US008026848B2

(12) **United States Patent**
Hanson

(10) **Patent No.: US 8,026,848 B2**
(45) **Date of Patent: Sep. 27, 2011**

(54) **RADIO-BASED POSITION LOCATION SYSTEMS, ANTENNA CONFIGURATIONS, AND METHODS FOR DETERMINING ANTENNA CONFIGURATIONS**

(75) Inventor: **James Edward Hanson**, Tucson, AZ (US)

(73) Assignee: **Freeport McMoRan Copper & Gold Inc.**, 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 558 days.

(21) Appl. No.: **12/184,727**

(22) Filed: **Aug. 1, 2008**

(65) **Prior Publication Data**

US 2010/0026577 A1 Feb. 4, 2010

(51) **Int. Cl.**
H01Q 3/00 (2006.01)

(52) **U.S. Cl.** **342/359**

(58) **Field of Classification Search** 342/359, 342/458, 367, 423, 432; 455/575.5
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,406,275	A	4/1995	Hassett et al.	
5,532,709	A	7/1996	Talty	
6,191,733	B1	2/2001	Dizchavez	
6,285,318	B1	9/2001	Schoen et al.	
6,665,333	B2	12/2003	McCrady et al.	
7,139,651	B2	11/2006	Knowlton et al.	
7,245,267	B2	7/2007	Gottl et al.	
7,269,174	B2	9/2007	Olson et al.	
H002224	H *	10/2008	Madden	342/424
7,715,466	B1 *	5/2010	Oh et al.	375/211
2007/0268155	A1	11/2007	Holmes et al.	
2008/0040029	A1	2/2008	Breed	

OTHER PUBLICATIONS

International Search Report dated Jul. 31, 2009 for PCT Application No. PCT/US09/48654, 4 pages.
Written Opinion of the International Searching Authority dated Jul. 31, 2009 for PCT Application No. PCT/US09/48654, 6 pages.

* cited by examiner

Primary Examiner — Thomas Tarcza
Assistant Examiner — Nga X Nguyen
(74) *Attorney, Agent, or Firm* — Fennemore Craig, P.C.

(57) **ABSTRACT**

A radio-based position location system for determining a relative position of a first object with respect to a second object may include a first radio operatively associated with the first object. A first directional antenna having at least a high gain region is mounted to the second object so that the high gain region is directed generally outwardly from the second object and defines a first detection zone. A second directional antenna having at least a high gain region is also mounted to the second object and is oriented so that the high gain region is also directed generally outwardly and defines a second detection zone. A second radio connected to the first and second directional antennas exchanges radio signals with at least the first radio to determine the relative position of the first object with respect to the second object at least in part by determining a time-of-flight of a radio signal. The radio signals are primarily exchanged via the first directional antenna when the first object is in the first detection zone, whereas the radio signals are primarily exchanged via the second directional antenna when the first object is in the second detection zone.

24 Claims, 4 Drawing Sheets