

# Ex. PGS 1059

- [54] MULTI-ANTENNA GAS RECEIVER FOR SEISMIC SURVEY VESSELS
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- [73] Assignee: Western Atlas International, Inc., Houston, Tex.
- [21] Appl. No.: 147,123
- [22] Filed: Jan. 21, 1988

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Related U.S. Application Data

- [63] Continuation of Ser. No. 35,662, Apr. 6, 1987, which is a continuation-in-part of Ser. No. 852,016, Apr. 14, 1986, which is a continuation-in-part of Ser. No. 353,331, Mar. 1, 1982.

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- [52] U.S. Cl. .... 342/352; 342/357
- [58] Field of Search ..... 342/352, 357; 375/1

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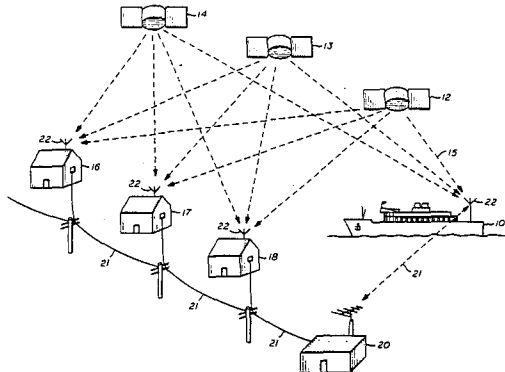
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[57] ABSTRACT

Method and apparatus are disclosed for accurately determining position from GPS satellites and received on a ship using observations of C/A code group delay, L1 band center frequency carrier phase, L1 band 5.115 MHz implicit carrier phase, and L2 band 5.115 MHz implicit carrier phase. A precise measurement of the range to each satellite is made based upon the L1 center frequency carrier phase. A correction for ionospheric effects is determined by simultaneous observation of the group delays of the wide bandwidth P code modulations in both the L1 and L2 bands. These group delays are determined by measuring the phases of carrier waves implicit in the spread-spectrum signals received in both bands. These carriers are reconstructed from both the L1 and L2 band signals from each satellite without using knowledge of the P code. The unknown biases in the L1 center frequency carrier phase range measurements are determined from simultaneous, pseudorange measurements, with time averaging. The instantaneous position of the antenna receiving these signals, and therefore the ship, may then be determined from the ranges so determined, with both the bias and the ionospheric effects having been eliminated. Additional antennas are positioned on the ship and a seismic streamer towed by the ship to reject false signals, compensate for blockage of signals by the ship's structure, and determine the position of sensors in the streamer.

9 Claims, 25 Drawing Sheets



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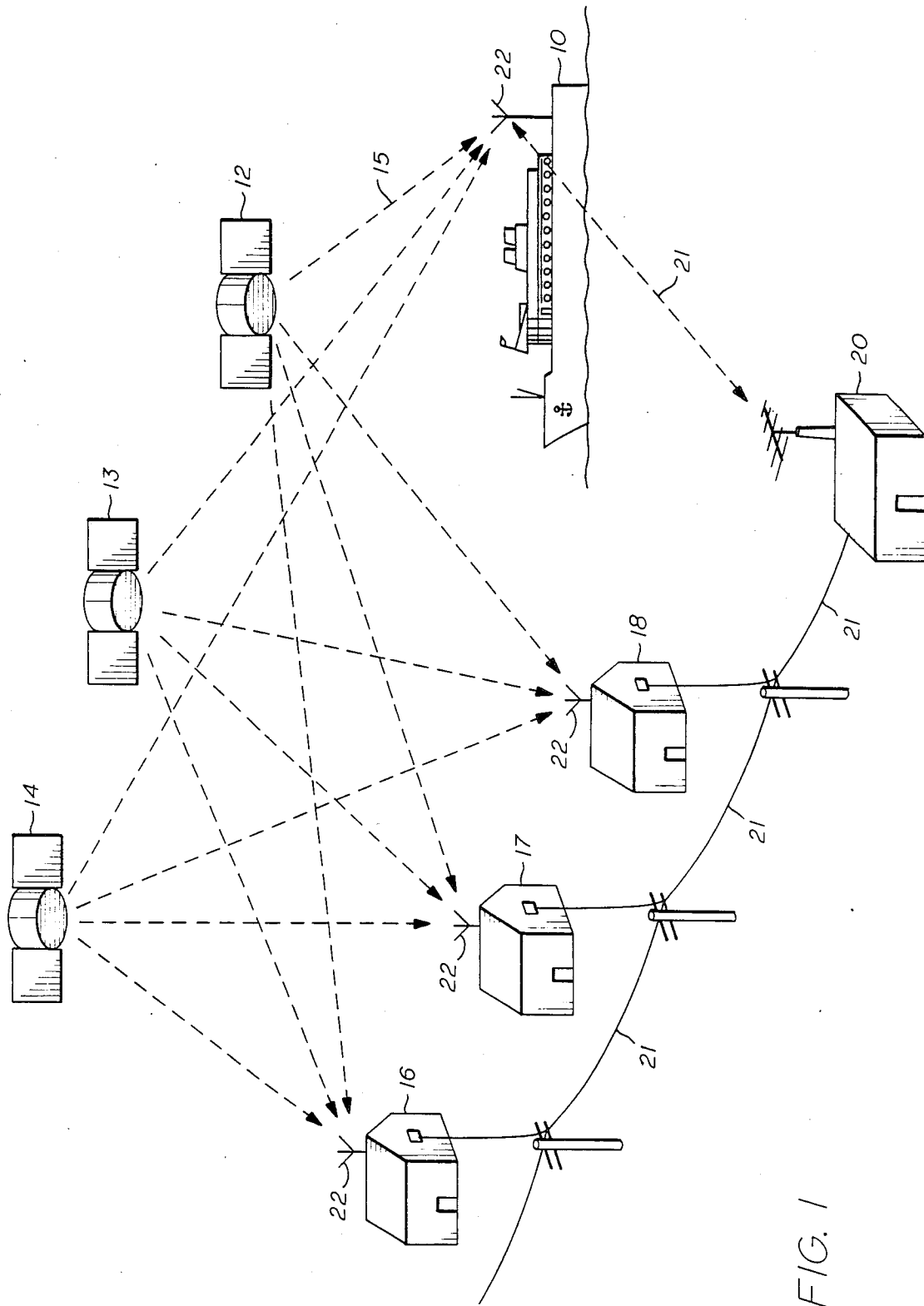


FIG. 1

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