US008493182B2

(12) **United States Patent**
Hofer et al.

(10) **Patent No.:** **US 8,493,182 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **PHASE RANGING RFID LOCATION SYSTEM**

(75) Inventors: **Russell Hofer**, St. Louis, MO (US);
Graham P. A. Bloy, St. Louis, MO (US)

(73) Assignee: **RF Controls, LLC**, St. Louis, MO (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 691 days.

(21) Appl. No.: **12/580,365**

(22) Filed: **Oct. 16, 2009**

(65) **Prior Publication Data**

US 2011/0090062 A1   Apr. 21, 2011

(51) **Int. Cl.**
H04Q 5/22 (2006.01)
G08C 19/16 (2006.01)
G08B 13/14 (2006.01)

(52) **U.S. Cl.**
USPC **340/10.1**; 340/8.1; 340/12.1; 340/539.13; 340/572.4

(58) **Field of Classification Search**
USPC 340/572.1, 825.49, 539.13, 572.7, 340/825.7, 10.1–10.6; 342/42, 44, 47, 127
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,170,412	B2 *	1/2007	Knox et al.	.... 340/572.1
7,257,418	B1	8/2007	Chang et al.	
7,511,662	B2	3/2009	Mathews et al.	
7,580,378	B2 *	8/2009	Carrender et al.	.... 370/278
7,667,646	B2	2/2010	Kalliola et al.	
7,873,326	B2 *	1/2011	Sadr	.... 455/67.16
8,072,311	B2 *	12/2011	Sadr et al.	.... 340/10.1
2005/0110674	A1	5/2005	Mendolia et al.	
2005/0280504	A1	12/2005	Pettus	
2006/0012521	A1	1/2006	Small	
2006/0044147	A1	3/2006	Knox et al.	
2006/0050625	A1	3/2006	Krasner	
2006/0232467	A1	10/2006	Small	
2007/0040739	A1	2/2007	Small	
2007/0041427	A1	2/2007	Small	
2007/0100548	A1	5/2007	Small	
2008/0030422	A1	2/2008	Gevargiz et al.	
2008/0143584	A1 *	6/2008	Shoarinejad et al.	.... 342/127
2009/0224045	A1	9/2009	Toda et al.	
2009/0224873	A1	9/2009	Puskala et al.	
2009/0231140	A1	9/2009	Hong et al.	
2009/0237253	A1	9/2009	Neuwirth	
2009/0256750	A1	10/2009	Mathews et al.	
2010/0207738	A1 *	8/2010	Bloy	.... 340/10.3
2010/0328073	A1 *	12/2010	Nikitin et al.	.... 340/572.1

FOREIGN PATENT DOCUMENTS

EP	1462989	9/2004
WO	PCT2009/035723	3/2009

OTHER PUBLICATIONS

Gonzalez Moreno, J: Extended European Search Report for EP application No. 08789680.9, European Patent Office, Apr. 12, 2011 (transmitted Apr. 19, 2011), Munich DE.
Extended European Search Report, related to application EP10186569.9, issued Jan. 14, 2011 by European Patent Office, Munich.
Extended European Search Report, related to application EP10186756.2, issued Jan. 14, 2011 by European Patent Office, Munich.

* cited by examiner
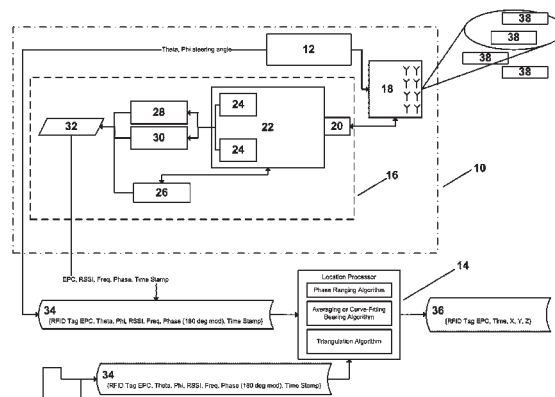
Primary Examiner — Daniel Wu
Assistant Examiner — Mancil Littlejohn
(74) *Attorney, Agent, or Firm* — Babcock IP, PLLC

(57)   **ABSTRACT**

A method and apparatus for phase ranging the distance an RFID tag is from an RFID location system antenna along the interrogation signal beam, based upon the phase readings included in data sets obtained from monitoring reply signals corresponding to interrogation signals at multiple frequencies and a common interrogation signal beam direction; by comparison of measured phase and frequency data sets with theoretical phases calculated with respect to the same frequencies over a range of positions corresponding to a beam extent of the interrogation signal.
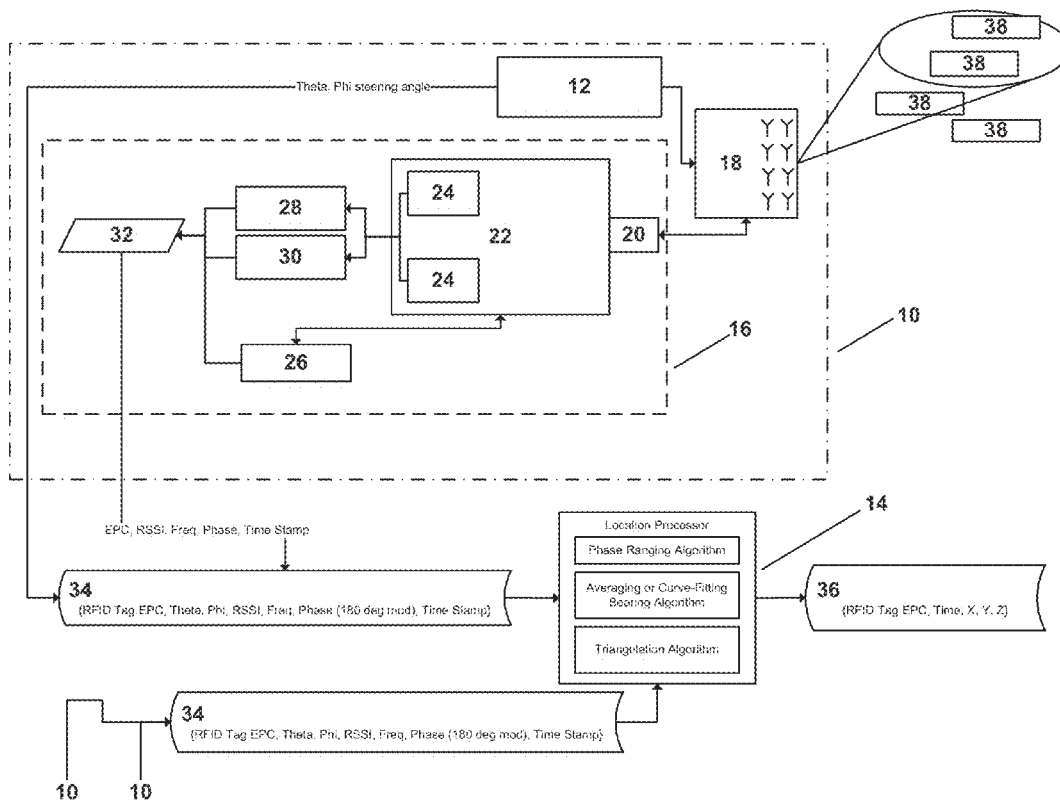
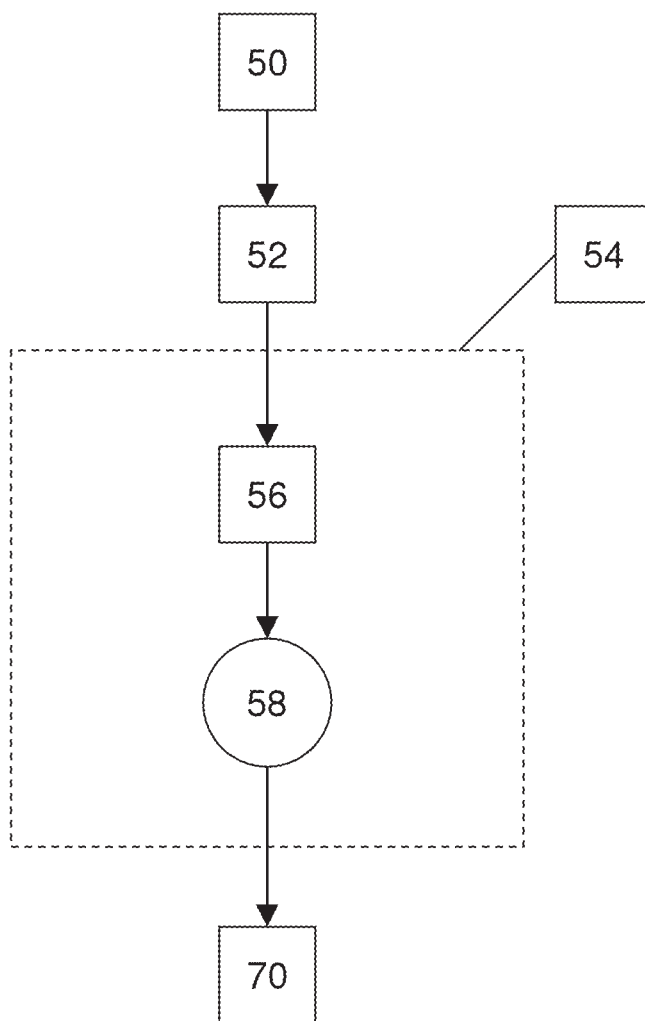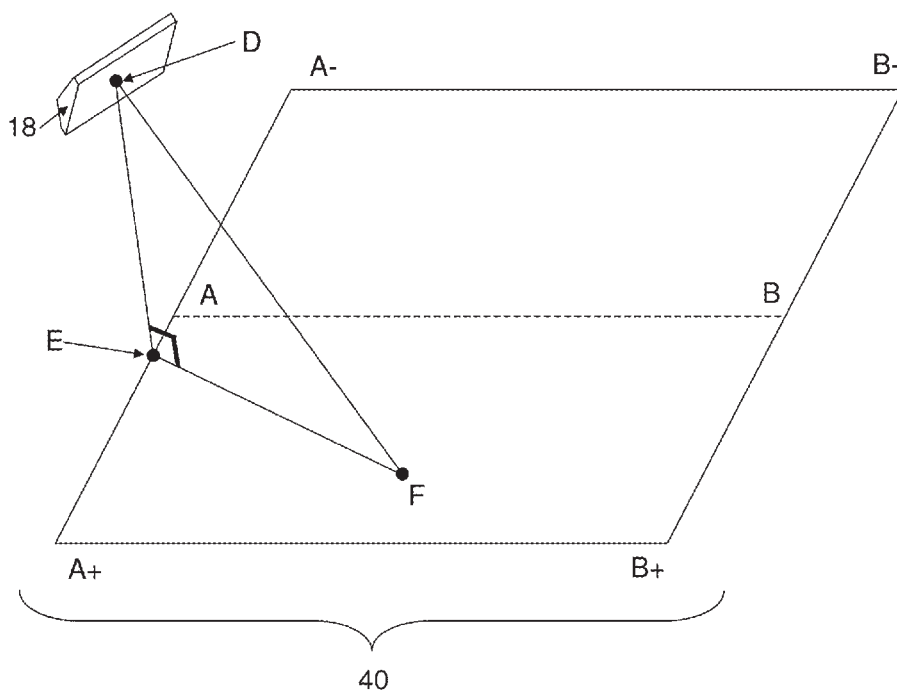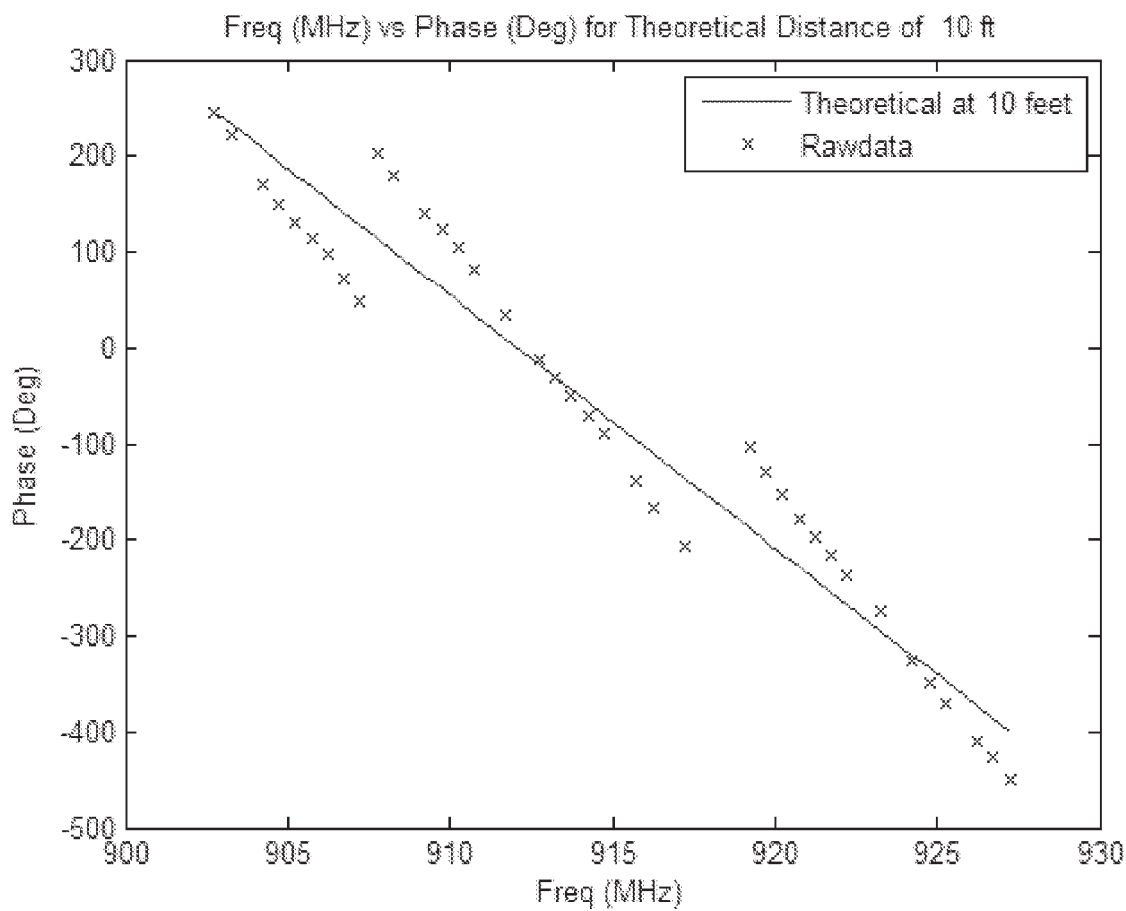**20 Claims, 7 Drawing Sheets**

Fig. 1

Fig. 2

Fig. 3

Fig. 4

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.

fastcase
Smarter legal research.