(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 June 2005 (23.06.2005)

PCT

(10) International Publication Number
WO 2005/056471 A1

(51) International Patent Classification[7]: C01B 13/02, B01J 7/02, A62B 21/00

(21) International Application Number: PCT/US2004/010122

(22) International Filing Date: 31 March 2004 (31.03.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/718,131 20 November 2003 (20.11.2003) US

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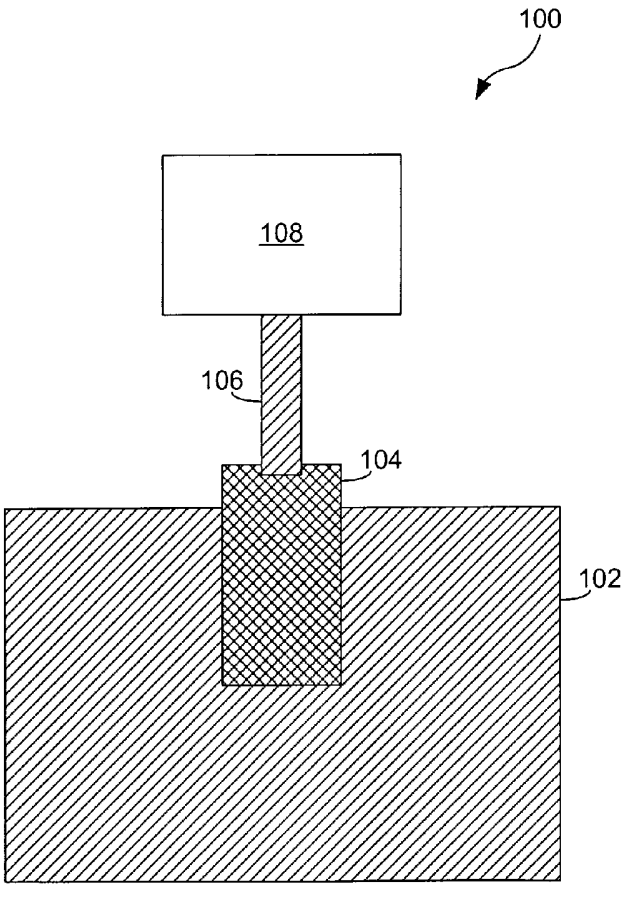
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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR,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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR,

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR GENERATING OXYGEN



(57) Abstract: A method and apparatus are provided for generating Oxygen. Water-soluble chemicals are mixed in water, and the result is medically pure Oxygen. The water-soluble chemicals have long shelf-lives and are non-toxic, not an environmental hazard, not a fire hazard, and not an explosive hazard. Once the reaction is complete, the remaining waste solution can be disposed of in a conventional waste disposal system with no adverse affects. All of these attributes contribute to a safe, compact, and easily usable Oxygen generation system.

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GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND APPARATUS FOR GENERATING OXYGEN

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates generally to oxygen generation and, more particularly, to robust oxygen generation from a solid or liquid.

Description of the Related Art

Highly pure oxygen gas is used within a variety of applications. More particularly, medical devices use highly pure oxygen for patient care. However, production or generation, transportation, delivering, usage and storage of oxygen can be both cumbersome and dangerous.

Typical devices today utilize a variety of means to store and produce oxygen. Far and above, the most common apparatus is a compressed gas tank. The compressed gas tank, though, is heavy, requires a regulator, and can be quite dangerous. Oxygen is a very reactive element that can be explosive. Therefore, compressed tanks of pure Oxygen gas can pose a very realistic fire or explosive hazard.

There are a variety of other Oxygen generation devices that utilize chemical reactions. For example, Oxygen generation canisters are used in passenger aircraft for supplying Oxygen to passengers if the aircraft depressurizes. These canisters, though, can be very unstable devices, especially once the canisters have been deemed to have outlived their respective

shelf-lives. In addition, these canisters typically require a spark to initiate the chemical reaction.

Moreover, with both compressed gas and chemical generators, each type typically requires metal containers and safety equipment. These metal containers are highly subjected to corrosion, which could render the container useless. These metal containers may also require ongoing maintenance, and have moving parts. Also, utilization of metal containers can be quite heavy. As a consequence, they can limit the range of applications for usage, or they may not be well-suited to a broad range of applications.

Therefore, there is a need for a method and/or apparatus for generating Oxygen that is more robust and less hazardous and that addresses at least some of the problems associated with conventional methods and apparatuses for producing or generating, transporting, using, delivering or storing Oxygen.

SUMMARY OF THE INVENTION

The present invention provides an apparatus for generating Oxygen. The apparatus comprises a vessel. Also, the apparatus comprises an aqueous, Oxygen producing solution contained in the vessel, wherein the resulting waste solution is at least configured to be non-toxic and wherein the resulting waste solution is at least configured to not be an environmental hazard.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a block diagram depicting an Oxygen generator;

FIGURE 2 is a flow chart depicting a first method of producing Oxygen;

FIGURE 3 is a flow chart depicting a second method of producing Oxygen; and

FIGURE 4 is a flow chart depicting a third method of producing Oxygen.

DETAILED DESCRIPTION

In the following discussion, numerous specific details are set forth to provide a thorough understanding of the present invention. However, those skilled in the art will appreciate that the present invention may be practiced without such specific details. In other instances, well-known elements have been illustrated in schematic or block diagram form in order not to obscure the present invention in unnecessary detail. Additionally, for the most part, details concerning mechanical connections, simple inorganic chemistry, and the like, have been omitted inasmuch as such details are not considered necessary to obtain a complete understanding of the present invention, and

are considered to be within the understanding of persons of ordinary skill in the relevant art.

Referring to FIGURE 1 of the drawings, the reference numeral 100 generally designates an Oxygen generator. The Oxygen generator comprises a vessel 102, a humidifier 104, output line 106, and a usage device 108.

The vessel 102 contains the compartment where a chemical reaction that produces the Oxygen takes place. The vessel 102 can be composed of a variety of materials. For example, the vessel can be composed of polypropylene. However, the Oxygen generator 100 only requires that the vessel 102 be composed of a material that can withstand, or which has a conductivity to withstand, the heat generated inside the vessel 102 during the chemical reaction. Typically, the walls of the vessel can vary in thickness. However, the Oxygen generator 100 only requires that the walls of the vessel 102 have a thickness that can withstand the internal pressures that result from aqueous solutions and gas pressure.

The oxygen generated within the vessel 102 is a result of a chemical reaction. The chemical reaction takes place in an aqueous environment so, that upon complete depletion of a limiting reactant, the remaining waste solution can be discarded into conventional waste disposal systems. The waste solution is also not an environmental hazard as defined by generally accepted systems for measuring material properties, such as the Environmental Protection Agency's (EPA) Risk Screening

Environmental Indicators Model. For example, the waste solution can be soda ash dissolved in water.

In order to achieve the desired Oxygen generation and environmental acceptability, there are several chemicals that can be utilized. The limiting reactant should be a water-soluble powder or liquid that is non-toxic, not an environmental hazard, not an explosive, not a fire hazard, and have a long shelf-life. Non-toxic, not a fire hazard, and not an explosive can be defined as compounds that are not deemed to be, respectively, non-toxic, a fire hazard, or an explosive, by a generally accepted system for measuring material properties, such as the Hazardous Materials Information System (HMIS). Also, a long shelf-life can be defined as a material that can be stored for an indefinite period of time when stored below the standard temperature of 86° Fahrenheit (F). For example, Sodium Percarbonate ($2Na_2CO_3 \bullet 3H_2O_2$) powder can be an acceptable material that can be dissolved in water. The resulting waste liquid from using Sodium Percarbonate ($2Na_2CO_3 \bullet 3H_2O_2$) in an Oxygen generation reaction is an aqueous solution of Soda Ash. There are also a variety of other chemicals that can be used as the limiting reactant, such as Sodium Perborate ($NaBHO_3$).

These powders or liquids, though, can also require the use of a catalyst. The catalysts, too, should be water-soluble, non-toxic, not an environmental hazard, not an explosive, not a fire hazard, and have a long shelf-life. Typically, a metal-

based catalyst can be used to initiate the chemical reaction, combined with a hydrated salt to absorb the heat generated during the reaction. For example, a combination of a Manganese compound and a Sodium-based compound or similar hydrated salt can be used. There are also a variety of catalysts that can be used, such as compounds containing Iron or Iron Oxides and Copper or Copper Oxides.

Intuitively, the flow rate from the generators can be varied. Depending on the amount of the limiting reactant and the amount of the catalyst, the flow rate varies. Generation of Oxygen could occur continuously or for predetermined periods of time depending on the amount of the limiting reactant and the catalyst.

Once a limiting reactant and, possibly, a catalyst have been added to water contained within the vessel 102, then a humidifier 104 allows for the humidification and/or cooling of Oxygen generated within the vessel 102. Typically, the humidifier 104 humidifies, or adds water vapor, to the volume of Oxygen gas being generated. The various configurations of the humidifier can also vary the amount of humidity that can be added to the flow of Oxygen. For example, the humidifier 104 can be configured for use by an individual where the relative humidity of the Oxygen gas is 65%. The humidifier can have a variety of configurations that can also vary the temperature of the Oxygen out of the vessel 102.

Attached to the humidifier 104 is a carrying tube 106. The carrying tube carries to a usage device 108. The tube may be a variety of configurations. For example, the carrying tube can be standard medical tubing. Also, the carrying tube can be omitted in order to provide Oxygen to a room or compartment. The usage device can also be a variety of configurations. For example, the usage device can be a standard medical breathing mask.

Referring to FIGURE 2 of the drawings, the reference numeral 200 generally designates a flow chart depicting a first method of producing oxygen.

Steps 202, 204, 206, and 208 provide a first method for generating Oxygen that utilizes the Oxygen generator of FIGURE 1. In step 202, water is added to the vessel 102 of FIG. 1. In step 204, the limiting reactant powder is added to the water and dissolved. In step 206, the catalyst, if any, is added to the aqueous solution containing the limiting reactant. In step 208, the vessel 102 of FIG. 1 is sealed. The Oxygen generated from the Oxygen generator of FIG. 1 can then be used for a variety of purposes.

Referring to FIGURE 3 of the drawings, the reference numeral 300 generally designates a flow chart depicting a second method of producing oxygen.

Steps 302, 304, and 306 provide a second method for generating Oxygen that utilizes the Oxygen generator of FIGURE 1. In step 302, water is added to the vessel 102 of FIG. 1. In

step 304, the limiting reactant powder and the catalyst, if any, are simultaneously added to the water. In step 306, the vessel 102 of FIG. 1 is sealed. The Oxygen generated from the Oxygen generator of FIG. 1 can then be used for a variety of purposes.

Referring to FIGURE 4 of the drawings, the reference numeral 400 generally designates a flow chart depicting a third method of producing oxygen.

Steps 402, 404, and 406 provide a third method for generating Oxygen that utilizes the Oxygen generator of FIGURE 1. In step 402, a liquid limiting reactant dissolved in water is added to the vessel 102 of FIG. 1. In step 404, the catalyst, if any, is added to the liquid limiting reactant. In step 406, the vessel 102 of FIG. 1 is sealed. The Oxygen generated from the Oxygen generator of FIG. 1 can then be used for a variety of purposes.

It will further be understood from the foregoing description that various modifications and changes may be made in the preferred embodiment of the present invention without departing from its true spirit. This description is intended for purposes of illustration only and should not be construed in a limiting sense. The scope of this invention should be limited only by the language of the following claims.

CLAIMS

1. An apparatus for generating Oxygen, characterized by:

a vessel (102); and

an aqueous, Oxygen producing solution contained in the vessel (102), wherein a resulting waste solution is at least non-toxic and wherein the resulting waste solution is at least not an environmental hazard.

2. The apparatus of Claim 1, wherein the aqueous, Oxygen producing solution is further characterized by a reactant selected from the group consisting of Sodium Percarbonate ($2Na_2CO_3 \bullet 3H_2O_2$) and Sodium Perborate ($NaBHO_3$) dissolved in water.

3. The apparatus of Claims 1 or 2, wherein the aqueous, Oxygen producing solution is further characterized by a water-soluble catalyst, wherein the water-soluble catalyst is at least non-toxic, at least not an environmental hazard, at least not an explosive hazard, at least not a fire hazard, and at least having a long shelf-life.

4. The apparatus of Claim 1, wherein the aqueous, Oxygen producing solution is further characterized by a catalyst of Manganese Dioxide (MnO_2) and Sodium Carbonate (Na_2CO_3).

5. The apparatus of Claim 3, wherein the water-soluble catalyst is further characterized by a mixture of Manganese Dioxide (MnO_2) and Sodium Carbonate (Na_2CO_3).

6. The apparatus of Claim 1, wherein the aqueous, Oxygen producing solution is further characterized by a catalyst of metal oxide.

7. The apparatus of Claims 3, wherein the water-soluble catalyst is further characterized by a metal oxide.

8. The apparatus of Claim 1, wherein the apparatus is further characterized by a humidifier (104) at least configured to be coupled to the vessel (102).

9. The apparatus of Claim 8, wherein the apparatus is further characterized by a carrier tube (106) at least configured to be attached the humidifier (104).

10. A method for operating an Oxygen producing generator, characterized by steps of:

filling a vessel with water (202, 302, 402);

dissolving a water-soluble powder or liquid at least used as a Oxygen producing reactant, wherein the water-soluble powder is at least non-toxic, at least not an environmental hazard, at

least not an explosive hazard, at least not a fire hazard, and at least having a long shelf-life (204, 304, 402).

11. The method of Claim 10, wherein the method is further characterized by steps of:

dissolving a water-soluble catalyst after the water-soluble powder is dissolved, wherein the water-soluble powder is at least non-toxic, at least not an environmental hazard, at least not an explosive hazard, at least not a fire hazard, and at least having a long shelf-life (206, 304, 404).

12. The method of Claim 10, wherein the method is further characterized by steps of:

dissolving a water-soluble catalyst simultaneously with the water-soluble powder, wherein the water-soluble powder is at least non-toxic, at least not an environmental hazard, at least configured not an explosive hazard, at least not a fire hazard, and at least having long shelf-life (206, 304, 404).

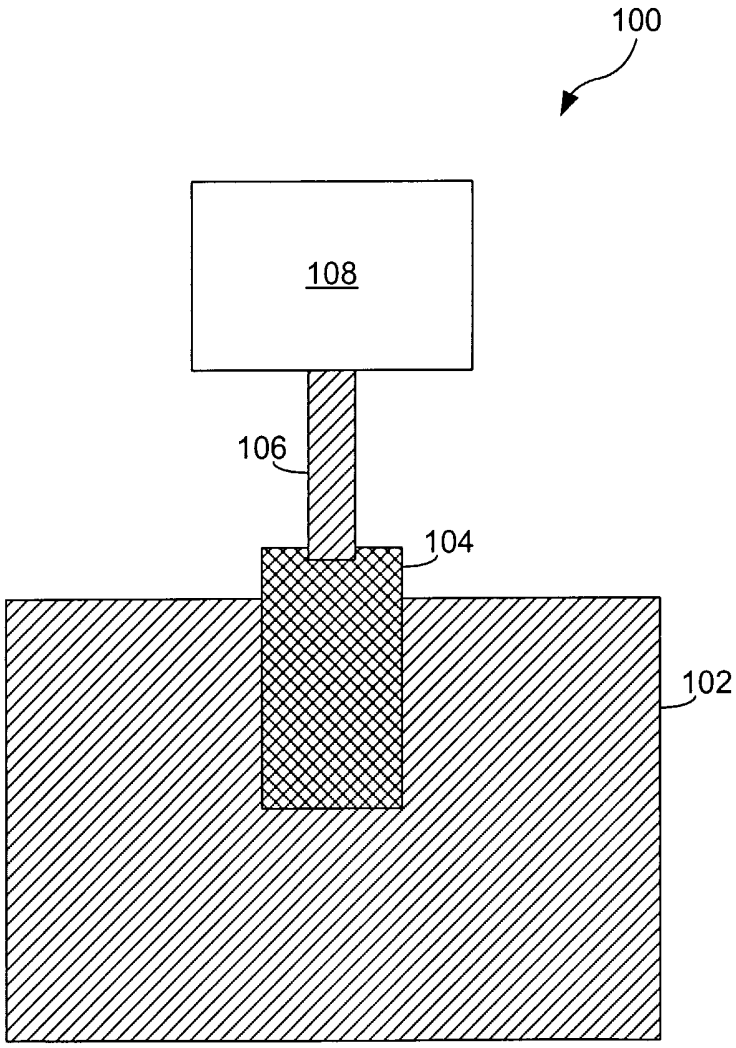


FIG. 1

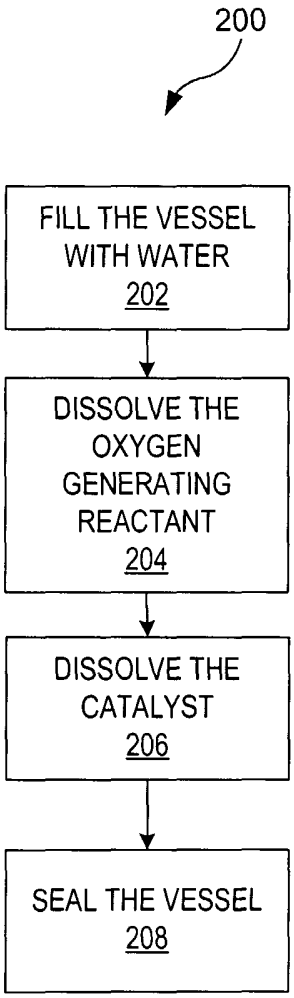


FIG. 2

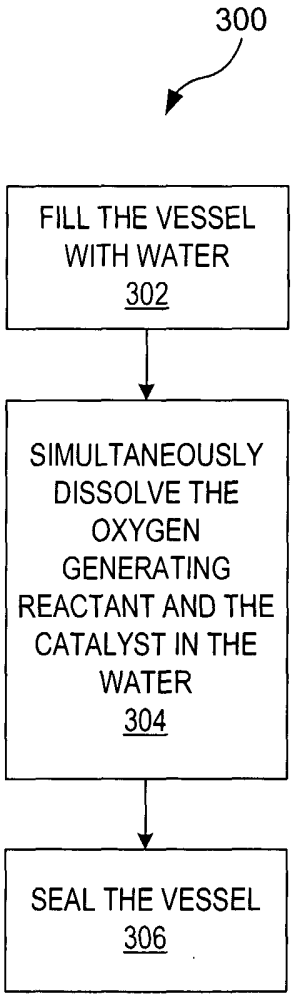


FIG. 3

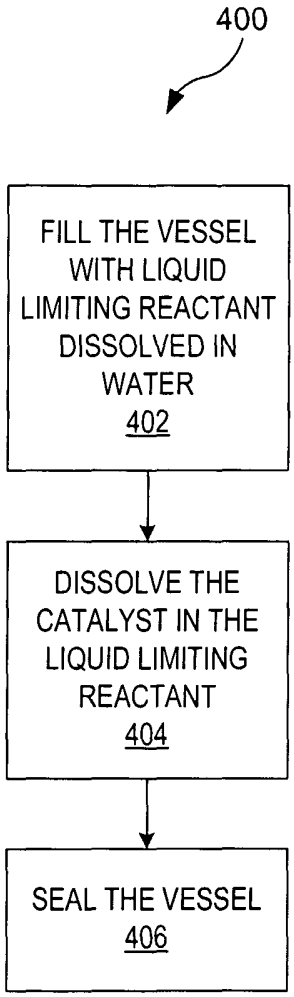


FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/010122

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C01B13/02 B01J7/02 A62B21/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C01B B01J A62B

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

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 86/02063 A (CAPRARA MARIO) 10 April 1986 (1986-04-10) page 1, line 5 - page 7, line 19	1-12
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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 September 2004	06/10/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Besana, S

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2004/010122

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

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

2. ☒ Claims Nos.: -
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

see FURTHER INFORMATION sheet PCT/ISA/210

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 III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying 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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: -

The initial phase of the search revealed a very large number of documents relevant to the issue of novelty. So many documents were retrieved that it is impossible to determine which parts of the claims may be said to define subject-matter for which protection might legitimately be sought (Article 6 PCT). For these reasons, a meaningful search over the whole breadth of the claims is impossible.
Consequently, the search has been restricted to an apparatus for generating oxygen comprising a vessel, an aqueous reactant selected form the group consisting of sodium percarbonate and sodium perborate and a catalyst selected form the group consisting of manganese dioxide and sodium carbonate (i.e. the combination of features of claims 1, 2 and 4) and further to a method for operating the apparatus with the above restrictions (claims 10-12).

Moreover, present claims 1, 3 and 10-12 relate to a product defined by reference to a desirable characteristic, namely that
(i) the resulting waste solution is at least non-toxic and not an enviromental hazard (claim 1) or that
(ii) the catalyst is at least non-toxic, not an enviromental hazard, not an explosive hazard, not a fire hazard and has a long shelf-life (claim 3) or that
(iii) the water-soluble powder is at least non-toxic, not an enviromental hazard, not an explosive hazard, not a fire hazard and has a long shelf-life (claims 10-12).
The claims cover all products having this characteristic or property, whereas the application provides support within the meaning of Article 6 PCT and/or disclosure within the meaning of Article 5 PCT for only a very limited number of such products, namely for sodium percarbonate or sodium perborate as water-soluble powders (iii) and manganese dioxide or sodium carbonate as catalyst (ii).
Independent of the above reasoning, the claims also lack clarity (Article 6 PCT): an attempt is made to define the product by reference to a result to be achieved. Again, this lack of clarity in the present case is such as to render a meaningful search over the whole of the claimed scope impossible.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US2004/010122

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