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61/439,571 4 February 2011 (04.02.2011) US(71) Applicant (for all designated States except US): **CLIMAX MOLYBDENUM COMPANY** [US/US]; 333 North Central Avenue, Phoenix, Arizona 85004 (US).

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(54) Title: MOLYBDENUM DISULFIDE POWDERS AND METHODS AND APPARATUS FOR PRODUCING THE SAME

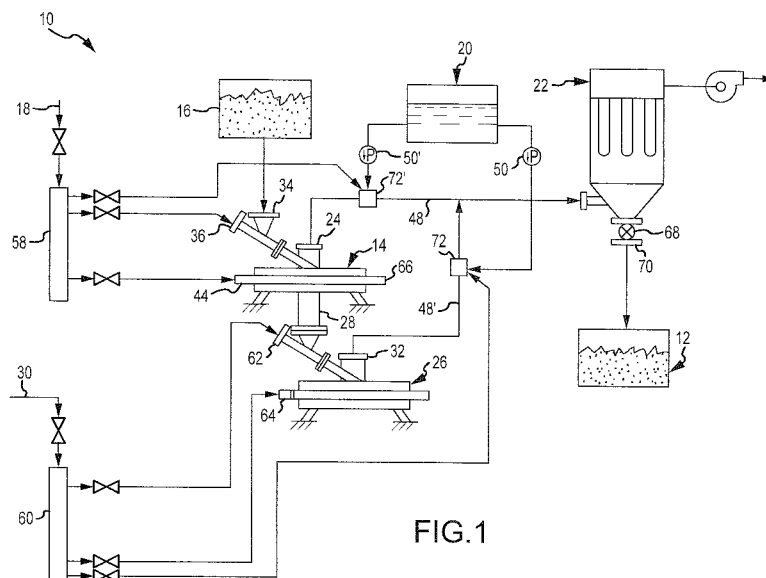


FIG. 1

(57) Abstract: A molybdenum disulfide powder product produced by jet milling a molybdenum disulfide precursor material and substantially continuously combining newly sized-reduced particles with oil to produce said molybdenum disulfide powder product, said molybdenum disulfide powder product having a D50 particle size of less than 4 μm and an acid number that is less than about 0.5 mg KOH/g. A method for producing powder product includes the steps of: Providing a supply of a precursor powder material; accelerating particles of the precursor powder material by combining them with a flow of gas; confining the accelerated particles in a milling chamber so that they collide with one another to effect a size reduction; and coating newly exposed surfaces of size-reduced particles with oil.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/23757

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B02C 23/08 (2012.01)

USPC - 241/20; 209/5

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8)- B02C 23/08 (2012.01);

USPC- 241/20; 209/5

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Patents and NPL (classification, keyword; search terms below)Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest (US Pat, PgPub, EPO, JPO), GoogleScholar (PL, NPL), FreePatentsOnline (US Pat, PgPub, EPO, JPO, WIPO, NPL);
search terms: molybdenum, disulfide, powder, particle, nanoparticle, granule, particulate, D50, acid, oil, number, KOH, jet, mill, FSSS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0248119 A1 (YOUNG et al.) 30 September 2010 (30.09.2010), para [0012], [0020], [0045], [0064], [0070], [0084]-[0087], [0097], [0100], [0104], [0108], [0109]	1-8
Y	US 5,512,406 A (TAKEDA et al.) 30 April 1996 (30.04.1996), col 5, ln 51-67; col 8, ln 7-16; col 8, ln 59 to col 9, ln 3	1-3
Y	WO 2010/043968 A2 (GRIES) 22 April 2010 (22.04.2010), pg 5, ln 20-26; pg 8, ln 6-14; pg 7, ln 24 to pg 8, ln 14; pg 16, ln 3-7; pg 23, ln 9-12; pg 27, ln 13-14	4-8
Y	US 2006/0086205 A1 (JOHNSON et al.) 27 April 2006 (27.04.2006), para [0004]-[0088]	1-8
Y	US 2003/0094810 A1 (GOTO et al.) 22 May 2003 (22.05.2003), para [0014]-[0122]	1-8

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

02 July 2012 (02.07.2012)

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Name and mailing address of the ISA/US

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/23757

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:

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: claims 1-8 directed to a molybdenum disulfide powder product produced by jet milling a molybdenum disulfide precursor material and substantially continuously combining newly sized-reduced particles with oil to produce said molybdenum disulfide powder product, said molybdenum disulfide powder product having a D50 particle size of less than 4 micron and an acid number that is less than about 0.5 mgKOH/g.

– 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 additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-8

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/US 12/23757

Continued from Box No. 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: claims 1-8 directed to a molybdenum disulfide powder product produced by jet milling a molybdenum disulfide precursor material and substantially continuously combining newly sized-reduced particles with oil to produce said molybdenum disulfide powder product, said molybdenum disulfide powder product having a D50 particle size of less than 4 micron and an acid number that is less than about 0.5 mgKOH/g.

Group II: claims 9-25 directed to a method for producing a powder product, comprising:
providing a supply of a precursor powder material;
accelerating particles of the precursor powder material by combining them with a flow of gas;
confining the accelerated particles in a milling chamber so that they collide with one another to effect a size reduction; and
coating newly exposed surfaces of size-reduced particles with oil.

The inventions listed as Groups I-II 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 technical features for the following reasons:

Group I does not include the processing precursor powder by accelerating particles of the precursor powder material by combining them with a flow of gas; confining the accelerated particles in a milling chamber so that they collide with one another to effect a size reduction of group II.

Group II does not include a molybdenum disulfide powder product having a D50 particle size of less than 4 micron and an acid number that is less than about 0.5 mgKOH/g of group I.

The common feature of groups I and II of producing a powder and coating particles with oil is taught by US 2008/0118538 A1 to Hasegawa et al. (para [0011]; [0033]; [0055]); therefore the common feature is not an improvement over the prior art.

None of these technical features are common to the other groups, nor do they correspond to a special technical feature in the other groups. Therefore, unity of invention is lacking.