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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 April 2004 (08.04.2004)

PCT

(10) International Publication Number
WO 2004/029332 A3

(51) International Patent Classification[7]: C22B 34/12, 9/22, 9/14, C25C 3/28, B22F 5/00, 3/18

(21) International Application Number:
PCT/GB2003/004093

(22) International Filing Date:
24 September 2003 (24.09.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

0222219.8	25 September 2002 (25.09.2002)	GB
0222358.4	26 September 2002 (26.09.2002)	GB
0222348.5	26 September 2002 (26.09.2002)	GB

(71) Applicant *(for all designated States except US)*: **QINETIQ LIMITED** [GB/GB]; Registered Office, 85 Buckingham Gate, London SW1E 6PD (GB).

(72) Inventors; and

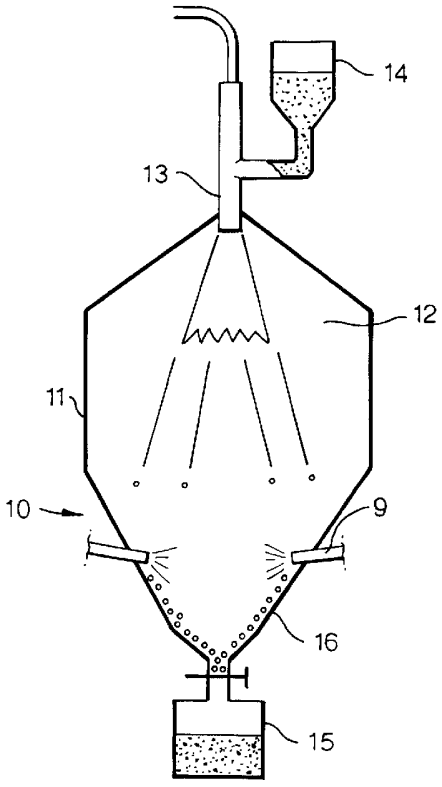
(75) Inventors/Applicants *(for US only)*: **WARD-CLOSE, Charles, Malcolm** [GB/GB]; QinetiQ Limited, Cody Technology Park, Rm 2008 Building A7, Ively Road, Hants, Farnborough GU14 0LX (GB). **GODFREY, Alastair, Bryan** [GB/GB]; QinetiQ Limited, Cody Technology Park, Rm 2008 Building A7, Ively Road, Hants, Farnborough GU14 0LX (GB). **GOODWIN, Paul, Stephen** [GB/GB]; Casting Technology International, Product Development, 7 East Bank Road, Sheffield S2 3PT (GB).

(74) Agent: **LOWTHER, Deborah, Jane**; IP QinetiQ Formalities, Cody Technology Park, A4 Building, Room G016, Ively Road, Farnborough, Hampshire GU14 0LX (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, 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,

[Continued on next page]

(54) Title: PURIFICATION OF ELECTROCHEMICALLY DEOXIDISED REFRACTORY METAL PARTICLES BY HEAT PROCESSING



(57) Abstract: A method for purifying metal M1 particles manufactured by an electrochemical reduction process, the method comprising the steps of introducing the metal M1 particles into a heat source (13) at a temperature substantially equal to or higher than the melting point of M1 so as to cause vaporisation of some or substantially all of the contaminating impurities present, removing the vaporised impurities from the vicinity of the particles, and cooling the purified metal M1 particles. The heat source may comprise a plasma torch, a laser, an electric arc or an induction coil. Preferably the particles are heated by free-fall through a plasma torch.The purified particles can be used directly in lower temperature powder metallurgy processes and have a fully dense spherical particle morphology, imparting good flowability. The purification process can also be incorporated as an integral stage of sheet or stock production processes based on particle feedstocks that have been produced by electrochemical reduction.

WO 2004/029332 A3

MN, MW, MX, MZ, 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 *(regional)*: ARIPO patent (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, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

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

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:
21 October 2004

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.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 03/04093

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C22B34/12 C22B9/22 C22B9/14 C25C3/28 B22F5/00
B22F3/18

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 C22B C25C C25F B22F

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 Y	EP 0 047 665 A (WESTINGHOUSE ELECTRIC CORP) 17 March 1982 (1982-03-17) page 1, line 1 - line 18; claim 7 page 2, line 23 - line 31	1 2-30
Y	GB 2 359 564 A (SECR DEFENCE) 29 August 2001 (2001-08-29) claims 1-11	1-30
Y	EP 0 153 296 A (KOS BERND) 28 August 1985 (1985-08-28) page 7 - page 9; claims 4-10; figures 1-3	1-30

-/--

[X] Further documents are listed in the continuation of box C.

[X] 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
11 August 2004	20/08/2004

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	Bombeke, M

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 03/04093

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	MAC RAE D R: "PLASMA ARC PROCESS SYSTEM, REACTORS, AND APPLICATIONS" PLASMA CHEMISTRY AND PLASMA PROCESSING, PLENUM PRESS. NEW YORK, US, vol. 9, no. 1, SUPPL, 1 March 1989 (1989-03-01), pages 85S-118, XP000117580 ISSN: 0272-4324 page 113S - page 114S; figures 17,22,24,25; tables II,III	2-30
Y	BOMBERGER H B: "The melting of titanium" JOURNAL OF METALS - JOM, METALLURGICAL SOCIETY OF THE AIME. NEW YORK, US, vol. 36, no. 12, 1 December 1984 (1984-12-01), pages 39-47, XP002086633 figures 7-9	1-30
Y	PATENT ABSTRACTS OF JAPAN vol. 0124, no. 62 (C-549), 5 December 1988 (1988-12-05) & JP 63 183145 A (SUMITOMO ELECTRIC IND LTD), 28 July 1988 (1988-07-28) abstract	2-5,16, 27-30
X Y	US 5 147 451 A (LELAND JOHN D) 15 September 1992 (1992-09-15) claims 1-4	1,3,6,7, 12,14 17
X	US 4 727 928 A (DE VYNCK IVAN A ET AL) 1 March 1988 (1988-03-01) claims 1,2; example 1	1,3,6,7, 9,10,19, 24-30
Y	US 4 114 251 A (SOUTHERN RAYMOND L ET AL) 19 September 1978 (1978-09-19) column 1, line 36 - column 2, line 62; figures 1-3	2-5,7,9, 19-23
Y	US 3 442 321 A (DEVILLARD JACQUES ET AL) 6 May 1969 (1969-05-06) claim 1; figures 1,3	19-25
Y	US 4 612 179 A (SANJURJO ANGEL ET AL) 16 September 1986 (1986-09-16) abstract	1,8,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 03/04093

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0047665 A	17-03-1982	CA 1163800 A1	20-03-1984
		EP 0047665 A1	17-03-1982
		JP 57079134 A	18-05-1982
GB 2359564 A	29-08-2001	AU 3387101 A	03-09-2001
		AU 3387601 A	03-09-2001
		AU 3389001 A	03-09-2001
		CA 2401034 A1	30-08-2001
		CN 1404530 T	19-03-2003
		EP 1257677 A1	20-11-2002
		EP 1257678 A1	20-11-2002
		EP 1257679 A1	20-11-2002
		WO 0162994 A1	30-08-2001
		WO 0162995 A1	30-08-2001
		WO 0162996 A1	30-08-2001
		GB 2376241 A ,B	11-12-2002
		JP 2003524072 T	12-08-2003
		JP 2003524073 T	12-08-2003
		US 2003057101 A1	27-03-2003
		US 2003047462 A1	13-03-2003
		US 2003047463 A1	13-03-2003
EP 0153296 A	28-08-1985	AT 380491 A	26-05-1986
		AT 35984 A	15-10-1985
		EP 0153296 A2	28-08-1985
JP 63183145 A	28-07-1988	NONE	
US 5147451 A	15-09-1992	NONE	
US 4727928 A	01-03-1988	LU 86090 A1	02-04-1987
		AT 39366 T	15-01-1989
		DE 3661482 D1	26-01-1989
		EP 0216398 A1	01-04-1987
		JP 2053499 B	16-11-1990
		JP 62080235 A	13-04-1987
US 4114251 A	19-09-1978	NONE	
US 3442321 A	06-05-1969	FR 1445684 A	15-07-1966
		BE 681646 A	31-10-1966
		CH 469517 A	15-03-1969
		DE 1408800 A1	14-05-1970
		DE 1508800 B	14-05-1970
		GB 1108930 A	10-04-1968
		IL 25865 A	22-03-1970
		LU 51223 A	01-08-1966
		NL 6607559 A	05-12-1966
		SE 327055 B	10-08-1970
US 4612179 A	16-09-1986	AU 590311 B2	02-11-1989
		AU 6091886 A	11-02-1988
		DE 3690134 T	12-03-1987
		EP 0215121 A1	25-03-1987
		GB 2179644 A ,B	11-03-1987
		JP 62502319 T	10-09-1987
		NL 8620174 T	02-02-1987
		US 4828814 A	09-05-1989

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 03/04093

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4612179 A		WO 8605475 A1	25-09-1986