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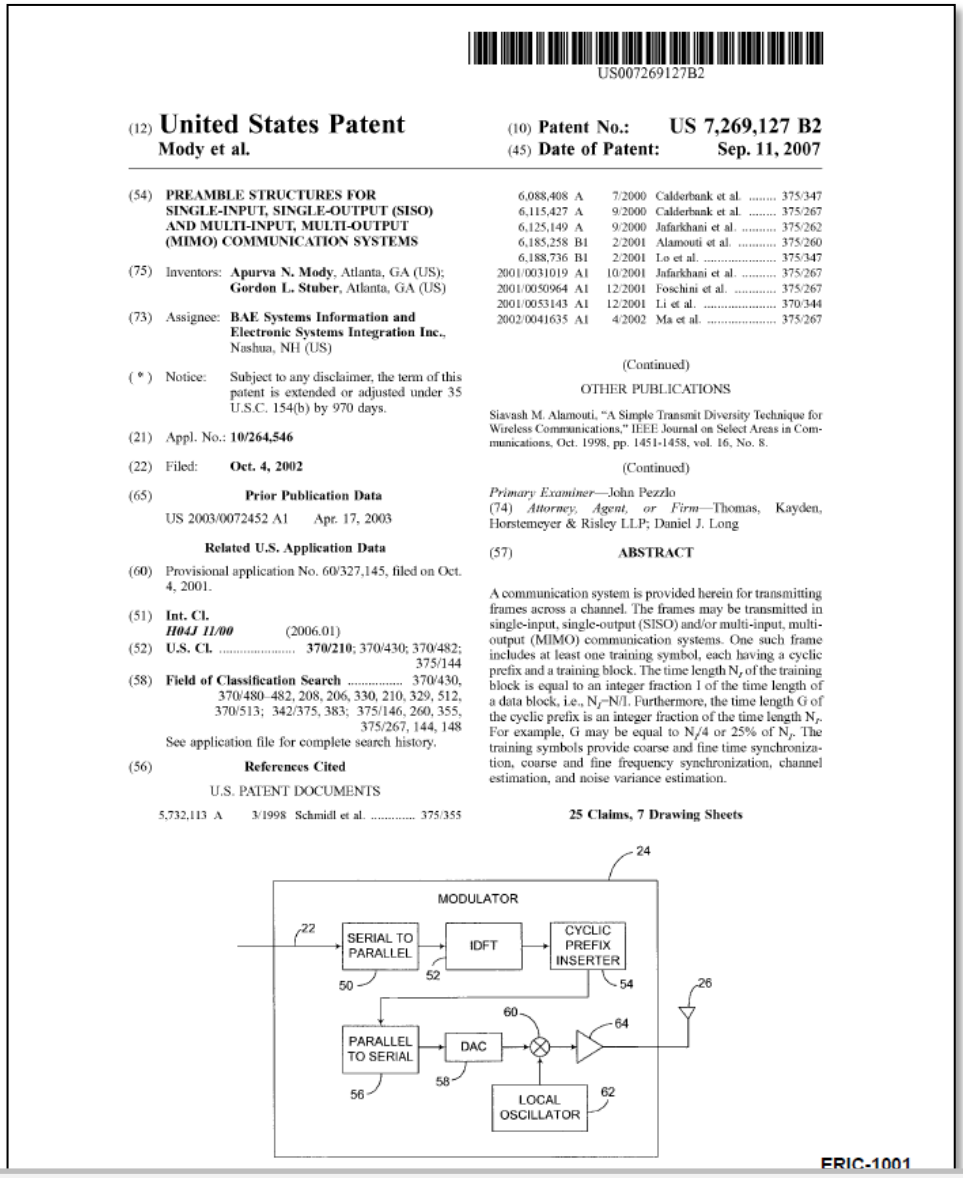

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(12) **United States Patent**
Mody et al.

(10) **Patent No.: US 7,269,127 B2**
(45) **Date of Patent: Sep. 11, 2007**

(54) **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION 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 970 days.

(21) Appl. No.: **10/264,546**

(22) Filed: **Oct. 4, 2002**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**
H04J 11/00 (2006.01)

(52) **U.S. Cl.** **370/210**; 370/430; 370/482; 375/144

(58) **Field of Classification Search** 370/430, 370/480–482, 208, 206, 330, 210, 329, 512, 370/513; 342/375, 383; 375/146, 260, 355, 375/267, 144, 148

See application file for complete search history.

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(57) **ABSTRACT**

A communication system is provided herein for transmitting frames across a channel. The frames may be transmitted in single-input, single-output (SISO) and/or multi-input, multi-output (MIMO) communication systems. One such frame includes at least one training symbol, each having a cyclic prefix and a training block. The time length N_f of the training block is equal to an integer fraction I of the time length of a data block, i.e., $N_f = N/I$. Furthermore, the time length G of the cyclic prefix is an integer fraction of the time length N_f. For example, G may be equal to $N_f/4$ or 25% of N_f. The training symbols provide coarse and fine time synchronization, coarse and fine frequency synchronization, channel estimation, and noise variance estimation.

25 Claims, 7 Drawing Sheets

ERIC-1001

U.S. Patent 7,269,12 to Mody et

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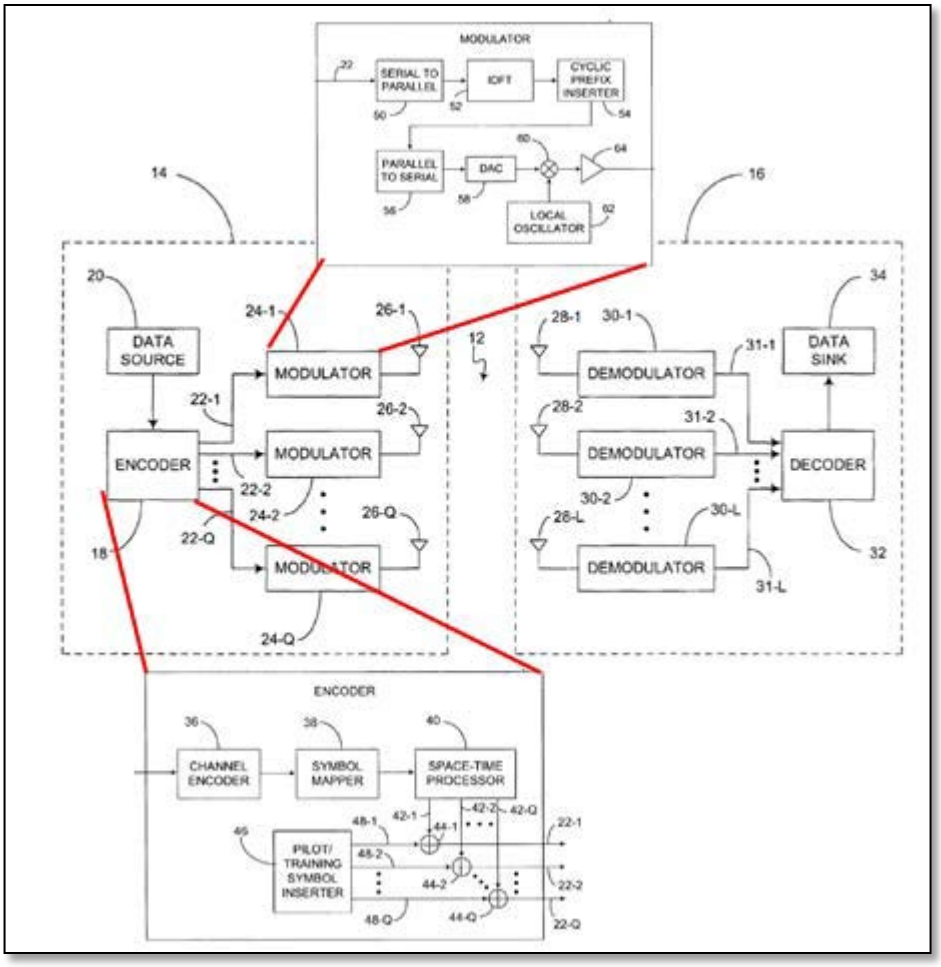

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Claim 1

A transmitter of a communication system, the transmitter comprising:

an encoder having a pilot/training symbol inserter, the pilot/training symbol inserter configured to insert pilot symbols into data blocks and combine training symbols with the data blocks;

at least one modulator, each modulator having an inverse discrete Fourier transform ([I]DFT) stage and a cyclic prefix inserter, each modu outputting a frame structure comprising a preamble structure and a dat structure, the preamble structure comprising at least one training symb and an enhanced training symbol; and

at least one transmit antenna, each transmit antenna correspondir a respective one or the at least one modulator, each transmit antenna transmitting the frame structure output from the corresponding modula wherein the enhanced training symbol is a single symbol.

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