**PCT** WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

**(51) International Patent Classification 5 :** G21G 1/00 — A1

**(11) International Publication Number:** WO 94/03905

**(43) International Publication Date:** 17 February 1994 (17.02.94)

**(21) International Application Number:** PCT/US93/01376

**(22) International Filing Date:** 19 February 1993 (19.02.93)

**(30) Priority data:**
923,690 4 August 1992 (04.08.92) US

**(71) Applicant:** TELANDER, William, L. [US/US]; 6540 Washington Street, Yountville, CA 94599 (US).

**(72) Inventor:** CHAMPION, Joe, E., Jr. ; 1869 Carignan Way, Yountville, CA 94599 (US).

**(74) Agents:** HOLMAN, John, Clarke et al.; Jacobson, Price, Holman & Stern, The Jenifer Building, 400 Seventh Street, N.W., Washington, DC 20004 (US).

**(81) Designated States:** AU, BB, BG, BR, CA, CZ, FI, HU, JP, KP, KR, LK, MG, MN, MW, NO, NZ, PL, RO, RU, SD, SK, UA, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).

**Published**
*With international search report.*

**(54) Title:** METHOD FOR TRANSMUTATION OF SELECT ISOTOPES OF INDIVIDUAL ELEMENTS FROM COMPOSITIONS CONTAINING SUCH

$$
\begin{aligned}
&(T_1)\quad {}_{80}Hg^{201} \rightarrow {}_{78}Pt^{197} + \alpha \rightarrow {}_{79}Au^{197} + \beta\\
&(T_2)\quad {}_{80}Hg^{199} \rightarrow {}_{78}Pt^{195} + \alpha\\
&(T_3)\quad {}_{47}Ag^{109} \rightarrow {}_{45}Rh^{105} + \alpha \rightarrow {}_{46}Pd^{105} + \beta \qquad (T)\\
&(T_4)\quad {}_{47}Ag^{107} \rightarrow {}_{45}Rh^{108} + \alpha\\
&(T_5)\quad {}_{27}Co^{60} \rightarrow {}_{25}Mn^{56} + \alpha \rightarrow {}_{26}Fe^{56} + \beta
\end{aligned}
$$

**(57) Abstract**

A method permitting the converting of a select isotope of certain predetermined elements to elements of lower mass and atomic number. More particularly, the method produces select isotopes of new elements such as transmutations (T). The isotope to be transmuted has a magnetic moment, it is provided along with a heat generator and a resonance generator to form a mixture. The mixture is heated and subjected to a resonant frequency unique to the nucleus of the isotope for a time sufficient for the isotope to undergo an alpha fission to a new element of lower mass and atomic number.

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

| | | | | | |
|---|---|---|---|---|---|
| **AT** | Austria | **FR** | France | **MR** | Mauritania |
| **AU** | Australia | **GA** | Gabon | **MW** | Malawi |
| **BB** | Barbados | **GB** | United Kingdom | **NE** | Niger |
| **BE** | Belgium | **GN** | Guinea | **NL** | Netherlands |
| **BF** | Burkina Faso | **GR** | Greece | **NO** | Norway |
| **BG** | Bulgaria | **HU** | Hungary | **NZ** | New Zealand |
| **BJ** | Benin | **IE** | Ireland | **PL** | Poland |
| **BR** | Brazil | **IT** | Italy | **PT** | Portugal |
| **BY** | Belarus | **JP** | Japan | **RO** | Romania |
| **CA** | Canada | **KP** | Democratic People's Republic of Korea | **RU** | Russian Federation |
| **CF** | Central African Republic | | | **SD** | Sudan |
| **CG** | Congo | **KR** | Republic of Korea | **SE** | Sweden |
| **CH** | Switzerland | **KZ** | Kazakhstan | **SI** | Slovenia |
| **CI** | Côte d'Ivoire | **LI** | Liechtenstein | **SK** | Slovak Republic |
| **CM** | Cameroon | **LK** | Sri Lanka | **SN** | Senegal |
| **CN** | China | **LU** | Luxembourg | **TD** | Chad |
| **CS** | Czechoslovakia | **LV** | Latvia | **TG** | Togo |
| **CZ** | Czech Republic | **MC** | Monaco | **UA** | Ukraine |
| **DE** | Germany | **MG** | Madagascar | **US** | United States of America |
| **DK** | Denmark | **ML** | Mali | **UZ** | Uzbekistan |
| **ES** | Spain | **MN** | Mongolia | **VN** | Viet Nam |
| **FI** | Finland | | | | |

# METHOD FOR TRANSMUTATION OF SELECT ISOTOPES OF INDIVIDUAL ELEMENTS FROM COMPOSITIONS CONTAINING SUCH

The method allows one to convert a select isotope of certain predetermined elements to elements of lower mass and atomic number. It more particularly refers to a novel technique for production of select isotopes of new elements such as the following transmutations (T):

$$(T_1)\quad {}_{80}Hg^{201} \rightarrow {}_{78}Pt^{197} + \alpha \rightarrow {}_{79}Au^{197} + \beta$$

$$(T_2)\quad {}_{80}Hg^{199} \rightarrow {}_{78}Pt^{195} + \alpha$$

$$(T_3)\quad {}_{47}Ag^{109} \rightarrow {}_{45}Rh^{105} + \alpha \rightarrow {}_{46}Pd^{105} + \beta$$

$$(T_4)\quad {}_{47}Ag^{107} \rightarrow {}_{45}Rh^{103} + \alpha$$

$$(T_5)\quad {}_{27}Co^{60} \rightarrow {}_{25}Mn^{56} + \alpha \rightarrow {}_{26}Fe^{56} + \beta$$

## BACKGROUND OF THE INVENTION

It is well known that throughout the Universe, transmutation occurs through various forms of nuclear reactions. These reactions can be generated from natural interstellar radiation sources, normal decay of unstable isotopes, or synthetic production of new isotopes by irradiation of stable and unstable isotopes using high energy accelerators. It is also understood in science that there are no absolutes in the way a nuclear reaction can occur, for a probability factor always exists. It is also well known that, even though theoretical postulations have been established, until now there has been no experimental proof of how the elements were

formed throughout the universe. It is certainly known that in geological deposits noble metals are associated with select minerals, the primary one being quartz.

In the past, many attempts have been made to transmute one element to another, such as mercury to gold. Despite such research effort toward this end, ecconomically attractive processes have not, to date, been found which have made their way into the commercial world. Thus, the potential to take a radioactive isotope and render it non-radioactive; take a non-radioactive isotope and convert it to a radioactive isotope; or convert a stable isotope to a stable isotope of another element, has not been viable until now.

Of course, it is well known that particle accelerators can cause select isotopes of certain elements to undergo a fission by the bombardment of neutral particles. This fission rate is a correlation of the thermal neutron cross section, in relationship with the speed and quantity of particles.

It is the object of this method to cause a transmutation of a starting isotope of the selected element to transform into a element of less mass. An essential criteria of this method is that the starting isotope has a magnetic moment. If the starting isotope does not have a magnetic moment it will not be susceptible to this method.

It is another object of this method to provide a means of transformation (transmutation) without the requirement of any radioactive stimulation to start the method.

Other and additional objects of this method will become apparent from the following disclosure the claims appended hereto.

## SUMMARY OF THE INVENTION

This method is based upon the discovered ability to selectively manipulate predetermined isotopes in a process that causes the starting isotope to undergo a transmutation to an isotope of a lesser mass and atomic number. A requirement for this transmutation to occur is the starting isotope must have a magnetic moment, thus having nuclear magnetic resonance qualities. Another requirement is that the reaction requires a heat generator which can be obtained from an endothermic or exothermic reaction. It is also required to have a resonance generator. In the preferred embodiment of the method the resonance generator is $SiO_2$, however other resonance generators can be substituted. In accordance with and fulfilling the above setforth requirements, this method takes advantage of the recent discovery that isotopes of elements having characteristic resonant components (magnetic moments), in a specified state, and has imposed upon them the heat generator and resonant generator, a transmutation will occur. This transmutation is preferably an alpha particle fission, but is not limited to this reaction, and even with the alpha particle fission there can also occur secondary and tertiary radioactive decays. For example:

$$_{80}Hg^{201} \rightarrow {}_{78}Pt^{197} + \alpha \rightarrow {}_{79}Au^{197} + \beta \qquad (T_1)$$

In this transmutation, the mercury$^{201}$ isotope's first transmutation is an alpha decay that ends with a platinum$^{197}$ isotope. Platinum$^{197}$ is a natural radioactive isotope which undergoes decay through a beta emission to gold$^{197}$. It is well known and accepted that gold has only one stable isotope in nature which is $Au^{197}$.

It has been discovered, and it is an important attribute of this method, that elements that have become radioactive by irradiation can be converted to isotopes of new elements that are no longer radioactive. To illustrate this point:

$$_{27}Co^{60} \rightarrow {}_{25}Mn^{56} + \alpha \rightarrow {}_{26}Fe^{56} + \beta \qquad (T_5)$$

Cobalt$^{60}$ is a radioactive isotope synthetically produced from $Co^{59}$

by irradiating $Co^{59}$ with neutrons. $Cobalt^{60}$ has many industrial and biomedical uses, but it has a half life of 5.275 years. $Cobalt^{60}$ meets the requirements of this method for it has an established magnetic moment. As shown in the example above, if $cobalt^{60}$ was processed to undergo an alpha decay it would be converted to $manganese^{56}$, which is also a radioactive isotope, but the half life of $manganese^{56}$ is only 65 seconds. $Manganese^{56}$ undergoes a natural decay by beta emission to $iron^{56}$. This particular isotope of iron is non-radioactive and is found in nature at an abundance of 0.28%. Many examples of conversion from radioactive isotopes exist and are applicable to this method.

## DETAILED DESCRIPTION OF THE INVENTION

The method can be substantially started at any ambient temperature and pressure. The method has been carried out at pressures of atmospheric, subatmospheric, and superatmospheric and temperatures starting from ambient to temperatures as high as 1500°C. Thus, the operating parameters of the method are a matter of choice on the part of the engineering process designer. It does appear, however, that there is an important relationship between the allotropic crystalline configurations of the molecular chemical compounds of the heat and resonance generators. It is also thought, that there is an important relationship between the magnetic properties of the susceptible transmutation isotopes. That is to say, the isotopes of the elements that have magnetic moments have properties that are unique to themselves. Because of this fact, the final chemical matrix will vary dependent upon the inter-relationship of resonance qualities of the elements (isotopes) within the total matrix. Also, there is an important relationship between the aggregate physical size of the chemical crystals and the metallic particles that make up the entire chemical matrix. Thus, it can be said that for a given temperature there must be proper crystalline configuration of the chemical molecules, and proper aggregate size

of the starting chemicals and elements, for transmutation to be achieved.

As stated above, there is a characteristic resonance unique to the starting isotope to be transmuted. According to this method, it is preferred that the strongest resonant generation be established by the introduction of $SiO_2$, generically known as quartz. This resonance is absorbed by the targeted isotope to be transmuted and the other isotopes within the chemical matrix that have like qualities. For example refer to the Table I where a correlation between certain of the isotopes can be seen.

TABLE 1

Resonance data for chemical fusion elements

| ISOTOPE | | | | NATURAL | MAGNETIC | |
|---|---|---|---|---|---|---|
| A | EL | I | NMR FREQ | ABUNDANCE | MOMENT | T N C S |
| 1 | H | 1 | 42.57590 | 99.99% | 2.79268 | 0.33 |
| 3 | Li | 6 | 6.26530 | 7.42% | 0.82192 | 0.00 |
| 3 | Li | 7 | 16.54600 | 92.58% | 3.25600 | 0.05 |
| 7 | N | 14 | 3.07560 | 99.63% | 0.40347 | 0.00 |
| 7 | N | 15 | 4.31420 | 0.37% | (0.28298) | 0.00 |
| 14 | Si | 29 | 8.45780 | 4.70% | (0.55477) | 0.13 |
| 16 | S | 33 | 3.26540 | 0.76% | 1.00000 | 0.46 |

TABLE I - CONTINUED

| A | EL | I | NMR FREQ | NATURAL ABUNDANCE | MAGNETIC MOMENT | T N C S |
|---|---|---|---|---|---|---|
| 17 | Cl | 35 | 4.17170 | 75.53% | 0.82091 | 43.70 |
| 17 | Cl | 37 | 3.47200 | 24.47% | 0.68330 | 10.00 |
| 19 | K | 39 | 1.95680 | 93.10% | 0.39097 | 2.10 |
| 19 | K | 41 | 1.09050 | 6.88% | 0.21459 | 1.46 |
| 26 | Fe | 57 | 1.37580 | 2.19% | 1.37580 | 2.50 |
| 48 | Cd | 111 | 9.02800 | 12.75% | (0.59220) | 2.40 |
| 48 | Cd | 113 | 9.44500 | 12.26% | (0.61950) | 2.06e+04 |
| 80 | Hg | 199 | 7.59012 | 16.84% | 0.49786 | 2,100.00 |
| 80 | Hg | 201 | 2.80990 | 13.22% | (0.55293) | 60.00 |
| 82 | Pb | 207 | 8.90771 | 22.60% | 0.58428 | 0.70 |

A = Atomic number; EL = Element; I = Isotope number;
NMR Freq. = Nuclear Magnetic Resonance Frequency stated in mHz;
T N C S = Thermal nuclear cross section

Table I shows the relationship of the nuclear magnetic resonance frequencies of the isotopes used in the preferred embodiments. There is a direct correlation between the starting magnetic resonance frequencies and the ending magnetic resonance frequencies in the production of precious metals. This relationship can be illustrated by the following Table II:

Table II

Resonance data for precious metal isotopes

| Isotope | | | | NATURAL | MAGNETIC | |
|---|---|---|---|---|---|---|
| A | EL | I | NMR FREQ | ABUNDANCE | MOMENT | T N C S |
| 44 | Ru | 99 | 1.96070 | 12.72% | (0.64300) | 4.00 |
| 44 | Ru | 101 | 2.19750 | 17.07% | 0.72070 | 5.00 |
| 45 | Rh | 103 | 1.34010 | 100.00% | 0.08790 | 11.00 |
| 46 | Pd | 105 | 1.95000 | 22.23% | 0.63900 | 22.20 |
| 47 | Ag | 107 | 1.72290 | 51.82% | (0.11301) | 36.00 |
| 47 | Ag | 109 | 1.98070 | 48.18% | (0.12992) | 87.00 |
| 76 | Os | 187 | 0.98059 | 1.64% | 0.06430 | 200.00 |
| 76 | Os | 189 | 3.30340 | 16.10% | 0.65004 | 40.00 |
| 77 | Ir | 191 | 0.73180 | 37.30% | 0.14400 | 650.00 |
| 77 | Ir | 193 | 0.79680 | 62.70% | 0.15680 | 105.00 |
| 78 | Pt | 195 | 9.15300 | 33.80% | 0.60040 | 28.00 |
| 79 | Au | 197 | 0.72919 | 100.00% | 0.14349 | 98.70 |

A = Atomic number; EL = Element; I = Isotope number;
NMR Freq. = Nuclear Magnetic Resonance Frequency stated in mHz;
T N C S = Thermal nuclear cross section

To simplify the relationship between the magnetic resonances of the starting chemical matrix and the ending transmuted precious metal isotopes, the following tables set forth the correlation.

**Table III**

Resonance Data for Group A:

| Isotope | NMR Frequency |
|---|---|
| $_{19}K^{41}$ | 1.09050 |
| $_{26}Fe^{57}$ | 1.37580 |
| $_{45}Rh^{103}$ | 1.34010 |
| $_{76}Os^{187}$ | 0.98059 |
| $_{77}Ir^{191}$ | 0.73180 |
| $_{77}Ir^{193}$ | 0.79680 |
| $_{79}Au^{197}$ | 0.72919 |

**Table IV**

Resonance Data for Group B:

| Isotope | NMR Frequency |
|---|---|
| $_{19}K^{39}$ | 1.95680 |
| $_{44}Ru^{99}$ | 1.96070 |
| $_{44}Ru^{101}$ | 2.19750 |
| $_{46}Pd^{105}$ | 1.95000 |
| $_{47}Ag^{107}$ | 1.72290 |
| $_{47}Ag^{109}$ | 1.98070 |

The imposition of the characteristic resonant frequency as denoted in Tables III and IV, show a direct relationship between the

resonant qualities of the starting chemical matrix and that of the ending precious metals. The resonance data of Tables III and IV, is exemplary of the two strongest characteristic resonant groups.

The physical size of the chemical compounds and the metallic elements has a direct relationship to the efficiency of the overall method. It is preferred that all compounds and elements be reduced to a physical size less than 200 mesh (sieve size). Also, it is important to have a totally homogeneous mixture, for it is necessary for all of the compounds and elements to be in intimate contact with each other.

Chemical compounds within the matrix can be substituted, such as replacement of all but the heat generator and the required starting isotopes to be transmuted, with a sulfide mineral that contains all of the qualities of the resonant generator.

It is also possible to substitute for the heat generator specific gases under pressure. Such gases act in place of the heat generator compounds when added to the resonance generator and transmutive isotopes. Preferred examples of such gases are:

$$CO_2 + H + N + O$$

## SPECIFIC EXAMPLES OF THE INVENTION

The following are specific examples of the practice of this method and will serve to illustrate it. These examples are not to be considered in any way as limiting the scope of this method but only as examplary of it. In these examples, chemicals and precentages are by weight unless specified to the contrary.

**Example 1**

HEAT GENERATOR

| | |
|---|---|
| $FeSO_4$ | 100 grams |
| S | 80 grams |
| C | 300 grams |
| $KNO_3$ | 900 grams |

RESONANCE GENERATOR

| | |
|---|---|
| $SiO_2$ | 120 grams |
| CaO | 30 grams |

Basic Metals

| | |
|---|---|
| Ag | 5 grams |
| HgCl | 100 grams |
| PbO | 50 grams |
| Cd | 30 grams |

A 2.0 liter stainless steel container was utilized, in which the above compounds and elements were physically reduced in size to less than 200 mesh and thoroughly homogenized by physical mixing. Next, the container, with the prepared chemical matrix within, was placed in a fume hood and ignited. The average time for total ignition was approximately 200 seconds.

After the thermal melt process, the residue was allowed to cool and then was removed from the original container. At this point, the reaction was complete and there was an observable presence of gold, platinum, palladium, and rhodium. These metals are then separated from the residue by any one of many standard accepted metallurgical processes.

Another example of the method is as follows:

**Example 2**

HEAT GENERATOR

| | |
|---|---|
| C | 300 grams |
| $KNO_3$ | 900 grams |

RESONANCE GENERATOR

| | |
|---|---|
| Mineral[1] | 120 grams |

Basic Metals

| | |
|---|---|
| HgCl | 100 grams |
| PbO | 50 grams |

[1]Mineral can be any sulfide compound containing >30% natural quartz having a sufficient native Ag content to permit transmutation to rhodium.

In accordance with Example 1 a 2.0 liter stainless steel container was utilized, in which the above chemicals and elements were physically reduced in size to less than 200 mesh, and thoroughly homogenized by physical mixing. Next, the container, with the prepared chemical matrix within, was placed in a fume hood and ignited. The average time for total ignition was approximately 90 seconds.

After the thermal melt process, the residue was allowed to cool and then removed from the original container. At this point, the reaction was complete and there was an observable presence of gold, platinum, palladium, and rhodium. These metals are then separated from the residue by any one of many standard accepted metallurgical processes.

## CLAIMS

Claim 1. A method of transmutating isotopes of elements from a mixture containing such elements comprising the steps of:

providing the isotope to be transmuted, which isotope has a magnetic moment; further providing a heat generator and a resonance generator and forming a mixture; subjecting said mixture to heat and a resonant frequency unique to the nucleus of the isotope for a time sufficient for the isotope to undergo an alpha fission to a new element of lower mass and atomic number.

Claim 2. The method as claimed in claim 1 wherein said heat generator is composed of one or more members selected from the group consisting of $FeSO_4$,S,C, or $KNO_3$.

Claim 3. The method as claimed in claim 1 wherein said resonance generator is composed of one or more members selected from the group consisting of $SiO_2$, CaO or any sulfide compound containing more than 30% natural quartz.

Claim 4. The method as claimed in claim 1 comprising the further step of physically reducing the particle size of said mixture to less than 200 mesh and homogenizing said mixture.

Claim 5. The method as claimed in claim 1 wherein the heat and unique resonant frequency is provided by the mixture.

Claim 6. The method as claimed in claim 1 wherein the heat generator is composed of one or more gases selected from the group consisting of $CO_2$,H,N, or O.

Claim 7. The method as claimed in claim 1 wherein multiple transmutations occur during the method.

Claim 8. The method as claimed in claim 1 wherein the isotope is mercury$^{201}$ and the transmutation is $_{80}Hg^{201}\text{--->}_{78}Pt^{197}+ \alpha$.

Claim 9. The method as claimed in claim 7 wherein the isotope is mercury$^{201}$ and the transmutations are:

$$_{80}Hg^{201}\text{--->}_{78}Pt^{197}+ \alpha\text{--->}_{79}Au^{197}+ \beta.$$

Claim 10. The method as claimed in claim 1 wherein the isotope is silver$^{107}$ and the transmutation is: $_{47}Ag^{107}\text{--->}_{45}Rh^{103}+ \alpha$.

Claim 11. The method as claimed in claim 10 wherein the isotope is silver$^{107}$ and the transmutations are: $_{47}Ag^{109}\text{--->}_{45}Rh^{105} + \alpha \text{ --> } _{46}Pd^{105} + \beta$.

Claim 12. The method as claimed in claim 1 wherein the starting isotope is radioactive and the new element is a stable isotope.

Claim 13. The method as claimed in claim 12 wherein the starting isotope is cobalt$^{60}$ and the transmutations are:

$$_{27}Co^{60}\text{--->}_{25}Mn^{56}+ \alpha \text{ --->}_{26}Fe^{56} + \beta.$$

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/01376

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(5) :G21G 1/00
US CL :376/156

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 149/72,87,108.2;252/629

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

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

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| L | Physics Letters, vol. 101A, No. 1, 05 March 1984, pages 58-60, Becker et al. (cited as alpha emission from a nucleus). | 1-13 |
| L | JETP Lett., vol. 39, No. 6, 25 March 1984, pages 338-341, Akhmeder. (cited as casting doubt on the ability to cause alpha emission form a nucleus). | 1-13 |
| X | US,A, 4,224,177 (Macedo et al.) 23 September 1980, (see col. 2,4,6,8,10). | 1,3,5,6,7, 12,13 |
| X | US,A 4,659,477 (Macedo et al.) 21 April 1987, (see col. 5,8,13,14,21). | 1-5,7-13 |

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

| | | | |
|---|---|---|---|
| * | Special categories of cited documents: | "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
| "A" | document defining the general state of the art which is not considered to be part of particular relevance | "X" | document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| "E" | earlier document published on or after the international filing date | "Y" | document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "L" | document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "&" | document member of the same patent family |
| "O" | document referring to an oral disclosure, use, exhibition or other means | | |
| "P" | document published prior to the international filing date but later than the priority date claimed | | |

| | |
|---|---|
| Date of the actual completion of the international search<br>19 MAY 1993 | Date of mailing of the international search report<br>29 JUN 1993 |
| Name and mailing address of the ISA/US<br>Commissioner of Patents and Trademarks<br>Box PCT<br>Washington, D.C. 20231<br>Facsimile No. NOT APPLICABLE | Authorized officer<br>Nguyen Ngoc-Ho<br>for HARVEY E. BEHREND NGUYEN NGOC-HO<br>INTERNATIONAL DIVISION<br>Telephone No. (703) 308-0439 |

Form PCT/ISA/210 (second sheet)(July 1992)*

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/01376

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US,A, 4,544,499 (Tran et al.) 01 October 1985, (see col. 2,11,12,13,14,15,17). | 1-7,12,13 |
| X | US,A, 4,514,329 (Wakabayashi et al.) 30 April 1985, (see col. 5,6). | 1,3,5,7,12, 13 |
| X | US,A, 4,469,628 (Simmons et al) 04 September 1984 (see cols. 6,7,9,11,15,17,21,27). | 1-9,12,13 |
| X | US,A, 4,547,235 (Schneiter et al.) 15 October 1985, (see col. 1,4). | 1-7 |
| X | US,A, 2,823,105 (Stevenson et al.) 11 February 1958, (see col. 2,4). | 1-3,5,7 |
| X | US,A, 3,944,448 (Marlowe et al.) 16 March 1976, (see the abstract and col. 5). | 1-3,5,7 |
| X | US,A, 3,329,068 (Knowles et al.) 09 July 1968, (see cols. 1-3). | 1-5,7 |
| X | US,A, H169 (Mackenzie et al.) 02 December 1986, (see the abstract). | 1-5,7 |
| Y | US,A, 1,424,204 (Motte) 01 August 1922, (see col. 1). | 8,9 |
| Y | US,A, 2,927,849 (Greblick et al.) 08 March 1960, (see col. 2,4). | 10,11 |

# INTERNATIONAL SEARCH REPORT

rnational application No.
PCT/US93/01376

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:
(Telephone Practice)
Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/01376

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

There is lack of unity under PCT Rule 13 because to the following independent and distinct species:

Group I. The embodiment wherein the isotope is mercury-201 and the least generator is one or more of $FeSo_4$, C, or $KNo_3$ (claims 1-5,7-9).

Group II. The embodiment wherein the isotope is mercury-201 and the heat generator is gaseous (claims 1,3-9).

Group III. The embodiment wherein the isotope is silver-107 and the heat generator is one or more of $FeSo_4$,S,C, or $KNo_3$ (claims 1-5,7,10,11).

Group IV. The embodiment wherein the isotope is silver-107 and the heat generator is gaseous (claims 1,3-7,10,11).

Group V. The embodiment wherein the isotope is radioactive and the heat generator is one or more $FeSo_4$,S,C, or $KNo_3$ (claims 1-5,7,12,13).

Group VI. The embodiment wherein the isotope is radioactive and the heat generator is gaseous (claims 1,3-7,12,13)