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**Lee et al.**

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(54) **APPARATUS AND METHOD FOR SIGNAL CONSTITUTION FOR DOWNLINK OF OFDMA-BASED CELLULAR SYSTEM**

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(58) **Field of Classification Search** ..... 370/347,  
370/344; 455/562.1

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,496,535 B2\* 12/2002 Xu ..... 375/219

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 938 208 A1 8/1999

(Continued)

OTHER PUBLICATIONS

Magnus Sandell, et al., "A comparative study of pilot-based channel estimators for wireless OFDM", Sep. 1996, Research Report, LuleA University, Sweden, 1402-1528.

(Continued)

*Primary Examiner*—Chi H. Pham

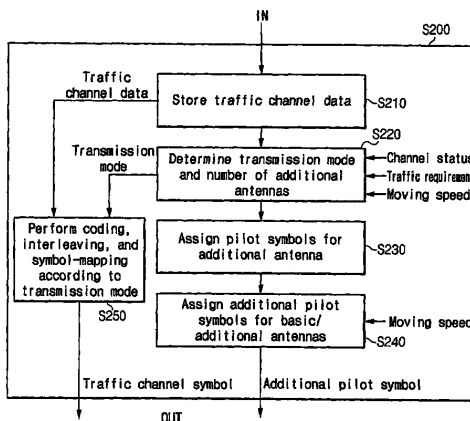
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(57) **ABSTRACT**

Disclosed are an adaptive pilot symbol assignment method that flexibly controls the number of transmit antennas according to each user's moving speed, channel status, or user request, and assigns proper pilot symbols in the downlink of an OFDMA (Orthogonal Frequency Division Multiplexing Access) based cellular system; and a sub-carrier allocation method for high-speed mobile that allocates some sub-carriers to assign proper pilot symbols for ultrahigh-speed mobile users, and the rest of the sub-carriers to the other users to assign proper pilot symbols to the users, on the assumption that the ultrahigh-speed mobile users have a traffic volume almost insignificant to the whole traffic volume.

**10 Claims, 9 Drawing Sheets**



U.S. PATENT DOCUMENTS

6,545,997	B1 *	4/2003	Bohnke et al. ....	370/347
6,836,484	B2	12/2004	Suzuki .....	370/465
6,907,026	B2 *	6/2005	Akiyama .....	370/344
6,959,052	B2 *	10/2005	Harada et al. ....	375/340
6,993,092	B1	1/2006	Murakami et al. ....	375/298
2001/0004604	A1 *	6/2001	Toshimitsu et al. ....	455/562
2001/0055287	A1	12/2001	Sawada et al.	
2001/0055296	A1 *	12/2001	Akiyama .....	370/344

FOREIGN PATENT DOCUMENTS

JP	2001-1030114	4/2001
JP	2001-238269	8/2001
WO	WO 02/065685	8/2002

WO WO 2004/056022 A3 7/2004

OTHER PUBLICATIONS

Cheong Yui Wong, et al., "A Real-time Sub-carrier Allocation Scheme for Multiple Access Downlink OFDM Transmission", 0-7803-5435-4/99 1999 IEEE VTC '99 pp. 1124-1128.  
 Srihari Adireddy, et al., "Detection with Embedded Known Symbols; Optimal Symbol Placement and Equalization"; 0-7803-6293-4 2000 IEEE; pp. 2541-2544.  
 F. Classen, et al., "Channel estimation units for an OFDM system suitable for mobile communication", in ITG Conference on Mobile Radio, Neu-Ulm, Germany, Sep. 1995.  
 P. Hoeher, et al., "Pilot-symbol-aided channel estimation in time and frequency", Kluwer Academic Publishers, Multi-carrier Spread-Spectrum, 1997.  
 Ma. J. Fernandez-Getino Garcia, et al., "Efficient pilot patterns for channel estimation in OFDM systems over HF channels", Proc. IEEE VTC1999.

\* cited by examiner

Fig. 1

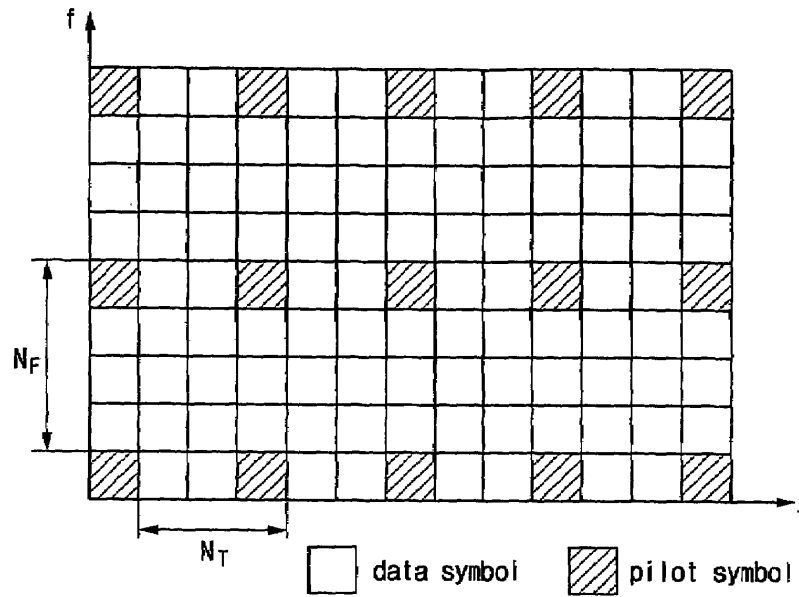


Fig. 2

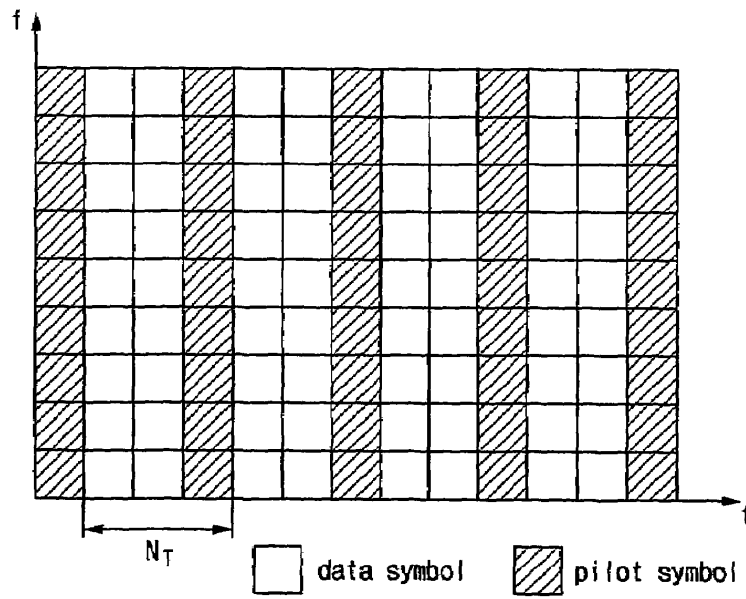
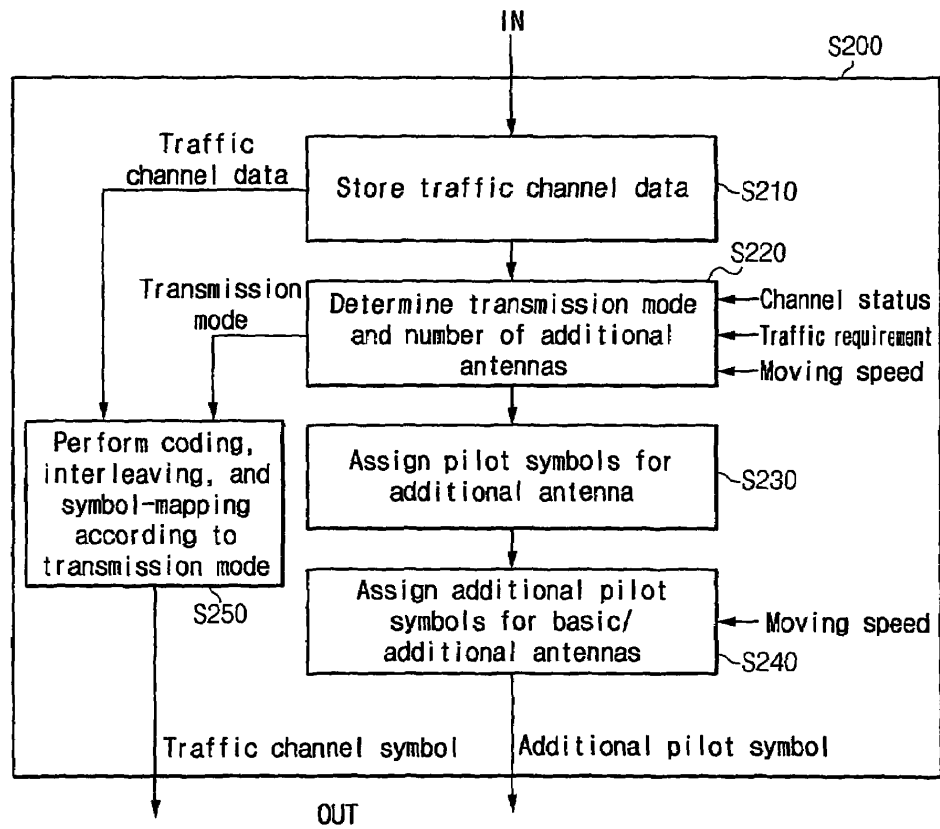




Fig. 5



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