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Cisneros et al.

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[54] **NAVIGATION AND POSITIONING SYSTEM AND METHOD USING UNCOORDINATED BEACON SIGNALS IN CONJUNCTION WITH AN ABSOLUTE POSITIONING SYSTEM**

[75] Inventors: **Joseph S. Cisneros**, San Dimas; **David C. Kelley**, Covina; **Michael Kiang**, Allso Viejo; **Louis A. Greenbaum**, Redondo Beach, all of Calif.

[73] Assignee: **Pinterra Corporation**, Garden Grove, Calif.

[21] Appl. No.: **570,747**

[22] Filed: **Dec. 12, 1995**

[51] **Int. Cl.**[6] **G01S 5/02**; H04B 7/185

[52] **U.S. Cl.** **701/213**; 342/457; 701/214

[58] **Field of Search** 364/449.8, 449.95, 364/449.1, 460, 452; 342/357, 457; 340/995; 701/214, 216, 207, 300, 219

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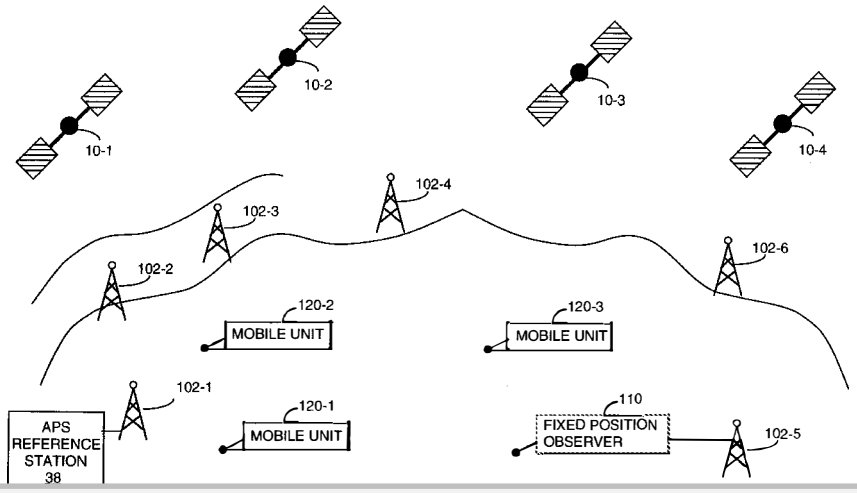
Primary Examiner—Michael Zanelli

Attorney, Agent, or Firm—Gary S. Williams; Flehr Hohbach Test Albritton & Herbert LLP

[57] **ABSTRACT**

A navigation system in which an uncoordinated beacon positioning system (UBS) is used in conjunction with an absolute positioning system (APS) is described herein. The UBS employs a multiplicity of transmitters, at known locations, each of which transmits a beacon signal having a phase that is at least partially un-synchronized with the phases of the beacon signals of the other transmitters. Within a mobile unit, separate receivers are provided for receiving these beacon signals and for receiving APS signals. The absolute positioning system (APS) receiver is disposed to receive the APS signals, and to estimate an initial position of the mobile unit therefrom. The mobile unit processor is disposed to modify the estimated mobile unit position on the basis of the detected beacon signal phases. The mobile unit processor may also be programmed to determine the uncertainty of location information provided by the beacon signal receiver and by the APS receiver. This allows the current location of the mobile unit to be updated by selecting the location estimate having associated therewith the least amount of location uncertainty, or by weighting each estimate based on its uncertainty and combining the two weighted location estimates. In another implementation, the mobile unit includes an estimator operative to compute an estimate of mobile unit position on the basis of selected pseudorange measurements from the UBS and APS receivers. The estimator may include a Kalman filter configured to process residual pseudorange information provided by the UBS and APS receivers.

36 Claims, 16 Drawing Sheets



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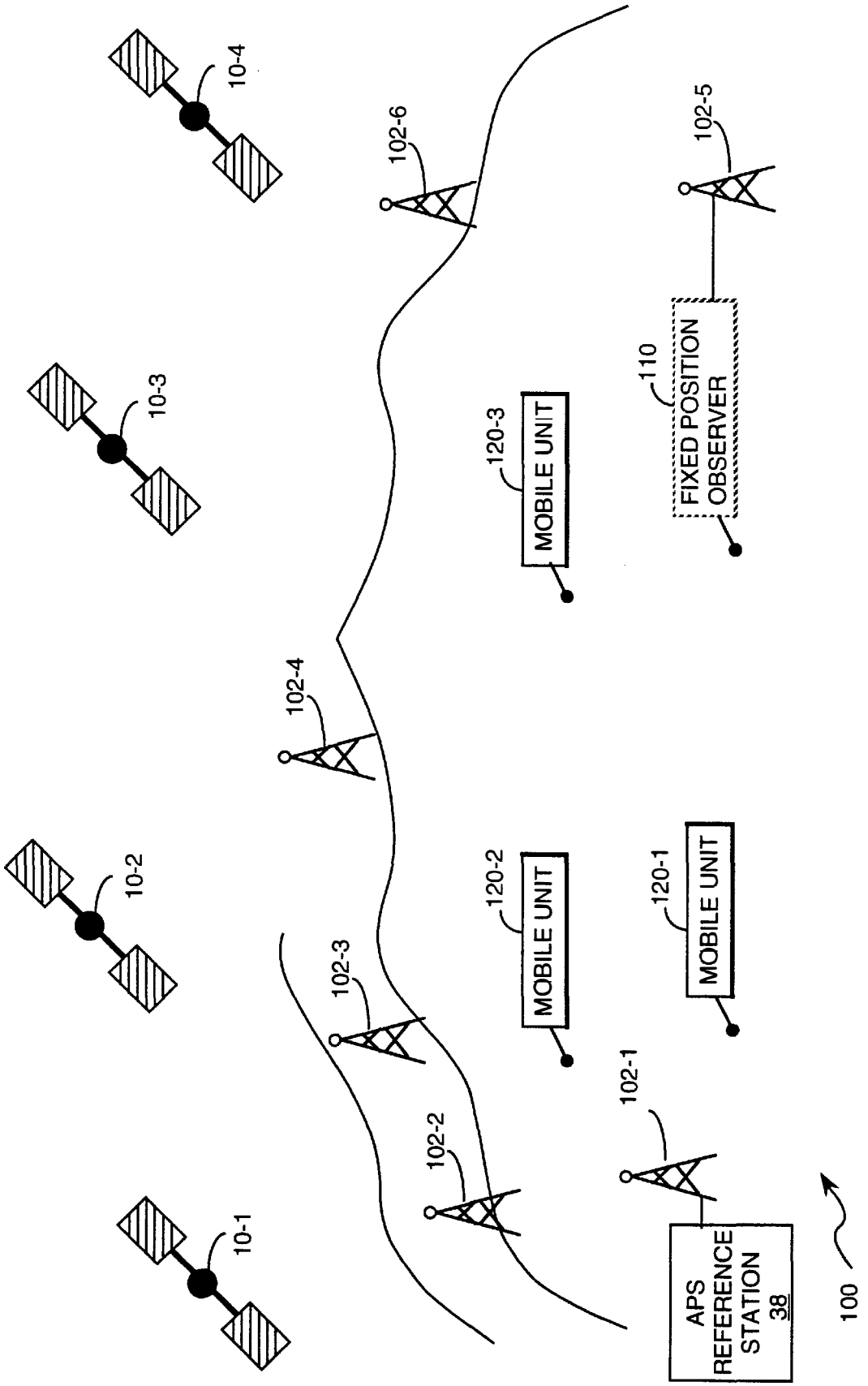

FIGURE 1

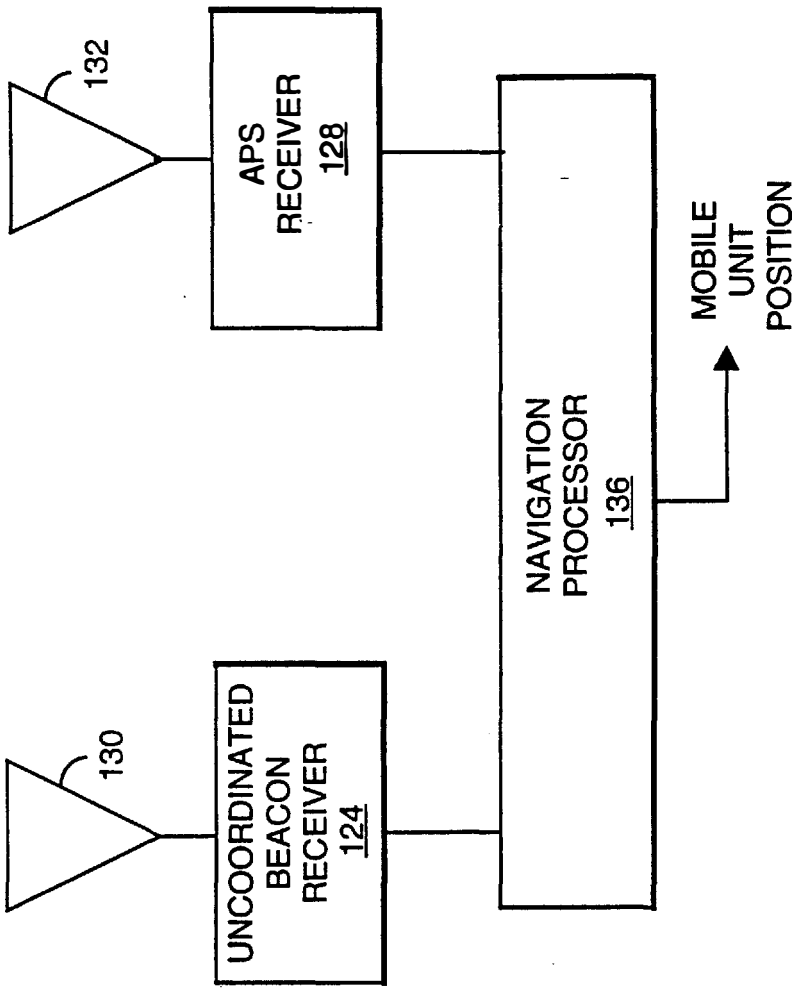

FIGURE 2A

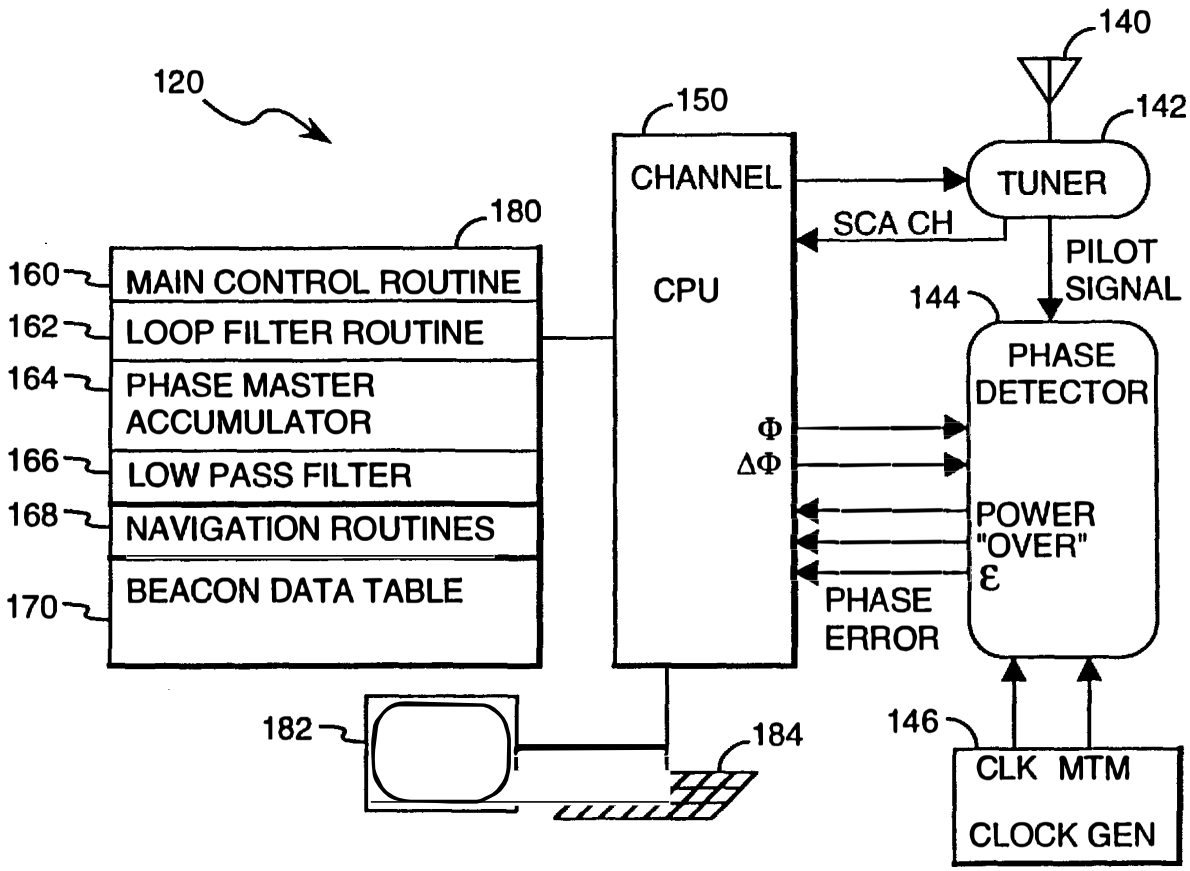

FIGURE 2B

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