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**Eberlein et al.**

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(54) **METHOD AND APPARATUS FOR FINE FREQUENCY SYNCHRONIZATION IN MULTI-CARRIER DEMODULATION SYSTEMS**

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(57) **ABSTRACT**

§ 371 (c)(1),  
(2), (4) Date: **Nov. 29, 2000**

A method and an apparatus relating to a fine frequency synchronization compensating for a carrier frequency deviation from an oscillator frequency in a multi-carrier demodulation system of the type capable of carrying out a differential phase decoding of multi-carrier modulated signals, the signals comprising a plurality of symbols, each symbol being defined by phase differences between simultaneous carriers having different frequencies. A phase difference between phases of the same carrier in different symbols is determined. Thereafter, a frequency offset is determined by eliminating phase shift uncertainties related to the transmitted information from the phase difference making use of a M-PSK decision device. Finally, a feedback correction of the carrier frequency deviation is performed based on the determined frequency offset. Alternatively, an averaged frequency offset can be determined by averaging determined frequency offsets of a plurality of carriers. Then, the feedback correction of the frequency deviation is performed based on the averaged frequency offset.

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**H03D 3/22** (2006.01)  
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(52) **U.S. Cl.** ..... **375/332; 370/210**

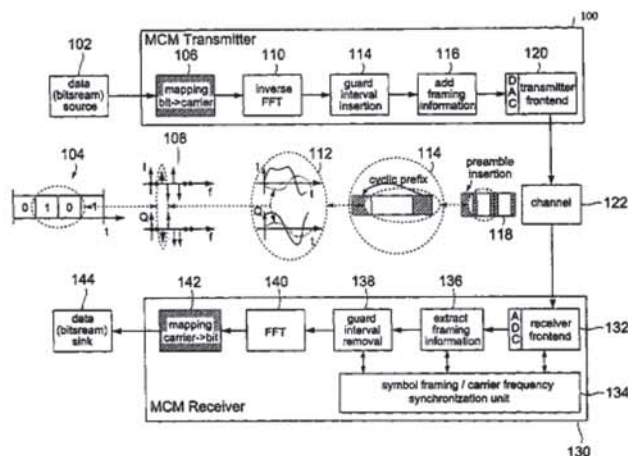
(58) **Field of Classification Search** ..... **375/332, 375/200; 370/203, 200, 207, 480, 210**  
See application file for complete search history.

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**7 Claims, 13 Drawing Sheets**



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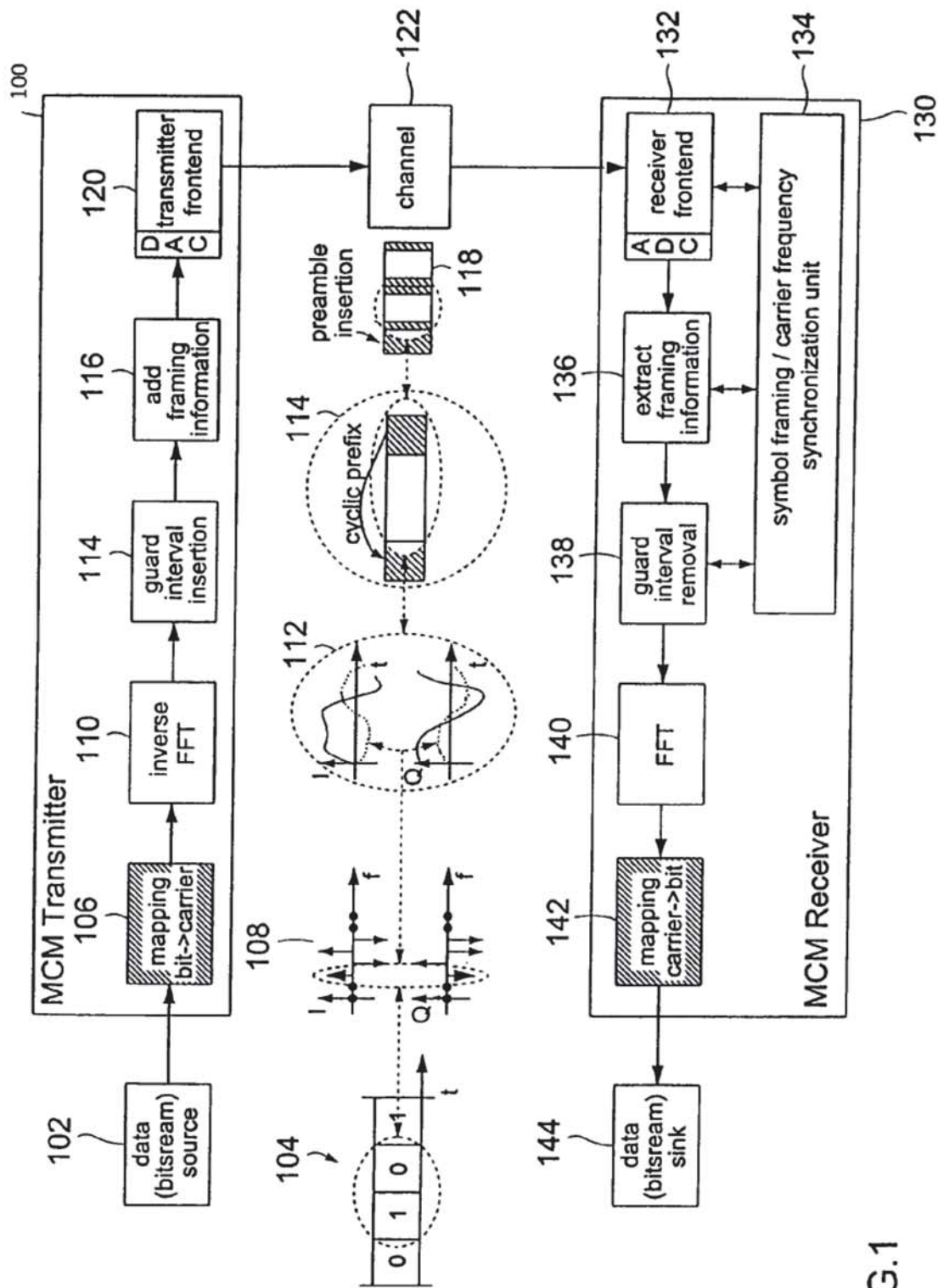


FIG.1

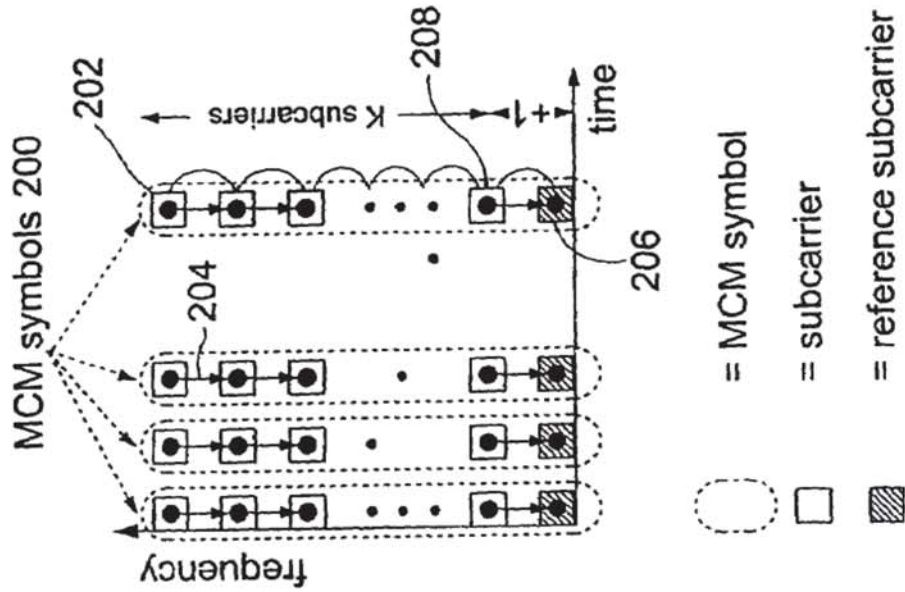


FIG. 2A

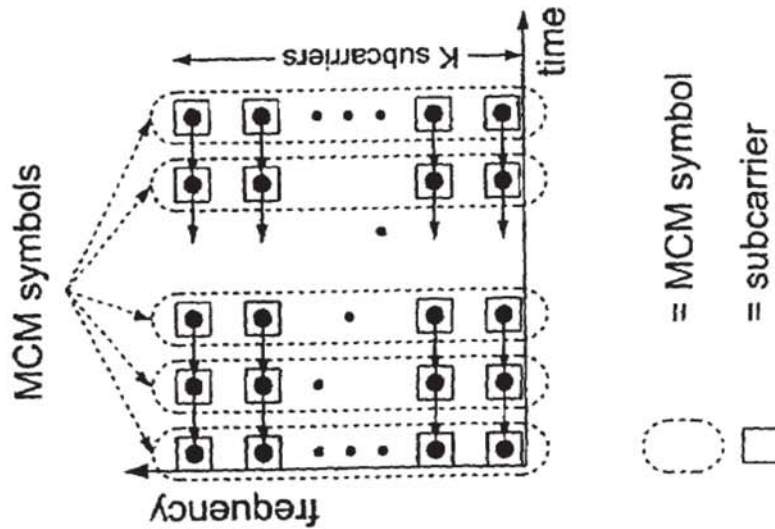


FIG. 2B



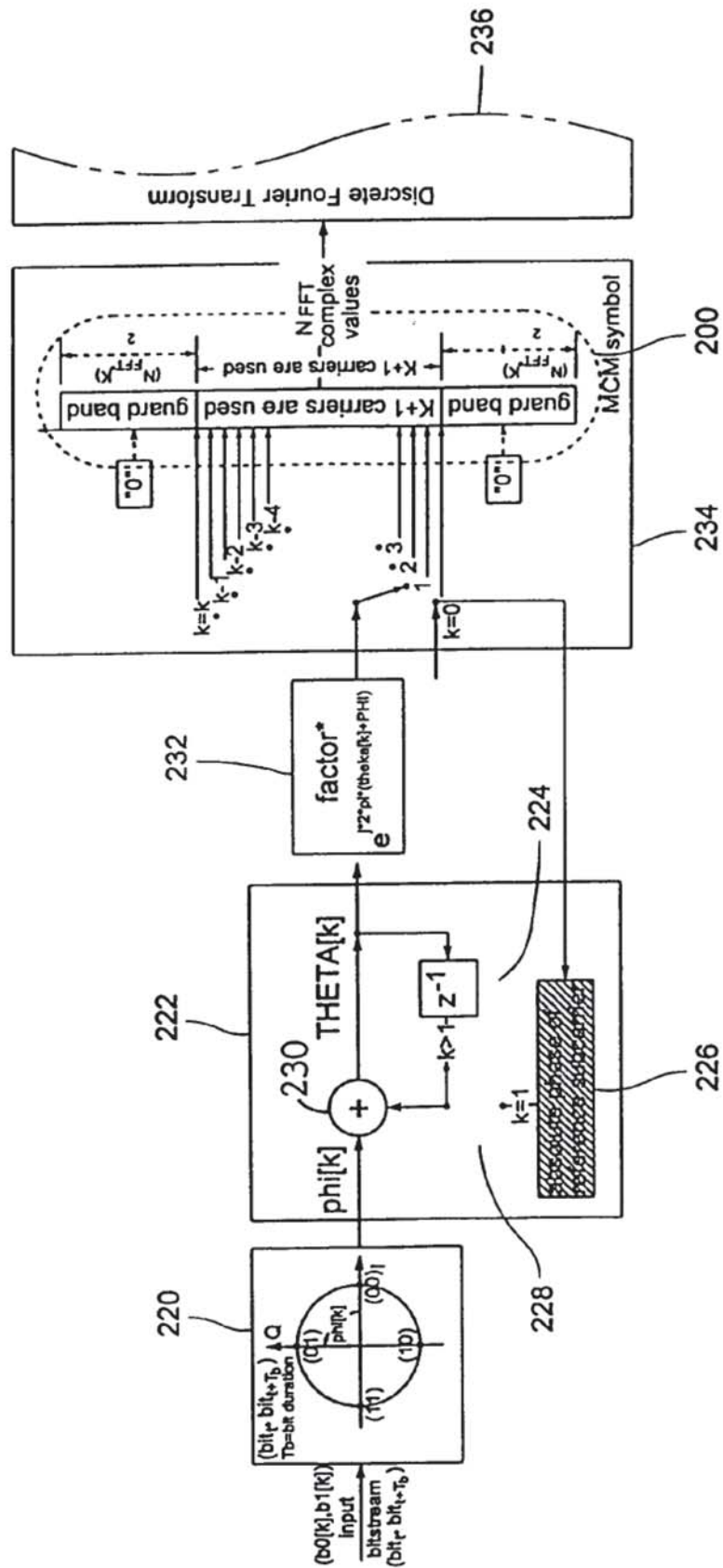


FIG.3

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