United States Patent [19]

Loomis et al.

[11] **Patent Number:** 5,936,572

[45] **Date of Patent:** Aug. 10, 1999

[54] **PORTABLE HYBRID LOCATION DETERMINATION SYSTEM**

[75] Inventors: **Peter Van Wyck Loomis**, Sunnyvale; **James M. Janky**, Los Altos; **John F. Schipper**, Palo Alto, all of Calif.

[73] Assignee: **Trimble Navigation Limited**, Sunnyvale, Calif.

[21] Appl. No.: **08/806,549**

[22] Filed: **Feb. 25, 1997**

Related U.S. Application Data

[63] Continuation of application No. 08/191,984, Feb. 4, 1994, abandoned.

[51] **Int. Cl.**[6] **G01S 5/02**; G01S 3/02
[52] **U.S. Cl.** **342/357**; 342/463; 342/457
[58] **Field of Search** 342/357, 457, 342/463, 464, 465

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,518,376	6/1970	Komen et al.	.
3,889,264	6/1975	Fletcher	.
4,054,880	10/1977	Dalabakis et al.	.
4,459,667	7/1984	Takeuchi	342/389
4,646,290	2/1987	Hills	370/84
4,651,156	3/1987	Martinez	342/457
4,660,193	4/1987	Young et al.	370/11
4,782,531	11/1988	Karr et al.	381/14
4,799,062	1/1989	Sanderford et al.	342/450
4,806,940	2/1989	Harral et al.	342/451
4,816,769	3/1989	Ma	329/50
4,914,735	4/1990	Ichiyoshi	342/125
5,023,934	6/1991	Wheeless	455/45
5,045,861	9/1991	Duffet-Smith	342/457
5,073,784	12/1991	Westfall	342/465
5,170,487	12/1992	Peek	455/45
5,173,710	12/1992	Kelley et al.	342/463
5,193,213	3/1993	Chon	455/45
5,235,632	8/1993	Raith	379/59

OTHER PUBLICATIONS

Loran–C User Handbook, Dept. of Transportation, U.S. Coast Guard, Commandant Instruction M16562.3, May 1990.

Tom Logsdon, *The NAVSTAR Global Positioning System*, Van Nostrand Reinhold, 1992, pp. 17–90.

R.G. Brown, *Introduction to Random Signal Analysis and Kalman Filtering*, Wiley and Sons, 1983, pp. 181–272.

Mark Sturza, "Navigation System Integrity Monitoring Using Redundant Measurements", Navigation, vol. 35 (1988–1989), pp. 483–501.

Primary Examiner—Gregory C. Issing
Attorney, Agent, or Firm—John Schipper
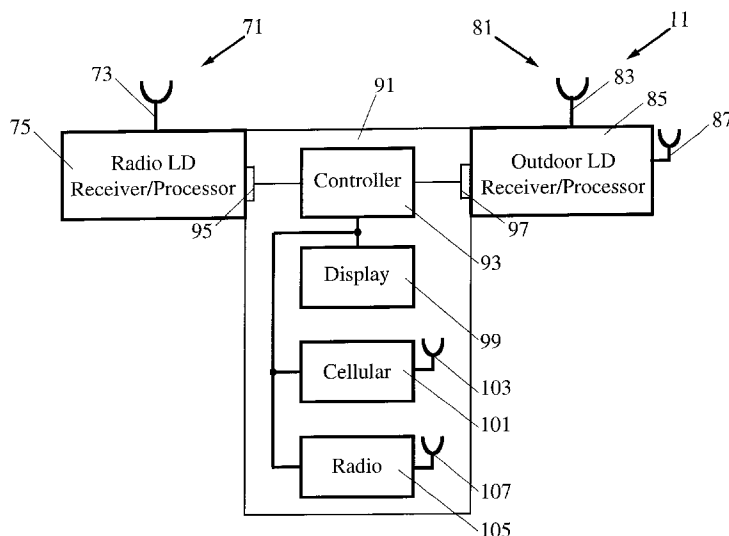
[57] **ABSTRACT**

Apparatus and method for determining the present location of a mobile user that carries the apparatus inside or outside buildings and structures within a region R. The apparatus includes a radio location determination (LD) signal module that receives radiowaves from at least three radio LD signal sources, such as FM carrier or subcarrier signals, and an outdoor LD signal module that receives outdoor LD signals from at three other satellite-based or ground-based outdoor LD signal sources, such as GPS, GLONASS or Loran-C signal sources. The radio LD signals and outdoor LD signals are used to (1) determine the location of the radio LD module, (2) determine the location of the outdoor LD module and (3) determine an indicium representing signal strength or signal quality for the radio LD signals and for the outdoor LD signals. The radio LD signal indicium and the outdoor LD signal indicium are compared with threshold values for these indicia, and at most one of the radio LD module location and the outdoor LD module location is selected as the present location of the apparatus user. The radio LD module and the outdoor LD module can be combined in a hybrid portable LD system, or the two modules can be separated from and move independently of each other.

18 Claims, 8 Drawing Sheets

FIG. 1

S(f)

FM Signal
Spectrum

f_c -19KHZ

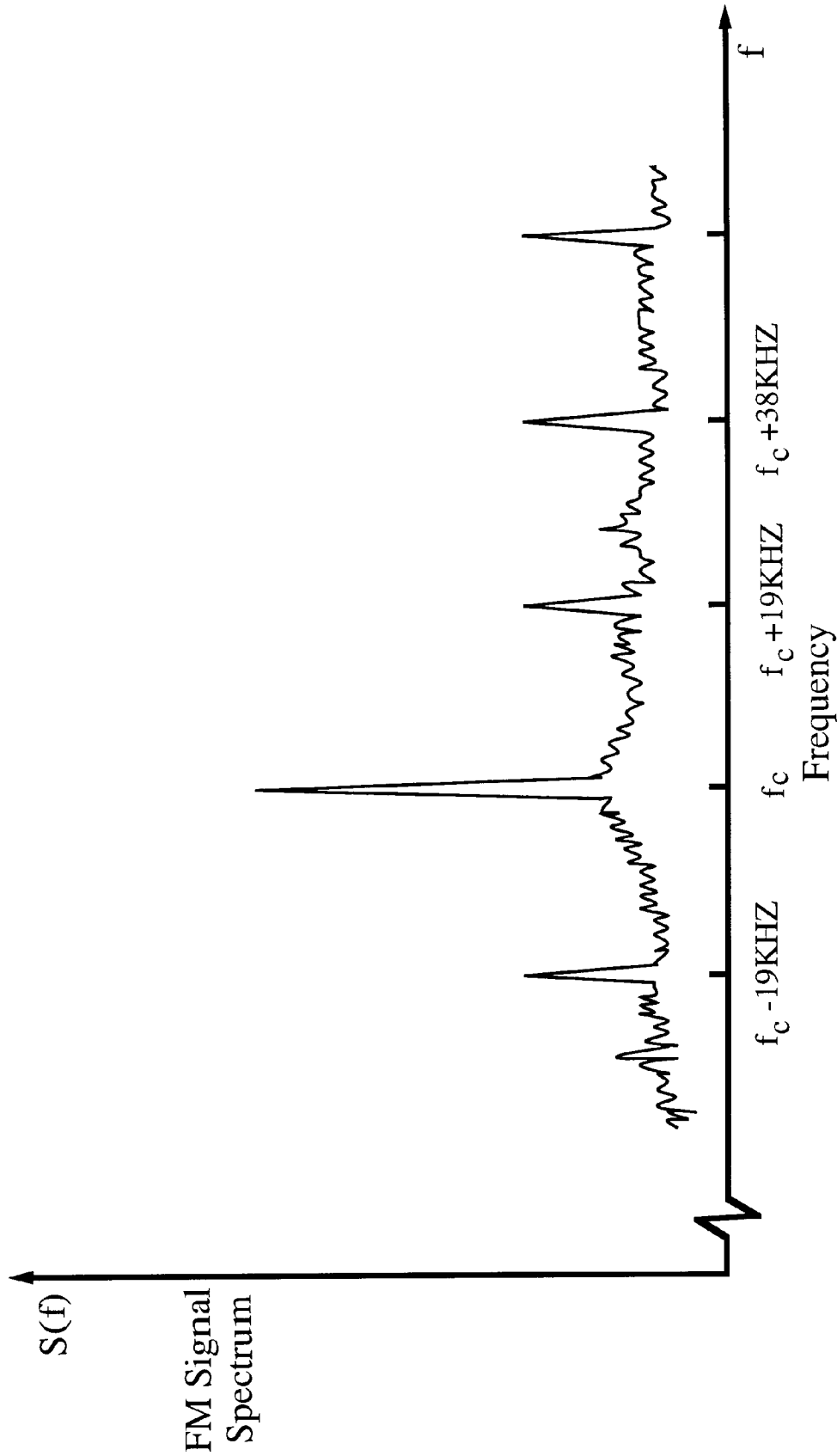f_c f_c +19KHZ f_c +38KHZ
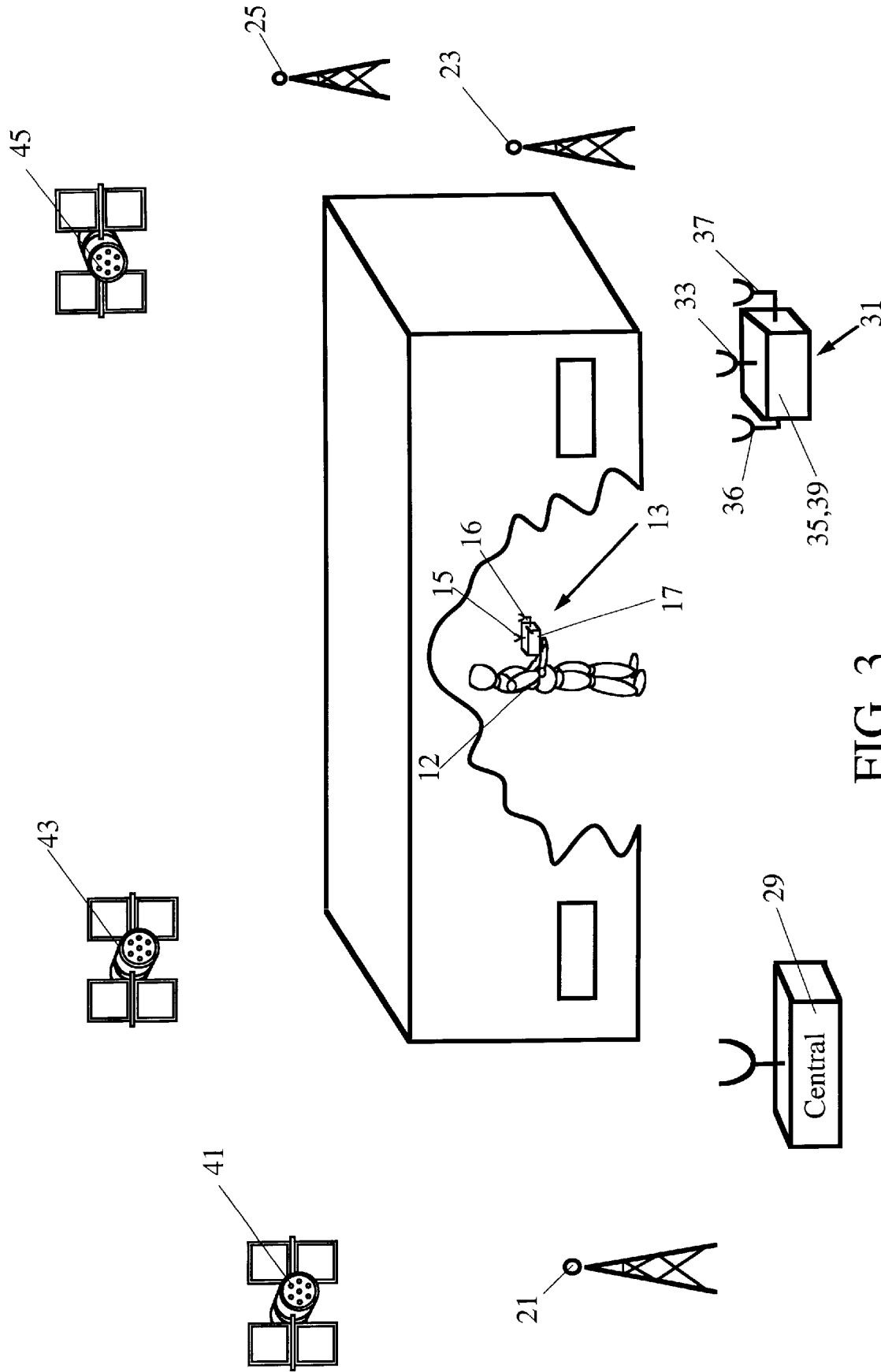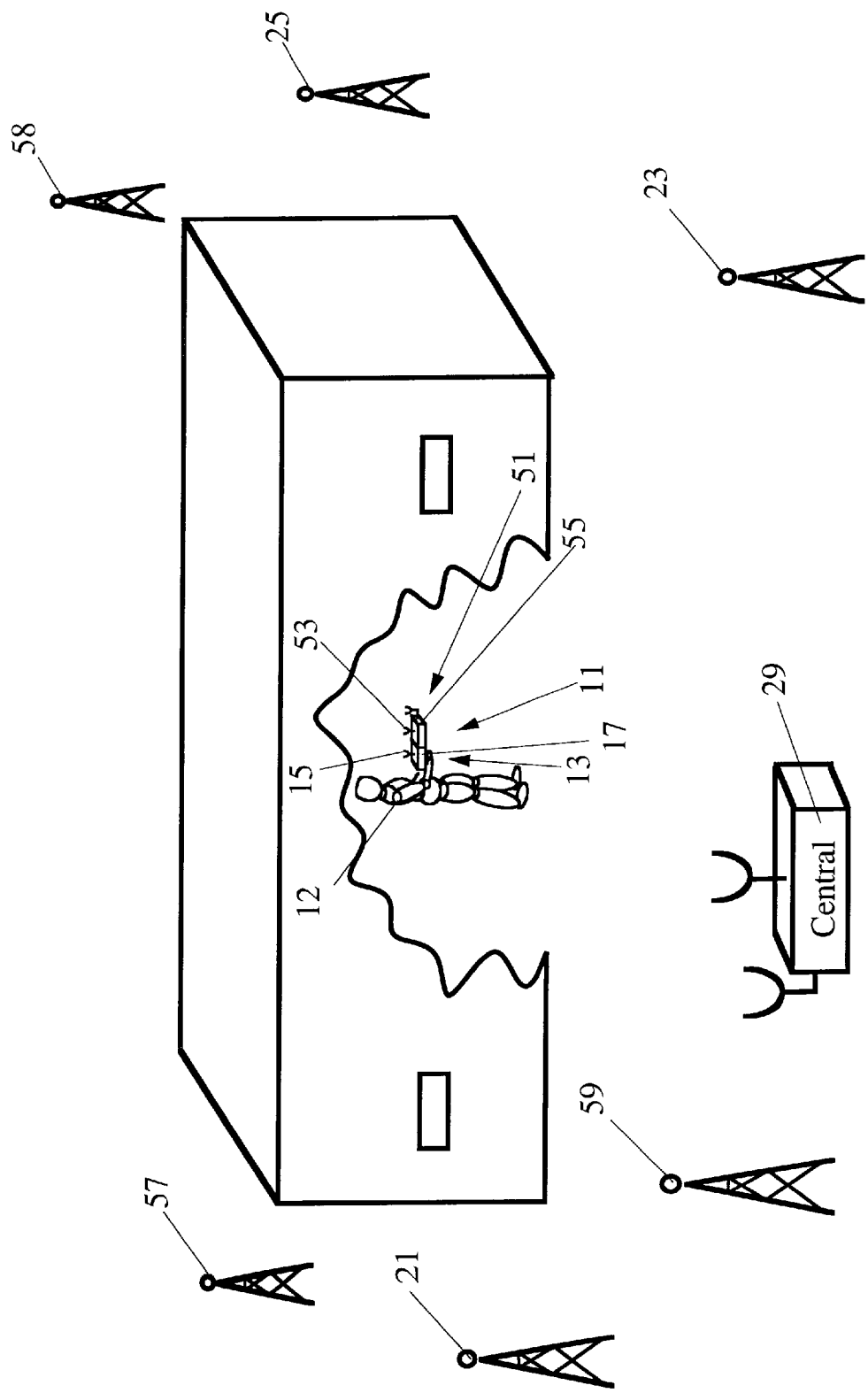
Frequency

f

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.