



US007452455B2

(12) **United States Patent**
Sandoval et al.(10) **Patent No.:** US 7,452,455 B2
(45) **Date of Patent:** *Nov. 18, 2008(54) **SYSTEM AND METHOD FOR PRODUCING METAL POWDER BY ELECTROWINNING**(75) Inventors: **Scot P Sandoval**, Morenci, AZ (US);
Antonioni C Stevens, Thatcher, AZ (US); **Timothy G Robinson**, Scottsdale, AZ (US); **John O Marsden**, Phoenix, AZ (US); **Stanley R Gilbert**, Thatcher, AZ (US)(73) Assignee: **Phelps Dodge Corporation**, Phoenix, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 181 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/160,913**(22) Filed: **Jul. 14, 2005**(65) **Prior Publication Data**

US 2006/0016697 A1 Jan. 26, 2006

Related U.S. Application Data

(60) Provisional application No. 60/590,882, filed on Jul. 22, 2004.

(51) **Int. Cl.**
C25C 1/12 (2006.01)(52) **U.S. Cl.** **205/579; 205/574; 205/575;**
205/576; 205/580; 205/584(58) **Field of Classification Search** **205/574,**
205/575, 576, 580, 584, 579

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,792,342 A 5/1957 Tuwiner
3,262,870 A 7/1966 Harlan
3,616,277 A 10/1971 Adamson et al.
3,876,516 A 4/1975 Pace et al.
3,887,396 A 6/1975 Walsh et al.
3,915,834 A 10/1975 Wright et al.
3,956,086 A 5/1976 Wilkinson et al.
3,972,795 A * 8/1976 Goens et al. 204/269
4,071,431 A 1/1978 Nicou et al.
4,219,401 A 8/1980 Johnson
4,226,685 A 10/1980 Portal et al.
4,272,339 A 6/1981 Knight et al.
4,278,521 A 7/1981 Kreysa
4,292,160 A 9/1981 Marcantonio
4,318,789 A 3/1982 Marcantonio
4,373,654 A 2/1983 Prengaman et al.
4,399,020 A * 8/1983 Branchick et al. 204/269
4,436,601 A 3/1984 Branchick et al.
4,445,990 A 5/1984 Kim et al.
4,515,672 A 5/1985 Platek et al.
4,556,469 A 12/1985 Kim et al.
4,560,453 A 12/1985 Hoffiman et al.
4,680,100 A 7/1987 Morin4,715,934 A 12/1987 Tamminen
4,762,603 A 8/1988 Morin
4,776,941 A 10/1988 Tezanos et al.
4,789,450 A 12/1988 Paterson
4,834,850 A 5/1989 deNora et al.
4,863,580 A 9/1989 Epner
4,960,500 A 10/1990 Epner
5,006,216 A 4/1991 Dietrich et al.
5,133,843 A 7/1992 Eisman
5,292,412 A 3/1994 Pitton
5,324,409 A 6/1994 Mayr et al.
5,368,702 A 11/1994 deNora
5,454,917 A 10/1995 Mattison et al.
5,458,746 A * 10/1995 Burgess et al. 205/77
5,492,608 A 2/1996 Sandoval et al.
5,622,615 A 4/1997 Young et al.
5,690,806 A 11/1997 Sunderland et al.
5,705,048 A 1/1998 Oxley et al.
5,725,752 A 3/1998 Sunderland et al.
5,770,037 A 6/1998 Goto et al.
5,783,050 A 7/1998 Coin et al.
5,837,122 A 11/1998 Snyder et al.
5,882,502 A 3/1999 Gomez
5,972,181 A 10/1999 Coin et al.
6,017,428 A 1/2000 Hill et al.
6,086,691 A 7/2000 Lehockey et al.
6,086,733 A 7/2000 Carey et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CA 1162514 2/1984
DE 19731616 1/1999
EP 0129845 10/1988
EP 0206941 10/1990
FR 2810681 12/2001
JP 02-229778 9/1990

(Continued)

OTHER PUBLICATIONS

Alkire, R., et al., "Flow Through Porous Electrodes;" J. Electrochem Soc.; 122, 1594; 1975.
Marracino, J.M., et al., "A First Investigation of Flow-Through Porous Electrodes Made of Metallic Felts or Foams;" Electrochim. Acta; 32, 1303; 1987.
Popov, K. I., et al., "The Comparison of Galvanostatis ... Aluminium Electrodes;" Journal of Applied Electrochemistry, V. 8, pp. 503-514.
Qi, J. et al., "Analysis of Flow-Through Porous Electrode ...;" J. Appl. Electrochem.; 23, 873; 1993.

(Continued)

Primary Examiner—Bruce F Bell
(74) *Attorney, Agent, or Firm*—Snell & Wilmer L.L.P.(57) **ABSTRACT**

This invention relates to a system and method for producing a metal powder product using either conventional electrowinning or alternative anode reaction chemistries in a flow-through electrowinning cell. The present invention enables the production of high quality metal powders, including copper powder, from metal-containing solutions using conventional electrowinning processes, direct electrowinning, or alternative anode reaction chemistries.

13 Claims, 2 Drawing Sheets