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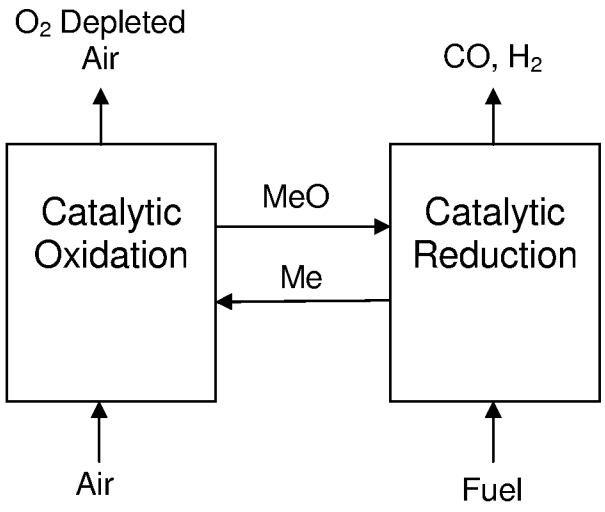
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(54) Title: CYCLIC CATALYTIC UPGRADING OF CHEMICAL SPECIES USING METAL OXIDE MATERIALS



(57) Abstract: Processes are disclosure which comprise alternately contacting an oxygen-carrying catalyst with a reducing substance, or a lower partial pressure of an oxidizing gas, and then with the oxidizing gas or a higher partial pressure of the oxidizing gas, whereby the catalyst is alternately reduced and then regenerated to an oxygenated state. In certain embodiments, the oxygen-carrying catalyst comprises at least one metal oxide-containing material containing a composition having one of the following formulas: (a) CexByB'zB"Od, wherein B = Ba, Sr, Ca, or Zr; B' = Mn, Co, or Fe; B"= Cu; 0.01< x <0.99; 0< y <0.6; 0< z <0.5; and 1 < δ <2.2; (b) SrvLawBxB'yB"zOd, wherein B = Co or Fe; B' = Al or Ga; B" = Cu; 0.01< v <1.4; 0.1< w <1.6; 0.1< x <1.9; 0.1< y <0.9; 0< z <2.2; and 3< δ <5.5).

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US07/79165

A. CLASSIFICATION OF SUBJECT MATTER

IPC: **B01D 53/02**(2006.01),**59/26**(2006.01),**53/56**(2006.01),**53/86**(2006.01);**C07C 1/02**(2006.01);**C01B 3/24**(2006.01);**B01J 20/34**(2006.01)

USPC: 95/138;252/373;423/213.2,219,650;502/39,51, 52, 53

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. : U.S.: 95/138;252/373;423/213.2, 219, 418.2, 648.1, 650;502/39,51, 52, 53

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)
EAST - search terms: oxidation, hydrocarbon, oxide, brownmillerite, perovskite,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 6,143,203 (ZENG et al) 07 Nov 2000 (07.11.2000), column 2, lines 1-67.	1-6, 10-12, 15, 18, 25-28 --- 8, 9, 13, 14, 19, 20, 21, 30, 31
Y	US 6,641,626 (VAN CALCAR et al) 04 Nov 2003 (04.11.2003), column 2, line 62 - column 3, line 30), column 7, lines 25-34), claim 1, 10.	8, 9, 13, 14, 19, 20, 21, 30, 31
A	US 5,714,091 (MAZANEC et al) 03 Feb 1998 (03.02.1998), column 6, lines 20-36), claims 1-3, 6.	1-6, 10-12, 15, 18, 20, 25-28, 30, 31
A	US 6,066,307 (KESKAR et al) 23 May 2000 (23.05.2000), claim 1, Table I.	1-5, 10-12, 15, 18, 25-28, 30, 31

☒ Further documents are listed in the continuation of Box C. ☐ See patent family 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 application or patent 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 disdosure, 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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US07/79165

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

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

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

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

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: 1-6,8-15,18-21,25-28,30 and 31

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

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US07/79165

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,124,697 (WHELAN) 07 Nov 1978 (07.11.1978), claim 1.	1-6, 12, 15, 25-28, 30, 31
A	US 2003/0198582 (GOLDEN) 23 Oct 2003 (23.10.2003), claims 1-4, paragraph 78.	1-6, 10-12, 15, 18, 25-28, 30, 31
A	US 6,747,066 (WANG et al) 8 June 2004 (08.06.2004)	1-5, 10-12, 15, 25-28, 30, 31

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US07/79165

BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

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

Group I, claim(s) 1-21, 25-28, 30 and 31, drawn to a process for alternatively reducing and oxidizing an oxygen carrying catalyst.

Group II, claim(s) 22-24, drawn to a process for separating oxygen from air through adsorption.

Group III, claim(s) 29, drawn to the generation of hydrogen peroxide.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Unity exists only when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding claimed technical features. The express "special technical features" is defined as meaning those technical features that define a contribution which each of the inventions, considered as a whole, makes over the prior art."(Rule 13.2). The question of unity of invention has been reconsidered retroactively by the examiner in view of the search performed; a review of Van Calcar, et al. (US 6,641,626) appears to demonstrate that the technical feature, i.e. alternately oxidizing and reducing a catalyst, does not define a contribution which each of the inventions, considered as a whole, makes over the prior art. US '626 teaches a process where an oxygen-selective mixed conductor of the composition $La_xSr_{2-x}B_yB'_{2-y}O_{5+z}$ is used to oxidize a gas. (claim 1) B or B' may be Al and Fe, respectively (claims 9 and 10) The additional oxidizing step for regenerating the oxide composition in the common technical feature is not expected to define a contribution over the prior art, since regeneration is well known in the art and would inherently involve re-oxidizing the oxide back to its original state. Groups I and II share a common oxygen-carrying catalyst composition, but that feature is also not expected to make a contribution over the prior art. Thus, lack of unity becomes apparent "a posteriori" after taking the prior art into consideration.

This application contains claims directed to more than one species of the generic invention. These species are deemed to lack unity of invention because they are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In order for more than one species to be examined, the appropriate additional examination fees must be paid. The species are as follows:

In Group I, species (a)-(h), as denoted by claim 1 of the application.
In Group II, species (a) and (b), as denoted by claim 1 of the application.

The claims are deemed to correspond to the species listed above in the following manner:

Note that some claims contain more than one species, of which only the elected portion will be examined.
Group I:
(a) 6, 18, 20
(b) 6, 8, 9, 13, 14, 18-21
(c) 6, 7
(d) 6
(e) 18
(f) 16, 17
(g) 16, 17
(h) 16, 17

Group II:
(a) 22-24
(b) 22-24

The following claim(s) are generic: 1, 22.

The species listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, the species lack the same or corresponding special technical features for the following reasons:

Lack of unity of invention may be directly evident "a priori" if before considering the claims in relation to prior art, they do not share a common technical feature. In the case of a species election, it is understood that they share a genus as a common feature. However, the further limitations (species) are imposed in order to make a contribution over prior art. If these species do not share a common technical feature, then they lack unity.
In this case, the species are all different oxygen-carrying compositions that are mutually exclusive and do not overlap in scope, at least in a significant way.