



US005220332A

United States Patent [19]

[11] Patent Number: **5,220,332**

Beckner et al.

[45] Date of Patent: **Jun. 15, 1993**

- [54] **RANGING BY SEQUENTIAL TONE TRANSMISSION**
- [75] Inventors: **Frederick L. Beckner; Darrell K. Ingram**, both of Palo Alto, Calif.
- [73] Assignee: **Cyberdynamics, Inc.**, Palo Alto, Calif.
- [21] Appl. No.: **877,869**
- [22] Filed: **May 4, 1992**
- [51] Int. Cl.⁵ **G01S 13/26**
- [52] U.S. Cl. **342/125; 342/127**
- [58] Field of Search **342/125, 50, 127**

4,454,512	6/1984	Millett	342/125
4,651,156	3/1987	Martinez	342/457
4,656,476	4/1987	Tavtigian	340/993
4,703,444	10/1987	Storms, Jr.	364/561
4,757,315	7/1988	Lichtenberg	342/125
4,809,006	2/1989	Dar	342/352
4,810,179	5/1974	Merrick	342/46
4,908,627	3/1990	Santos	342/125
5,126,746	6/1992	Gritton	342/125

Primary Examiner—John B. Sotomayor
Attorney, Agent, or Firm—Dennis T. Griggs

[57] ABSTRACT

A range finding system uses non-simultaneous measurements between two communicating and cooperating instruments such that a single carrier frequency is used to exchange information between the instruments with non-simultaneous transmission using the same transmission channel. The range finding system may be considered to be an interrogator/transponder arrangement in which the results of a phase measurement against a local clock is made at one transponder station during one time interval, and then the transponder transmits both a tone derived from the transponder's local clock and the measurement results back to the interrogator station during a second time interval. The interrogator then has everything it needs to accurately compute the range while eliminating local delays in clock differences, while permitting the interrogator and the transponder to share a single frequency intermittently.

4 Claims, 3 Drawing Sheets

References Cited

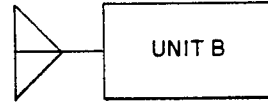
U.S. PATENT DOCUMENTS

H767	4/1990	Kretschmer, Jr. et al.	342/145
H1044	4/1992	Waters	342/125 X
3,004,254	10/1961	Steinberg et al.	342/30
3,144,645	8/1964	McIver et al.	342/125
3,243,812	3/1966	Williams	342/125
3,303,499	2/1967	Mahoney et al.	342/125
3,780,370	12/1973	Reeves	342/46
3,868,692	2/1975	Woodard et al.	342/458
3,919,708	11/1975	Pudsey	342/125
4,011,562	3/1977	Bruce	342/46
4,136,394	1/1979	Jones et al.	364/561
4,170,773	10/1979	Fitzsimmons	342/42
4,278,977	7/1981	Nossen	342/42
4,297,700	10/1981	Nard et al.	342/125
4,297,701	10/1981	Henriques	342/42
4,357,609	11/1982	Spencer	342/125

STEP 1: TRANSMIT RANGE TONE W1 FROM UNIT A TO UNIT B.



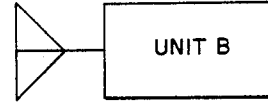
RECEIVE RANGE TONE W1 AT UNIT B, MEASURE AND STORE PHASE RELATIVE TO REFERENCE W2.



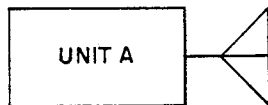
STEP 2: RECEIVE RANGE TONE W2 AT UNIT A, MEASURE AND STORE PHASE RELATIVE TO REFERENCE W1.



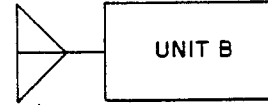
TRANSMIT RANGE TONE W2 FROM UNIT B TO UNIT A.



STEP 3: RECEIVE PHASE MEASUREMENT FROM UNIT B.



TRANSMIT STORED PHASE MEASUREMENT TO UNIT A.



STEP 4: COMPUTE AND DISPLAY RANGE AT UNIT A.