B7C04270641CF3D713F1896581B0265F44F6233299F595A0E9D1684F4A3CB2D62AF573697658C480A168B5A38A578A578DFFE8DB273B87C8A
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STENBERG_et_al_J_Labelled_Comp_Radiopharm_2020_v63_p129_NPL.pdf	A7F3791C9951A51235D78EA53211E2723E031A51BCC66D1D2D7FC0037E91D4267421B59DB563DEB873AE12E4103991F57D330CB016043596570DB5A990E7AF73

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

DOCKET NO.: A1389.70001US02

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	S. M. Luck
Art Unit:	2881

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: 11/22/24 Electronic Signature for Timothy Peng: /Timothy Peng/

MAIL STOP AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATEMENT FILED PURSUANT TO THE DUTY OF DISCLOSURE UNDER 37 C.F.R. §§ 1.56, 1.97 AND 1.98

Commissioner:

Pursuant to the duty of disclosure under 37 C.F.R. §§ 1.56, 1.97 and 1.98, the undersigned requests consideration of this Information Disclosure Statement.

PART I: Compliance with 37 C.F.R. § 1.97

This Information Disclosure Statement has been filed before the mailing of a first Office Action after the filing of a Request for Continued Examination under 37 C.F.R. § 1.114.

No fee or certification is required.

PART II: Information Cited

The undersigned hereby makes of record in the above-identified application the information listed on the attached form PTO-1449 (modified PTO/SB/08). The order of presentation of the references should not be construed as an indication of the importance of the references.

The undersigned hereby makes the following additional information of record in the above-identified application.

The undersigned would like to bring to the Examiner's attention the following co-pending applications that may contain subject matter related to this application:

Serial No.	Filing Date	Inventor(s)	Docket No.
*18/942,340	11-08-2024	Larsen	A1389.70001US03
*18/940,735	11-07-2024	Larsen	A1389.70001US04
*18/940,734	11-07-2024	Larsen	A1389.70001US05
*18/940,751	11-07-2024	Larsen	A1389.70001US06

*A copy of this reference is not provided as the Office has waived the requirement under 37 C.F.R. § 1.98(a)(2)(iii) for submitting a copy of a cited U.S. patent application if it is scanned to the Image File Wrapper system and is available on Patent Center.

PART III: Remarks

Documents cited anywhere in the Information Disclosure Statement are enclosed unless otherwise indicated. It is respectfully requested that:

1. The Examiner consider completely the cited information, along with any other information, in reaching a determination concerning the patentability of the present claims;

2. The enclosed form PTO-1449 (modified PTO/SB/08) be signed by the Examiner to evidence that the cited information has been fully considered by the United States Patent and Trademark Office during the examination of this application;

3. The citations for the information be printed on any patent which issues from this application.

By submitting this Information Disclosure Statement, the undersigned makes no representation that a search has been performed, of the extent of any search performed, or that more relevant information does not exist.

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, material to patentability as defined in 37 C.F.R. § 1.56(b).

By submitting this Information Disclosure Statement, the undersigned makes no representation that the information cited in the Statement is, or is considered to be, in fact, prior art as defined by 35 U.S.C. § 102, or an admission by Applicant as prior art.

Notwithstanding any statements by the undersigned, the Examiner is urged to form his or her own conclusion regarding the relevance of the cited information.

An early and favorable action is hereby requested.

The Director is hereby authorized to charge any deficiency or credit any overpayment in the fees occasioned by the filing of this Information Disclosure Statement to our Deposit Account No. 23/2825 under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Respectfully submitted,

Electronic signature: /John Harmon/
John S. Harmon, PhD, PE
Registration No.: 67,131
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
617.646.8000

Docket No.: A1389.70001US02
Date: 11/22/24

Doc Code: TRAN.LET
Document Description: Transmittal Letter

USED IN LIEU OF PTO/SB/21 (07-09)

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission	

Application Number	18/680,605-Conf. #5167
Filing Date	May 31, 2024
First Named Inventor	Roy H. Larsen
Art Unit	2881
Examiner Name	S. M. Luck
Attorney Docket Number	A1389.70001US02

ENCLOSURES (*Check all that apply*)

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [x] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Form PTO-1449
Copy of cited reference

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	WOLF, GREENFIELD & SACKS, P.C.		
Signature	/John Harmon/		
Printed name	John S. Harmon, PhD, PE		
Date	11/22/24	Reg. No.	67,131

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: 11/22/24 Electronic Signature for Timothy Peng: /Timothy Peng/

FORM PTO-1449/A and B (modified PTO/SB/08)	APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
	FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet 1 of 1	GROUP ART UNIT: 2881	EXAMINER: S. M. Luck

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document		Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		Number	Kind Code		
		2009-0162278	A1	Ravn et al.	06-25-2009
		2014-0186268	A1	Vasiljeva et al.	07-03-2014

FOREIGN PATENT DOCUMENTS

Examiner's Initials #	Cite No.	Foreign Patent Document			Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)
		Office/ Country	Number	Kind Code			

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
		STENBERG et al., Preparation of the alpha-emitting prostate-specific membrane antigen targeted radioligand [212 Pb]Pb-NG001 for prostate cancer. J Labelled Comp Radiopharm. 2020 Mar;63(3):129-143. doi: 10.1002/jlcr.3825. Epub 2020 Jan 29.	

[NOTE – No copies of U.S. patents, published U.S. patent applications, or pending, unpublished patent applications stored in the USPTO's Image File Wrapper (IFW) system, are included. See 37 CFR § 1.98 and 1287OG163. Copies of all other patent(s), publication(s), unpublished, pending U.S. patent applications, or other information listed are provided as required by 37 CFR § 1.98 unless 1) such copies were provided in an IDS in an earlier application that complies with 37 CFR § 1.98, and 2) the earlier application is relied upon for an earlier filing date under 35 U.S.C. § 120.]

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02

CONFIRMATION NO. 5167

23628
WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

PUBLICATION NOTICE

OC000000081271473

Date Mailed: 11/29/2024

Title:PRODUCTION OF HIGHLY PURIFIED 212PB

Publication No.US-2024-0395432-A1
Publication Date:11/28/2024

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be viewed using the USPTO's publicly available Searchable Databases via the Patent Public Search tool at www.uspto.gov. The direct link to access the Patent Public Search tool is currently https://ppubs.uspto.gov/pubwebapp/static/pages/ppubsbasic.html.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through Patent Center, the USPTO's electronic patent application filing and management system. The direct link to access this status information is currently https://patentcenter.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of Patent Center.

Further assistance in electronically accessing the publication, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	**Art Unit**
	SEAN M LUCK	2881

CPC						
Symbol					**Type**	**Version**
G21G	/	1	/	0005	F	2013-01-01
G21F	/	5	/	015	I	2013-01-01
G21F	/	5	/	018	I	2013-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	38	
/SEAN M LUCK/ Examiner, Art Unit 2881	26 November 2024	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3b

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	**Art Unit**
	SEAN M LUCK	2881

INTERNATIONAL CLASSIFICATION				
CLAIMED				
G21G	/	1	/	00
G21F	/	5	/	015
G21F	/	5	/	018

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 38	
/SEAN M LUCK/ Examiner, Art Unit 2881 (Primary Examiner) 26 November 2024 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 3b

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	**Art Unit**
	SEAN M LUCK	2881

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19		28		37						
	2		11		20		29		38						
	3		12		21		30								
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	6		15		24		33								
	7		16		25		34								
	8		17		26		35								
	9		18		27		36								

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	38	
/SEAN M LUCK/ Examiner, Art Unit 2881	26 November 2024	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3b

U.S. Patent and Trademark Office Part of Paper No.: 20241126

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/680,605	Larsen, Roy H.
	Examiner	Art Unit
	SEAN M LUCK	2881

CPC - Searched*		
Symbol	Date	Examiner
G21G1/0005	09/19/2024	SL
G21F5/015,018	09/19/2024	SL

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Cpc/text/inv/npl/for/applicant/AI/citations/backward-forward/family interference search. See attachment(s) for details.	09/19/2024	SL
Updated search, reviewed IDS, consulted with Primary examiner Nicole Ippollto and SPE Robert Kim.	11/26/2024	SL

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
G21G1/0005		11/26/2024	SL
G21F5/ 015,018		11/26/2024	SL

/SEAN M LUCK/ Examiner, Art Unit 2881	

FORM PTO-1449/A and B (modified PTO/SB/08)	APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
	FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet 1 of 2	GROUP ART UNIT: 2881	EXAMINER: S. M. Luck

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document Number	U.S. Patent Document Kind Code	Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		5,038,046		Norman et al.	08-06-1991
		9,202,600	B2	Ravn et al.	12-01-2015
		12,125,603	B2	Larsen	10-22-2024

FOREIGN PATENT DOCUMENTS

Examiner's Initials #	Cite No.	Foreign Patent Document Office/ Country	Foreign Patent Document Number	Foreign Patent Document Kind Code	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)
		RU	2742138	C1	FED GOSUDARSTVENNOE UNITARNOE PREDPRIYATIE PROIZVODSTVENNOE OBEDINENIE MAYAK	02-02-2021	Y – Machine Translation

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
		ATCHER et al., A radionuclide generator for the production of 211Pb and its daughters. J Radioanalyt Nucl Chem. 1989 Feb;135:215-21.	
		ATCHER et al., An improved generator for the production of 212Pb and 212Bi from 224Ra. Int J Rad Appl Instrum A. 1988;39(4):283-6. doi: 10.1016/0883-2889(88)90016-0.	
		BOLDYREV et al., 212Pb/212Bi Generator for nuclear medicine. Atomic Energy. 2012 Mar 23;111:422-7.	
		CHAPPELL et al., Synthesis, characterization, and evaluation of a novel bifunctional chelating agent for the lead isotopes 203Pb and 212Pb. Nucl Med Biol. 2000 Jan;27(1):93-100. doi: 10.1016/s0969-8051(99)00086-4.	
		HASSFJELL et al., A generator for production of 212Pb and 212Bi. Appl Radiat Isot. 1994 Oct;45(10):1021-5.	
		KNAPP et al., Availability of Alpha-Emitting Radioisotopes by Reactor and Accelerator Production and via Decay of Naturally Occurring Parents. In: Radiopharmaceuticals for Therapy. 2016. Knapp et al., Eds. Chapter 8:159-66.	
		KOZEMPEL, Radon Nuclides and Radon Generators. In: Radon. 2017. Adrovic, Ed. Chapter 2:7-23.	

EXAMINER:	DATE CONSIDERED:

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

FORM PTO-1449/A and B (modified PTO/SB/08) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**				APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
				FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
				FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet	2	of	2	GROUP ART UNIT: 2881	EXAMINER: S. M. Luck

		RUTHERFORD, A radio-active substance emitted from thorium compounds. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science. 1900 Jan;49(296):1-14.	
		RUTHERFORD, The Succession of Changes in Radioactive Bodies. Phil Trans Roy Soc A. 1905;204:169-219.	
		WRASIDLO et al., Generation of lead-212 and radioimmunoconjugates for use in cancer therapy and the 'emanating power' of stearates. Coll Surf A Physiochem Eng Aspects. 2001 Jul 31;186(1-2):123-8.	

[NOTE – No copies of U.S. patents, published U.S. patent applications, or pending, unpublished patent applications stored in the USPTO's Image File Wrapper (IFW) system, are included. See 37 CFR § 1.98 and 1287OG163. Copies of all other patent(s), publication(s), unpublished, pending U.S. patent applications, or other information listed are provided as required by 37 CFR § 1.98 unless 1) such copies were provided in an IDS in an earlier application that complies with 37 CFR § 1.98, and 2) the earlier application is relied upon for an earlier filing date under 35 U.S.C. § 120.]

EXAMINER:	DATE CONSIDERED:
/SEAN M LUCK/	11/26/2024

[#] EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

FORM PTO-1449/A and B (modified PTO/SB/08)	APPLICATION NO.: 18/680,605	ATTY. DOCKET NO.: A1389.70001US02
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	FILING DATE: May 31, 2024	CONFIRMATION NO.: 5167
	FIRST NAMED INVENTOR: Roy H. Larsen	
Sheet 1 of 1	GROUP ART UNIT: 2881	EXAMINER: S. M. Luck

U.S. PATENT DOCUMENTS

Examiner's Initials #	Cite No.	U.S. Patent Document Number	U.S. Patent Document Kind Code	Name of Patentee or Applicant of Cited Document	Date of Publication or Issue of Cited Document MM-DD-YYYY
		2009-0162278	A1	Ravn et al.	06-25-2009
		2014-0186268	A1	Vasiljeva et al.	07-03-2014

FOREIGN PATENT DOCUMENTS

Examiner's Initials #	Cite No.	Foreign Patent Document Office/ Country	Foreign Patent Document Number	Foreign Patent Document Kind Code	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Translation (Y/N)

OTHER ART – NON PATENT LITERATURE DOCUMENTS

Examiner's Initials #	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	Translation (Y/N)
		STENBERG et al., Preparation of the alpha-emitting prostate-specific membrane antigen targeted radioligand [212 Pb]Pb-NG001 for prostate cancer. J Labelled Comp Radiopharm. 2020 Mar;63(3):129-143. doi: 10.1002/jlcr.3825. Epub 2020 Jan 29.	

[NOTE – No copies of U.S. patents, published U.S. patent applications, or pending, unpublished patent applications stored in the USPTO's Image File Wrapper (IFW) system, are included. See 37 CFR § 1.98 and 1287OG163. Copies of all other patent(s), publication(s), unpublished, pending U.S. patent applications, or other information listed are provided as required by 37 CFR § 1.98 unless 1) such copies were provided in an IDS in an earlier application that complies with 37 CFR § 1.98, and 2) the earlier application is relied upon for an earlier filing date under 35 U.S.C. § 120.]

EXAMINER:	DATE CONSIDERED:
/SEAN M LUCK/	11/26/2024

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.M.L/

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/07/25 02:34 PM
L2	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 02:34 PM
L3	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 02:35 PM
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L46	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2024/08/14 01:38 PM

			CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L47	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L48	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L49	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM

		OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.					
L50	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L51	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L52	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L53	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L54	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM
L55	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L56	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L57	51	L6 AND isotope SAME	(US-PGPUB; USPAT;	OR	ON	ON	2024/08/14

		solid	USOCR)				01:38 PM
L58	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L59	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L60	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L61	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L62	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L63	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 01:38 PM
L64	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L65	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L66	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2024/08/14 01:38 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L67	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 01:38 PM
L68	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM
L69	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L70	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L71	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM

		(PGPB | USPT | USOC).dbnm.					
L72	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L73	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:38 PM
L74	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L75	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L76	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L77	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:38 PM
L78	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:38 PM
L79	1	L64 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:39 PM
L80	8	L64 AND (COLLECT$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:40 PM
L81	1	L64 AND ((PRECURSOR PARENT) SAME (DAUGHTER	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:41 PM

		PROGENY) SAME SOLID SAME GAS$4 SAME ISOTOP$4)					
L82	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:42 PM
L83	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:42 PM
L84	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:43 PM
L85	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$8)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:43 PM
L86	0	L64 AND (SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:45 PM
L87	0	L64 AND ((SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY)))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:45 PM
L88	6	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:45 PM
L89	5	(ISOTOP$8 WITH SOLID WITH (PARENT PRECURSOR)) AND (ISOTOP$8 WITH GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:46 PM
L90	64	L62 L63	(US-PGPUB; USPAT;	OR	ON	ON	2024/08/14

			USOCR)				01:47 PM
L91	0	L90 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:47 PM
L92	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:47 PM
L93	0	L90 AND L89	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:48 PM
L94	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:48 PM
L95	0	("20100224791").pn.	(USPAT)	OR	ON	ON	2024/08/14 01:50 PM
L96	0	"20100224791"	(USPAT)	OR	ON	ON	2024/08/14 01:50 PM
L97	1	"20100224791"	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:50 PM
L98	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:50 PM
L99	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:50 PM
L100	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM
L101	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM

L102	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM
L103	1	"20070158271"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:51 PM
L104	0	(11/610574).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM
L105	0	("2007/0158271").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM
L106	36	(Artificial Intelligence) More like doc: US-20070158271-A1 Text: (WO-2009003290-A1 OR EP-2179423-A1 OR AU-2006345883-A1 OR WO-2008004028-A2 OR EP-2011126-A2 OR US-20080093564-A1 OR CA-2631712-C OR CA-2631712-A1 OR CA-2692514-A1 OR US-7700926-B2 OR EP-2492920-A2 OR US-20100224791-A1 OR EP-2011126-B1 OR JP-2008139272-A OR WO-2008004028-A3 OR EP-2492920-A3 OR US-20240249856-A1 OR CN-110917658-A OR CN-110917658-B OR US-20180209921-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 01:52 PM
L107	1	(11/773022).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM
L108	52	("3576998" | "3655981" | "3749556" | "3774035" | "3882315" | "3920995" | "3946238" | "4020351" | "4039835" | "4084097" | "4144461" | "4160910" | "4280053" | "4286169" | "4387303" | "4414145" | "4782231" | "5109160" | "5186913" | "5397902" | "5831271" | "5834788" | "6157036" | "6781142" | "6998052" | "7060998" | "7091494" | "7163031" | "20030219366" | "20050104016" | "20050116186" | "20050253085" | "20060023829").pn. OR ("7700926").urpn. AND	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 01:52 PM

		(PGPB | USPT | USOC).dbnm.					
L109	0	L64 AND (COLLECT$4 SAME CERAMIC SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:59 PM
L110	2	L64 AND (COLLECT$4 SAME CERAMIC)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 01:59 PM
L111	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L112	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L113	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L114	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L115	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 09:28 PM
L116	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L117	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L118	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2024/08/14 09:28 PM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L119	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L120	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L121	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L122	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		AND (PGPB | USPT | USOC).dbnm.					
L123	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L124	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L125	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L126	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L127	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L128	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L129	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L130	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L131	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L132	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L133	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L134	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	ON	2024/08/14 09:28 PM

			DERWENT)				
L135	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L136	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L137	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L138	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2024/08/14 09:28 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L139	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L140	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L141	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L142	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L143	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L144	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO,	OR	ON	ON	2024/08/14 09:28 PM

		EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L145	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L146	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L147	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L148	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L149	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L150	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L151	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L152	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L153	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L154	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 09:28 PM
L155	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM

L156	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L157	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L158	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L159	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK,	OR	ON	ON	2024/08/14 09:28 PM

		JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L160	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L161	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L162	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L163	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L164	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L165	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

L166	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L167	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L168	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L169	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L170	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L171	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L172	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L173	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/08/14 09:28 PM
L174	6246	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L175	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L176	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2024/08/14 09:28 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L177	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/08/14 09:28 PM
L178	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L179	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L180	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT |	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		USOC).dbnm.					
L181	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L182	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L183	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR EP-2854870-A1 OR WO-2013174949-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L184	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L185	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L186	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L187	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L188	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L189	1	L64 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L190	8	L64 AND (COLLECT$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM

L191	1	L64 AND ((PRECURSOR PARENT) SAME (DAUGHTER PROGENY) SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L192	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L193	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L194	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L195	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$8)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L196	0	L64 AND (SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L197	0	L64 AND ((SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY)))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L198	6	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L199	5	(ISOTOP$8 WITH SOLID WITH (PARENT PRECURSOR)) AND (ISOTOP$8 WITH	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		GAS$6 WITH (DAUGHTER PROGENY))					
L200	64	L62 L63	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L201	0	L90 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L202	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L203	0	L90 AND L89	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L204	30	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR US-3576998-A OR EP-0466290-A1 OR JP-H01501423-A OR CA-2046546-A1 OR JP-H05264794-A OR AU-2024203219-A1 OR CA-2631712-C OR US-20100224791-A1 OR AU-2006345883-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L205	0	("20100224791").pn.	(USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L206	0	"20100224791"	(USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L207	1	"20100224791"	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L208	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L209	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L210	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14

							09:28 PM
L211	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L212	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L213	1	"20070158271"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L214	0	(11/610574).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L215	0	("2007/0158271").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L216	36	(Artificial Intelligence) More like doc: US-20070158271-A1 Text: (WO-2009003290-A1 OR EP-2179423-A1 OR AU-2006345883-A1 OR WO-2008004028-A2 OR EP-2011126-A2 OR US-20080093564-A1 OR CA-2631712-C OR CA-2631712-A1 OR CA-2692514-A1 OR US-7700926-B2 OR EP-2492920-A2 OR US-20100224791-A1 OR EP-2011126-B1 OR JP-2008139272-A OR WO-2008004028-A3 OR EP-2492920-A3 OR US-20240249856-A1 OR CN-110917658-A OR CN-110917658-B OR US-20180209921-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/08/14 09:28 PM
L217	1	(11/773022).APP.	(USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM
L218	52	("3576998" | "3655981" | "3749556" | "3774035" | "3882315" | "3920995" | "3946238" | "4020351" | "4039835" | "4084097" | "4144461" | "4160910" | "4280053" | "4286169" | "4387303" | "4414145" | "4782231" | "5109160" | "5186913" | "5397902" | "5831271" | "5834788" | "6157036" | "6781142" | "6998052" | "7060998" | "7091494" | "7163031" | "20030219366" |	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/08/14 09:28 PM

		"20050104016" | "20050116186" | "20050253085" | "20060023829").pn. OR ("7700926").urpn. AND (PGPB | USPT | USOC).dbnm.					
L219	0	L64 AND (COLLECT$4 SAME CERAMIC SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L220	2	L64 AND (COLLECT$4 SAME CERAMIC)	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:28 PM
L221	2	("10434198" "20230014219").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:09 PM
L222	0	"18680372"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:34 PM
L223	0	("18680372").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:34 PM
L224	0	"18680605"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 02:36 PM
L225	0	"18680605"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:33 PM
L226	0	"18680372"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:33 PM
L227	2	L174 AND ((seal$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4))	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:34 PM
L228	11	("4280053" | "4859431" | "4980093" | "4990787" | "5617860" | "5860295" | "6202440" | "7023000" | "7302812" | "7531150" | "20050044886").pn. OR ("8329122").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:35 PM
L229	34	(Artificial Intelligence) More like doc: US-8329122-B1 Text: (WO-2004105049-A1 OR US-7023000-B2 OR US-20060022127-A1 OR FR-3044426-A1 OR US-20230411033-A1 OR JP-2023550075-A OR CA-2576907-C OR CA-2576907-A1 OR EP-1774536-A1 OR EA-009820-B1 OR CA-3198969-A1 OR AU-2021376899-A1 OR WO-2022101500-A1	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:36 PM

		OR EP-4244874-A1 OR US-20230420153-A1 OR EP-4002392-A1 OR DE-69719962-T2 OR US-20210158987-A1 OR CA-2360721-C OR JP-S615000-A).did.					
L230	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L231	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L232	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L233	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L234	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L235	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L236	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L237	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2024/09/18 04:37 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L238	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L239	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L240	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L241	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L242	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L243	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L244	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L245	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L246	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L247	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L248	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L249	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L250	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L251	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L252	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L253	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L254	6265	G21G1/0005.cpc.	(US-PGPUB; USPAT;	OR	ON	ON	2024/09/18

		G21F5/015,018.cpc.	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				04:37 PM
L255	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L256	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L257	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN,	OR	ON	ON	2024/09/18 04:37 PM

			WO); FPRS; EPO; JPO)				
L258	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L259	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L260	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L261	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L262	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L263	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO;	OR	ON	ON	2024/09/18 04:37 PM

		2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	JPO; DERWENT; IBM_TDB)				
L264	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L265	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L266	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L267	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L268	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L269	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L270	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L271	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L272	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L273	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L274	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L275	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2024/09/18 04:37 PM

			CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L276	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L277	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L278	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM

		B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.					
L279	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L280	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L281	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L282	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L283	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L284	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L285	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L286	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L287	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L288	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L289	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L290	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L291	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L292	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L293	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L294	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L295	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE,	OR	ON	ON	2024/09/18 04:37 PM

			SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L296	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L297	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L298	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L299	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L300	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L301	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L302	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L303	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L304	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L305	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L306	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L307	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L308	1	L64 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L309	8	L64 AND (COLLECT$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L310	1	L64 AND ((PRECURSOR PARENT) SAME (DAUGHTER PROGENY) SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

L311	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L312	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L313	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L314	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$8)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L315	0	L64 AND (SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L316	0	L64 AND ((SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY)))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L317	7	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L318	5	(ISOTOP$8 WITH SOLID WITH (PARENT PRECURSOR)) AND (ISOTOP$8 WITH GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L319	64	L62 L63	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L320	0	L90 AND (CERAMIC SAME SOLID SAME	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

		GAS$4 SAME ISOTOP$4)					
L321	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L322	0	L90 AND L89	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L323	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L324	0	("20100224791").pn.	(USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L325	0	"20100224791"	(USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L326	1	"20100224791"	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L327	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L328	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L329	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L330	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L331	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L332	1	"20070158271"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L333	0	(11/610574).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L334	0	("2007/0158271").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L335	34	(Artificial Intelligence) More like doc: US-20070158271-A1 Text: (WO-2009003290-A1 OR EP-2179423-A1 OR AU-2006345883-A1 OR WO-2008004028-A2 OR EP-2011126-A2 OR US-20080093564-A1 OR CA-2631712-C OR CA-2631712-A1 OR CA-2692514-A1 OR US-7700926-B2 OR EP-2492920-A2 OR US-20100224791-A1 OR EP-2011126-B1 OR JP-2008139272-A OR WO-2008004028-A3 OR EP-2492920-A3 OR US-20240249856-A1 OR DE-2826833-A1 OR US-4160910-A OR CA-1093223-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L336	1	(11/773022).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L337	52	("3576998" | "3655981" | "3749556" | "3774035" | "3882315" | "3920995" | "3946238" | "4020351" | "4039835" | "4084097" | "4144461" | "4160910" | "4280053" | "4286169" | "4387303" | "4414145" | "4782231" | "5109160" | "5186913" | "5397902" | "5831271" | "5834788" | "6157036" | "6781142" | "6998052" | "7060998" | "7091494" | "7163031" | "20030219366" | "20050104016" | "20050116186" | "20050253085" | "20060023829").pn. OR ("7700926").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L338	0	L64 AND (COLLECT$4 SAME CERAMIC SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

L339	2	L64 AND (COLLECT$4 SAME CERAMIC)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L340	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L341	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L342	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L343	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L344	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L345	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L346	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L347	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE,	OR	ON	ON	2024/09/18 04:37 PM

			SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L348	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L349	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L350	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L351	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L352	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L353	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L354	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L355	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L356	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L357	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L358	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L359	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L360	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L361	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L362	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L363	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L364	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2024/09/18 04:37 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L365	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L366	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L367	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L368	31	(Artificial Intelligence) More like doc:	(US-PGPUB; USPAT; USOCR; FIT (AU, AP,	OR	ON	ON	2024/09/18 04:37 PM

		US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L369	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L370	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L371	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L372	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L373	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM

		10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.					
L374	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L375	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L376	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L377	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L378	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L379	1	"17756802"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L380	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L381	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L382	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L383	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L384	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L385	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV,	OR	ON	ON	2024/09/18 04:37 PM

			MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)				
L386	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L387	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L388	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM

		AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.					
L389	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L390	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L391	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L392	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L393	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L394	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L395	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L396	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L397	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L398	1	"17756802"	(US-PGPUB; USPAT;	OR	ON	ON	2024/09/18

			USOCR)				04:37 PM
L399	2	("20150170776" OR "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L400	3	("3453196" "7476370" "20060022127").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L401	11	((("SCIENCONS") near3 ("AS"))).AS,AANM.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L402	77	((("LARSEN") near3 ("Roy"))).INV.	(US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT)	OR	ON	ON	2024/09/18 04:37 PM
L403	6265	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L404	12	L4 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L405	13	L5 AND L6	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO;	OR	ON	ON	2024/09/18 04:37 PM

			JPO)				
L406	13	L7 L8	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO)	OR	ON	ON	2024/09/18 04:37 PM
L407	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L408	1	(14/402325).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L409	5	("4663129" | "5038046" | "6126909" | "6787042").pn. OR ("10020086").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L410	13	("3801818" | "4663129").pn. OR ("5038046").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L411	4	("3453196").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L412	31	(Artificial Intelligence) More like doc: US-20150170776-A1 Text: (US-20180308600-A1 OR AU-2013265268-B2 OR AU-2013265268-A2 OR US-11037690-B2 OR AU-2013265268-A1 OR EP-2854870-B1 OR WO-2013174949-A1 OR EP-2854870-A1 OR JP-2015523555-A OR JP-6392210-B2 OR DK-2854870-T3 OR FR-2990956-A1 OR TR-201811310-T4 OR ES-2683398-T3 OR US-10020086-B2 OR US-10861615-B2 OR EP-3174068-B1 OR US-20210050126-A1 OR US-20180350480-A1 OR EP-3174068-A1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L413	5	L6 AND isotope WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L414	0	L6 AND isotope WITH precursor SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L415	51	L6 AND isotope SAME solid	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L416	29	L6 AND (open clos$4) WITH rod	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L417	5	("3453196" "7476370" "20060022127" "20150170776" "20180047474").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L418	1	L64 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L419	8	L64 AND (COLLECT$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L420	1	L64 AND ((PRECURSOR PARENT) SAME (DAUGHTER PROGENY) SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L421	1	L64 AND ((PRECURSOR PARENT) SAME	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

		SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)					
L422	1	L64 AND ((PRECURSOR PARENT) SAME SOLID SAME ISOTOP$4) AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L423	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$4)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L424	4	L64 AND ((DAUGHTER PROGENY) SAME GAS$4 SAME SOLID SAME ISOTOP$8)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L425	0	L64 AND (SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L426	0	L64 AND ((SOLID WITH (PARENT PRECURSOR)) SAME (GAS$6 WITH (DAUGHTER PROGENY)))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L427	7	L64 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L428	5	(ISOTOP$8 WITH SOLID WITH (PARENT PRECURSOR)) AND (ISOTOP$8 WITH GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L429	64	L62 L63	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L430	0	L90 AND (CERAMIC SAME SOLID SAME GAS$4 SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

L431	0	L90 AND (SOLID WITH (PARENT PRECURSOR)) AND (GAS$6 WITH (DAUGHTER PROGENY))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L432	0	L90 AND L89	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L433	31	(Artificial Intelligence) More like doc: US-20230014219-A1 Text: (CA-3160031-A1 OR EP-4070341-A1 OR WO-2021110950-A1 OR AU-2020398382-A1 OR IL-293575-A OR KR-20220107058-A OR JP-2023505247-A OR CN-114902350-A OR JP-WO2021110950-A5 OR MX-2022006638-A OR BR-112022010778-A2 OR CN-104755145-B OR US-11348702-B2 OR US-3576998-A OR CN-104755145-A OR DE-1959586-A1 OR AU-2018201048-B2 OR DE-1959586-B2 OR CA-2889510-A1 OR CA-2889510-C).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L434	0	("20100224791").pn.	(USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L435	0	"20100224791"	(USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L436	1	"20100224791"	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L437	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L438	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L439	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L440	1	("2010/0224791").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L441	0	(12/724380).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L442	1	"20070158271"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L443	0	(11/610574).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM

L444	0	("2007/0158271").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L445	34	(Artificial Intelligence) More like doc: US-20070158271-A1 Text: (WO-2009003290-A1 OR EP-2179423-A1 OR AU-2006345883-A1 OR WO-2008004028-A2 OR EP-2011126-A2 OR US-20080093564-A1 OR CA-2631712-C OR CA-2631712-A1 OR CA-2692514-A1 OR US-7700926-B2 OR EP-2492920-A2 OR US-20100224791-A1 OR EP-2011126-B1 OR JP-2008139272-A OR WO-2008004028-A3 OR EP-2492920-A3 OR US-20240249856-A1 OR DE-2826833-A1 OR US-4160910-A OR CA-1093223-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L446	1	(11/773022).APP.	(USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L447	52	("3576998" | "3655981" | "3749556" | "3774035" | "3882315" | "3920995" | "3946238" | "4020351" | "4039835" | "4084097" | "4144461" | "4160910" | "4280053" | "4286169" | "4387303" | "4414145" | "4782231" | "5109160" | "5186913" | "5397902" | "5831271" | "5834788" | "6157036" | "6781142" | "6998052" | "7060998" | "7091494" | "7163031" | "20030219366" | "20050104016" | "20050116186" | "20050253085" | "20060023829").pn. OR ("7700926").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L448	0	L64 AND (COLLECT$4 SAME CERAMIC SAME ISOTOP$4)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L449	2	L64 AND (COLLECT$4 SAME CERAMIC)	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM

L450	2	("10434198" "20230014219").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L451	0	"18680372"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L452	0	("18680372").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L453	0	"18680605"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L454	0	"18680605"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L455	0	"18680372"	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L456	2	L174 AND ((seal$4 SAME SOLID SAME GAS$4 SAME ISOTOP$4))	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:37 PM
L457	11	("4280053" | "4859431" | "4980093" | "4990787" | "5617860" | "5860295" | "6202440" | "7023000" | "7302812" | "7531150" | "20050044886").pn. OR ("8329122").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/09/18 04:37 PM
L458	34	(Artificial Intelligence) More like doc: US-8329122-B1 Text: (WO-2004105049-A1 OR US-7023000-B2 OR US-20060022127-A1 OR FR-3044426-A1 OR US-20230411033-A1 OR JP-2023550075-A OR CA-2576907-C OR CA-2576907-A1 OR EP-1774536-A1 OR EA-009820-B1 OR CA-3198969-A1 OR AU-2021376899-A1 OR WO-2022101500-A1 OR EP-4244874-A1 OR US-20230420153-A1 OR EP-4002392-A1 OR DE-69719962-T2 OR US-20210158987-A1 OR CA-2360721-C OR JP-S615000-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2024/09/18 04:37 PM
L459	5	("20090162278" "20140186268" "5038049" "9202600" "12125603").pn.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2024/11/26 02:55 PM
L460	5	("20090162278"	(US-PGPUB; USPAT;	OR	ON	ON	2024/11/26

		"20140186268" "5038046" "9202600" "12125603").pn.	USOCR)				03:01 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	973	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 03:48 PM
N2	24	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 03:48 PM
N3	45	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 03:48 PM
N4	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 03:48 PM
N5	73	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 03:49 PM
N6	973	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
N7	24	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
N8	45	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
N9	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
N10	73	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/07/25 04:07 PM
N11	977	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N12	25	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N13	47	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N14	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N15	76	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N16	977	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N17	25	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N18	47	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N19	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N20	76	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/08/14 09:29 PM
N21	983	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM

N22	25	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N23	47	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N24	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N25	76	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N26	983	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N27	25	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N28	47	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N29	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N30	76	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N31	983	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N32	25	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N33	47	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N34	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N35	76	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N36	983	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N37	25	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N38	47	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N39	5	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N40	76	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/09/18 04:38 PM
N41	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N42	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N43	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N44	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N45	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N46	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM

N47	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N48	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N49	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N50	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N51	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N52	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N53	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N54	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N55	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N56	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N57	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N58	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N59	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N60	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N61	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N62	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N63	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N64	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N65	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N66	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N67	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N68	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N69	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N70	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N71	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM

N72	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N73	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N74	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N75	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N76	998	G21G1/0005.cpc. G21F5/015,018.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N77	28	N1 AND (open clos$4) WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N78	50	N1 AND isotope SAME solid	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N79	7	N1 AND isotope WITH rod	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM
N80	81	N2 N3 N4	(US-PGPUB; USPAT)	OR	ON	ON	2024/11/26 03:03 PM

Bibliographic Data

Application No: 18/680,605

Foreign Priority claimed: (●) Yes ( ) No

35 USC 119 (a-d) conditions met: [☑] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /SEAN M LUCK/ Examiner's Signature | Initials

Title: PRODUCTION OF HIGHLY PURIFIED 212PB

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
05/31/2024	376	2881	A1389.70001US02
RULE			

APPLICANTS

Sciencons AS, Oslo, NORWAY

INVENTORS

Roy H. Larsen,

CONTINUING DATA

This application is a CON of 17756802 06/02/2022 PAT 12125603

17756802 is a 371 of PCT/EP2020/084701 12/04/2020

FOREIGN APPLICATIONS

EPO EP19213759.4 12/05/2019

EPO EP20172038.0 04/29/2020

IF REQUIRED, FOREIGN LICENSE GRANTED**

06/17/2024

** **SMALL ENTITY** **

STATE OR COUNTRY

ADDRESS

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206
UNITED STATES

FILING FEE RECEIVED

$2,960

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

23628 7590 12/05/2024

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

EXAMINER	
LUCK, SEAN M	
ART UNIT	**PAPER NUMBER**
2881	

DATE MAILED: 12/05/2024

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

TITLE OF INVENTION: PRODUCTION OF HIGHLY PURIFIED 212PB

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0.00	$0.00	$480	03/05/2025

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

AdvanCell - Exhibit 1006 - Page 374

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23628 7590 12/05/2024
WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

TITLE OF INVENTION: PRODUCTION OF HIGHLY PURIFIED 212PB

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0.00	$0.00	$480	03/05/2025

EXAMINER	ART UNIT	CLASS-SUBCLASS
LUCK, SEAN M	2881	376-202000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via the USPTO patent electronic filing system ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

❑ Applicant asserting small entity status. See 37 CFR 1.27

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

❑ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

23628 7590 12/05/2024

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

EXAMINER	
LUCK, SEAN M	
ART UNIT	PAPER NUMBER
2881	

DATE MAILED: 12/05/2024

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

AdvanCell - Exhibit 1006 - Page 376

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013).
https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf

Routine uses of the information in this record may include disclosure to:

1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
2) a federal, state, local, or international agency, in response to its request;
3) a contractor of the USPTO having need for the information in order to perform a contract;
4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c));
9) the Office of Personnel Management (OPM) for personnel research purposes; and
10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

Notice of Allowability	Application No. 18/680,605	Applicant(s) Larsen, Roy H.	
	Examiner SEAN M LUCK	Art Unit 2881	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 11/22/2024.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-38 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☑ All b) ☐ Some* c) ☐ None of the:

   1. ☑ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/SEAN M LUCK/
Examiner, Art Unit 2881

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Reasons for Allowance

2. The following is an examiner's statement of reasons for allowance: The prior art in general discloses the decay of solid precursor isotopes in a collection container in general, but does not provide adequate detail to address the inventive features of exposing the collector surface to gaseous progeny isotopes to deposit solid progeny isotopes. The information provided in the prior art does not address these features, or provide a basis for a person of ordinary skill in the art to arrive at them without relying on improper hindsight reasoning or inappropriate claim interpretation.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SEAN M LUCK whose telephone number is (571)272-6493. The examiner can normally be reached 8-5 M-F.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Robert Kim can be reached on (571)272-2293. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SEAN M LUCK/
Examiner, Art Unit 2881

PART B–FEE(S) TRANSMITTAL

Complete and send this form, together with the applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

By fax, send to: (571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

23628
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being ~~deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being~~ transmitted via the USPTO electronic filing system ~~or by facsimile to (571) 273-2885,~~ on the date below.

Eileen M. MacKenzie	(Typed or printed name)
/Eileen M. MacKenzie/	(Signature)
January 27, 2025	(Date)

APPLICATION NO	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO	CONFIRMATION NO
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

TITLE OF INVENTION: PRODUCTION OF HIGHLY PURIFIED 212PB

APPLN: TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480.00			$480.00	03/05/2025

EXAMINER	ART UNIT	CLASS-SUBCLASS
S. M. Luck	2881	

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363)

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1. Wolf, Greenfield & Sacks, P.C.
2.
3.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Sciencons AS

(B) RESIDENCE: (CITY and STATE or COUNTRY): Oslo, Norway

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees Submitted: ☒ Issue Fee ☐ Publication Fee (if required)

4b. Method of Payment (*Please first reapply any previously paid fee shown above*):

☒ Electronic Payment via Patent Center or EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge ~~the required fee(s),~~ any deficiency, or credit any overpayment to Deposit Account No. 23/2825

5. Change of Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29. NOTE: Absent a valid Certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27. NOTE: If the application was previously under micro entity status, checking this box will be taken as a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status. NOTE: Checking this box will be taken as a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature: /John Harmon/ Date: 1/27/25

Typed or printed name: John S. Harmon, PhD, PE Registration No.: 67,131

13461880

Doc Code: TRAN.LET
Document Description: Transmittal Letter

USED IN LIEU OF PTO/SB/21 (07-09)

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission	

Application Number	18/680,605-Conf. #5167
Filing Date	May 31, 2024
First Named Inventor	Roy H. Larsen
Art Unit	2881
Examiner Name	S. M. Luck
Attorney Docket Number	A1389.70001US02

ENCLOSURES (*Check all that apply*)

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [x] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53

- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
  - [ ] Landscape Table on CD

- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):
  - Issue Fee Payment
  - Comments on Statement of Reasons for Allowance

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	WOLF, GREENFIELD & SACKS, P.C.		
Signature	/John Harmon/		
Printed name	John S. Harmon, PhD, PE		
Date	1/27/25	Reg. No.	67,131

Certificate of Electronic Filing under 37 C.F.R. § 1.8

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: January 27, 2025 Electronic Signature for Eileen M. MacKenzie: / Eileen M. MacKenzie /

13461878

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**01/27/2025 05:11:29 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Eileen MacKenzie
PATENT CENTER #	68937971	FILING DATE	05/31/2024
CUSTOMER #	23628	FIRST NAMED INVENTOR	Roy H. Larsen
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	John Harmon

Documents

TOTAL DOCUMENTS: 7

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
A138970001US02-312AMN-JSH.pdf		9	-	69 KB
A138970001US02-312AMN-JSH-A.NA.pdf	(1-1)	1	Amendment after Notice of Allowance (Rule 312)	26 KB
A138970001US02-312AMN-JSH-SPEC.pdf	(2-2)	1	Specification	21 KB
A138970001US02-312AMN-JSH-CLM.pdf	(3-7)	5	Claims	49 KB
A138970001US02-312AMN-JSH-REM.pdf	(8-9)	2	Applicant Arguments/Remarks Made in an Amendment	27 KB
A138970001US02-CSRA-JSH.pdf		2	Post Allowance Communication - Incoming	28 KB

A138970001US02-ISSFEE-JSH.pdf	1	Issue Fee Payment (PTO-85B)	38 KB
A138970001US02-TRN-JSH.pdf	1	Miscellaneous Incoming Letter	26 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
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A138970001US02-ISSFEE-JSH.pdf	A9517DA83F51E0A96C0349AB008E68B215A0E756BB03CC6160FA02E31175AD7F64618FC735746C42440790B90F8083DF0B16D90654F92F07788853569E4030AD
A138970001US02-TRN-JSH.pdf	8E647448E8B096542186FBDC086388546F13D9CC97303C5728608567B70442E96C5E50B99BFD99331347BE68C33A3CBC331502AAE8D93376D071064BF12BA040

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: A1389.70001US02
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	S. M. Luck
Art Unit:	2881

Certificate of Electronic Filing under 37 C.F.R. § 1.8
I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: January 27, 2025 Electronic Signature for Eileen M. MacKenzie: / Eileen M. MacKenzie /

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE UNDER 37 C.F.R. § 1.104(e)

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant has received the Examiner's Statement of Reasons for Allowance with the December 5, 2024 Notice of Allowance and Allowability regarding the above-identified application. Entry of the Statement into the record should not be construed as any agreement with or acquiescence in the reasoning stated by the Examiner. Each of the claims stands on its own merits and is patentable because of the combination it recites and not because of the presence or absence of any one particular element.

The Examiner's Statement was not prepared by Applicant and only contains the Examiner's possible positions in one or more reasons for allowability. Thus, any interpretation with respect to the Examiner's Statement of Reasons for Allowance should not be imputed to the Applicant.

Applicant believes no fee is due with this Comments on Statement of Reasons for Allowance (37 CFR 1.104(e)). However, if a fee is due with this Comments on Statement of Reasons for Allowance (37 CFR 1.104(e)), please charge our Deposit Account No. 23/2825, under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Dated: 1/27/25

Respectfully submitted,

By/John Harmon/
John S. Harmon, PhD, PE
Registration No.: 67,131
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
617.646.8000

13461794

Docket No.: A1389.70001US02
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	S. M. Luck
Art Unit:	2881

Certificate of Electronic Filing under 37 C.F.R. § 1.8
I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: January 27, 2025 Electronic Signature for Eileen M. MacKenzie: / Eileen M. MacKenzie /

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. § 1.312

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

INTRODUCTORY COMMENTS

Prior to issuance of the patent, applicant respectfully requests entry of this amendment under 37 C.F.R. § 1.312 for the above-captioned patent application.

Amendments to the Specification begin on page 2 of this amendment.

Amendments to the Claims begin on page 3 of this amendment.

Remarks/Arguments begin on page 8 of this amendment.

AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph beginning on page 7, line 24 of the as filed application with the following amended paragraph:

> In one or more embodiments of the invention the ^{212}Pb precursor isotope source is ^{228}Th that has at least 90%, such as at least 80%, such as at least 70%, such as at least 60%, such as at least 50%, such as at least 40%, such as at least 30%, such as at least 20%, such as at least 10% ~~228 Th~~ ^{228}Th measured as % radioactivity relative to ^{212}Pb.

Please replace the paragraph beginning on page 18, line 44 of the as filed application with the following amended paragraph:

> In a gas tight unit regardless of whether ^{212}Pb is at or lower than equilibrium it can be assumed that this is reached after 3 days since surplus ^{212}Pb is reduced by 99% and the ingrowth of ^{212}Pb from ~~224 Ra~~ ^{224}Ra is practically complete vs. "equilibrium".

AMENDMENTS TO THE CLAIMS

1. (Original) A radioisotope generator comprising:

a solid precursor isotope source configured to emanate one or more gaseous progeny isotopes, the solid precursor isotope source comprising a precursor isotope; and

wherein the solid precursor isotope source is configured to be fluidly coupled to a volume including a collector surface with a gas tight seal, and wherein the solid precursor isotope source and the collector surface are configured such that the one or more gaseous progeny isotopes deposit one or more solid progeny isotopes on the collector surface.

2. (Original) The radioisotope generator of claim 1, further comprising a flushing circuit configured to flush the collector surface.

3. (Original) The radioisotope generator of claim 1, further comprising a valve associated with the solid precursor isotope source.

4. (Original) The radioisotope generator of claim 1, further comprising a vacuum pump attached to the volume.

5. (Original) The radioisotope generator of claim 1, wherein the solid precursor isotope source comprises a porous material configured to retain the precursor isotope.

6. (Original) The radioisotope generator of claim 5, wherein the precursor isotope is absorbed, adsorbed, and/or encapsulated by the porous material.

7. (Original) The radioisotope generator of claim 1, wherein the precursor isotope comprises a thorium 228 isotope (^{228}Th) and/or a radium 224 isotope (^{224}Ra), the one or more gaseous progeny isotopes comprises a radon 220 isotope (^{220}Rn), and the one or more solid progeny isotopes comprises a lead 212 isotope (^{212}Pb).

8. (Original) The radioisotope generator of claim 1, wherein the collector surface is an interior surface of a container, and wherein the volume is an internal volume of the container.

9. (Original) The radioisotope generator of claim 8, wherein the solid precursor isotope source is configured to be connected to an opening of the container.

10. (Original) The radioisotope generator of claim 8, further comprising the container.

11. (Previously presented) The radioisotope generator of claim 10, wherein the container is configured to removably connect to the solid precursor isotope source.

12. (Original) The radioisotope generator of claim 10, further comprising a chelator disposed on the interior surface, the chelator configured to chelate the one or more solid progeny isotopes.

13. (Original) The radioisotope generator of claim 12, wherein the chelator comprises TCMC.

14. (Currently Amended) The radioisotope generator of claim [[1]] 10, wherein the volume is configured to receive a solvent configured to dissolve the one or more solid progeny isotopes from the interior surface.

15. (Original) The radioisotope generator of claim 1, wherein the radioisotope generator is configured to be converted from a first configuration in which the collector surface is not in fluid communication with the solid precursor isotope source, and a second configuration in which the collector surface is in fluid communication with the solid precursor isotope source.

16. (Original) A method of generating a progeny radioisotope, the method comprising:

allowing one or more gaseous progeny isotopes to emanate from a solid precursor isotope source, the solid precursor isotope source comprising a precursor isotope;

fluidly coupling a volume including a collector surface to the solid precursor isotope source using a gas tight seal; and

allowing one or more solid progeny isotopes of the one or more gaseous progeny isotopes to deposit on the collector surface.

17. (Original) The method of claim 16, further comprising flushing the collector surface.

18. (Original) The method of claim 16, wherein fluidly coupling the volume to the solid precursor isotope comprises opening a valve associated with the solid precursor isotope source.

19. (Original) The method of claim 16, further comprising drawing a vacuum in the volume.

20. (Original) The method of claim 16, wherein the solid precursor isotope source comprises a porous material configured to retain the precursor isotope.

21. (Original) The method of claim 20, wherein the precursor isotope is absorbed, adsorbed, and/or encapsulated by the porous material.

22. (Original) The method of claim 16, wherein the precursor isotope comprises a thorium 228 isotope (^{228}Th) and/or a radium 224 isotope (^{224}Ra), the one or more gaseous progeny isotopes comprises a radon 220 isotope (^{220}Rn), and the one or more solid progeny isotopes comprises a lead 212 isotope (^{212}Pb).

23. (Original) The method of claim 16, wherein the collector surface is an interior surface of a container, and wherein the volume is an internal volume of the container.

24. (Original) The method of claim 23, further comprising connecting the solid precursor isotope source to an opening of the container.

25. (Original) The method of claim 23, further comprising removably connecting the solid precursor isotope to the container.

26. (Original) The method of claim 23, further comprising chelating the one or more solid progeny isotopes using a chelator disposed on the interior surface.

27. (Original) The method of claim 26, wherein the chelator comprises TCMC.

28. (Original) The method of claim 23, further comprising receiving a solvent in the volume, and dissolving the one or more solid progeny isotopes from the interior surface in the solvent.

29. (Original) The method of claim 16, wherein fluidly coupling the volume to the solid precursor isotope source comprises converting a radioisotope generator from a first configuration in which the collector surface is not in fluid communication with the solid precursor isotope source to a second configuration in which the collector surface is in fluid communication with the solid precursor isotope source.

30. (Original) The method of claim 16, further comprising forming a radiopharmaceutical using the one or more solid progeny isotopes.

31. (Previously presented) The method of claim 18, further comprising closing the valve to isolate the volume from the solid precursor isotope source.

32. (Previously presented) The method of claim 16, wherein the solid precursor isotope is bound to a non-radioactive material.

33. (Previously presented) The method of claim 32, wherein the non-radioactive material is a ceramic.

34. (Previously presented) The method of claim 23, forming at least a portion of a single chamber with the solid precursor isotope source and the container.

35. (Previously presented) The radioisotope generator of claim 3, wherein the valve is configured to isolate the solid precursor isotope from the volume in a closed position.

36. (Previously presented) The radioisotope generator of claim 1, wherein the solid precursor isotope is bound to a non-radioactive material.

37. (Previously presented) The radioisotope generator of claim 36, wherein the non-radioactive material is a ceramic.

38. (Currently Amended) The radioisotope generator of claim [[1]] 10, wherein the solid precursor isotope source and the container form at least a portion of a single chamber when fluidly coupled.

REMARKS

The Specification has been amended to format the indicated text to be in the correct superscript arrangement as indicated in the as filed application and *which was incorrectly shown without superscript formatting in the published application*. The dependencies of claims 14 and 38 have been to address antecedent basis issues, reasons for these formality issues are provided below:

The dependency of claim 14 has been amended to provide proper antecedent basis for at least the phrase "interior surface".

The dependency of claim 38 has been amended to provide proper antecedent basis for at least the term "container".

No new matter has been added by any of the amendments made herein.

CONCLUSION

This application is believed to be in condition for allowance. If the Examiner believes, after this amendment, the application is not in condition for allowance, the Examiner is requested to call the undersigned at the telephone number indicated below to discuss any outstanding issues.

If this amendment is not considered timely filed and if a request for an extension of time is otherwise absent, Applicant hereby requests any necessary extension of time.

Applicant believes no fee is due with this Amendment. However, if a fee is due with this Amendment, please charge our Deposit Account No. 23/2825, under Docket No. A1389.70001US02 from which the undersigned is authorized to draw.

Dated: 1/27/25

Respectfully submitted,

By/John Harmon/_____
John S. Harmon, PhD, PE
Registration No.: 67,131
Jill L. Ryan
Registration No.: 81,655
WOLF, GREENFIELD & SACKS, P.C.
600 Atlantic Avenue
Boston, Massachusetts 02210-2206
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UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/680,605	**01/27/2025 05:11:29 PM Z ET**	**A1389.70001US02**

Title of Invention

PRODUCTION OF HIGHLY PURIFIED 212PB

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5167	FILED BY	Eileen MacKenzie
PATENT CENTER #	68937971	AUTHORIZED BY	John Harmon
CUSTOMER #	23628	FILING DATE	05/31/2024
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Roy H. Larsen

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 8543	**E20251QH12138258**	**Eileen MacKenzie**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2501	UTILITY ISSUE FEE	480.00	1	480.00
			TOTAL AMOUNT:	**$480.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	05/31/2024	Roy H. Larsen	A1389.70001US02	5167

23628 7590 02/10/2025

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

EXAMINER	
LUCK, SEAN M	

ART UNIT	PAPER NUMBER
2881	

NOTIFICATION DATE	DELIVERY MODE
02/10/2025	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

Patents_eOfficeAction@WolfGreenfield.com
WGS_eOfficeAction@WolfGreenfield.com

Response to Rule 312 Communication	Application No.	Applicant(s)	
	18/680,605	Larsen, Roy H.	
	Examiner	Art Unit	AIA (FITF) Status
	SEAN M LUCK	2881	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 27 January 2025 under 37 CFR 1.312 has been considered, and has been:

a) ☑ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

f) ☐ not entered because the supplemental or corrected Application Data sheet (ADS)

☐ was not accompanied by a petition to accept an unintentionally delayed claim under 37 CFR 1.55 or 27 CFR 1.78;

☐ did not identify the information being changed in accordance with 37 CFR 1.76(c)(2);

☐ was not properly signed in accordance with 37 CFR 1.76(e) (or 37 CFR 1.33(b) for applications filed prior to September 16, 2012).

/SEAN M LUCK/
Examiner, Art Unit 2881

OK TO ENTER: /S.M.L/

02/05/2025

Docket No.: A1389.70001US02
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Roy H. Larsen
Application No.:	18/680,605
Confirmation No.:	5167
Filed:	May 31, 2024
For:	PRODUCTION OF HIGHLY PURIFIED 212PB
Examiner:	S. M. Luck
Art Unit:	2881

Certificate of Electronic Filing under 37 C.F.R. § 1.8
I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office's electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4).

Dated: January 27, 2025 Electronic Signature for Eileen M. MacKenzie: / Eileen M. MacKenzie /

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. § 1.312

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

INTRODUCTORY COMMENTS

Prior to issuance of the patent, applicant respectfully requests entry of this amendment under 37 C.F.R. § 1.312 for the above-captioned patent application.

Amendments to the Specification begin on page 2 of this amendment.

Amendments to the Claims begin on page 3 of this amendment.

Remarks/Arguments begin on page 8 of this amendment.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/680,605	03/11/2025	12249437	A1389.70001US02	5167

23628 7590 02/19/2025

WOLF GREENFIELD & SACKS, P.C.
600 ATLANTIC AVENUE
BOSTON, MA 02210-2206

ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-888-217-9197.

The USPTO is implementing electronic patent issuance with a transition period, during which period the USPTO will mail a ceremonial paper copy of the electronic patent grant to the correspondence address of record. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Center (https://patentcenter.uspto.gov).

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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