



- (51) International Patent Classification:
B22F 9/18 (2006.01) *C22C 1/04* (2006.01)
C22B 34/12 (2006.01) *C22C 14/00* (2006.01)
- (21) International Application Number:
PCT/US2017/057607
- (22) International Filing Date:
20 October 2017 (20.10.2017)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
62/411,224 21 October 2016 (21.10.2016) US
- (71) Applicant: **GENERAL ELECTRIC COMPANY**
[US/US]; 1 River Road, Schenectady, New York 12345 (US).
- (72) Inventors: **COPLAND, Evan H.**; Research Way, Clayton, Victoria 3168 (AU). **STELLA, Albert Santo**; 1 Research Circle, Niskayuna, New York 12309 (US).
- (74) Agent: **MARSHALL, Alan, R.**; Dority & Manning, P.A., P.O. Box 1449, Greenville, South Carolina 29602-1449 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

(54) Title: PRODUCING TITANIUM ALLOY MATERIALS THROUGH REDUCTION OF TITANIUM TETRAHALIDE

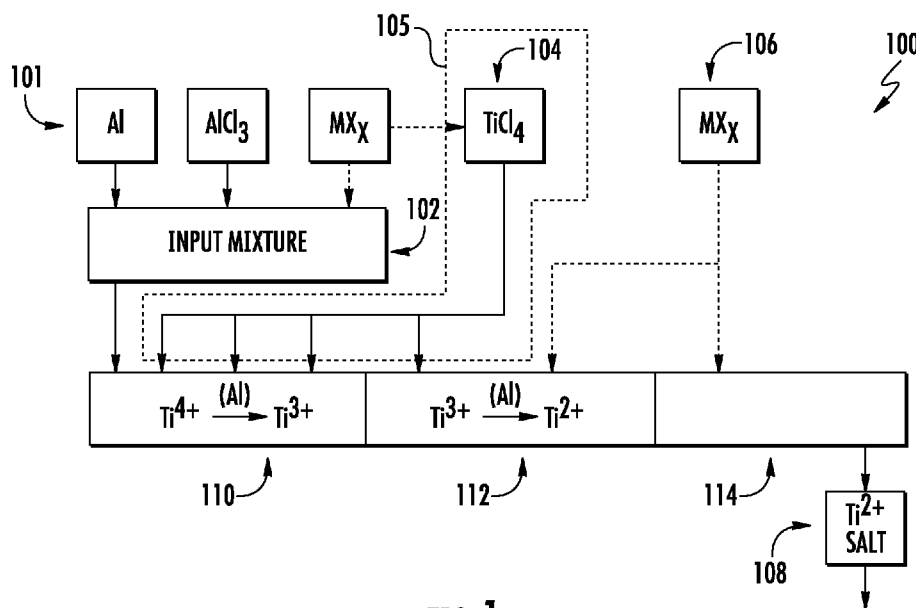


FIG. 1

(57) Abstract: Processes are provided for producing a titanium alloy material, such as Ti-Al alloys. In one embodiment, the process includes: heating an input mixture to a preheat temperature with the input mixture including aluminum, optionally, AlCl₃, and, optionally, one or more alloying element halide; introducing TiCl₄ to the input mixture at the first reaction temperature such that substantially all of the Ti⁴⁺ in the TiCl₄ is reduced to Ti³⁺; thereafter, heating to a second reaction temperature such that substantially all of the Ti³⁺ is reduced to Ti²⁺ to form an intermediate mixture (e.g., a Ti²⁺ salt); and introducing the intermediate mixture into a reaction chamber at a disproportionation temperature reaction to form the titanium alloy material from the Ti²⁺ via a disproportionation reaction.



GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:

02 August 2018 (02.08.2018)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/057607

A. CLASSIFICATION OF SUBJECT MATTER
INV. B22F9/18 C22B34/12 C22C1/04 C22C14/00
ADD.
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)
B22F C22B C22C

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/072338 A1 (COMMW SCIENT IND RES ORG [AU]; HAIDAR JAWAD [AU]) 23 June 2011 (2011-06-23) the whole document	1-20
X	WO 2009/129570 A1 (COMMW SCIENT IND RES ORG [AU]; HAIDAR JAWAD [AU]) 29 October 2009 (2009-10-29) cited in the application claims 15-25; figures 1-4	1-20
A	WO 2007/109847 A1 (COMMW SCIENT IND RES ORG [AU]; HAIDAR JAWAD [AU]; GNANARAJAN SABARATNA) 4 October 2007 (2007-10-04) cited in the application claims 1-94; figures 1-9	1-20
	-/--	

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

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p>
---	---

Date of the actual completion of the international search 25 June 2018	Date of mailing of the international search report 03/07/2018
--	---

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Liu, Yonghe
--	--

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/057607

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/002766 A1 (COMMW SCIENT IND RES ORG [AU]; HAIDAR JAWAD [AU]) 13 January 2005 (2005-01-13) claims 1-42; figures 1-10 -----	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/057607

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
WO 2011072338	A1	23-06-2011	AU 2010333714 A1	21-06-2012
			CA 2784196 A1	23-06-2011
			CN 102712966 A	03-10-2012
			EA 201290377 A1	30-01-2013
			EP 2513349 A1	24-10-2012
			JP 6129556 B2	17-05-2017
			JP 2013514456 A	25-04-2013
			JP 2016026265 A	12-02-2016
			KR 20120094516 A	24-08-2012
			NZ 600248 A	27-06-2014
			US 2013019717 A1	24-01-2013
			WO 2011072338 A1	23-06-2011
			ZA 201203935 B	27-08-2014
WO 2009129570	A1	29-10-2009	AU 2009240782 A1	29-10-2009
			CA 2722017 A1	29-10-2009
			CN 102065992 A	18-05-2011
			EA 201071214 A1	30-06-2011
			EP 2296805 A1	23-03-2011
			ES 2658355 T3	09-03-2018
			KR 20100135922 A	27-12-2010
			US 2011091350 A1	21-04-2011
			US 2013319177 A1	05-12-2013
			WO 2009129570 A1	29-10-2009
WO 2007109847	A1	04-10-2007	AU 2007231543 A1	04-10-2007
			CA 2644430 A1	04-10-2007
			CN 101454467 A	10-06-2009
			EA 200870372 A1	27-02-2009
			EP 1999285 A1	10-12-2008
			ES 2394851 T3	06-02-2013
			JP 5479886 B2	23-04-2014
			JP 5886815 B2	16-03-2016
			JP 2009531537 A	03-09-2009
			JP 2014074232 A	24-04-2014
			KR 20080106479 A	05-12-2008
			UA 91908 C2	10-09-2010
			US 2009165597 A1	02-07-2009
			WO 2007109847 A1	04-10-2007
WO 2005002766	A1	13-01-2005	CA 2526483 A1	13-01-2005
			CN 1812859 A	02-08-2006
			EA 200600178 A1	30-06-2006
			EP 1641581 A1	05-04-2006
			JP 4847321 B2	28-12-2011
			JP 2007523991 A	23-08-2007
			KR 20060026951 A	24-03-2006
			US 2006191372 A1	31-08-2006
WO 2005002766 A1	13-01-2005			