



[54] MULTIPLE ACCESS CODING FOR RADIO COMMUNICATIONS

[75] Inventors: Paul W. Dent, Stehag, Sweden; Gregory E. Bottomley, Cary, N.C.

[73] Assignee: Ericsson GE Mobile Communications Inc., Research Triangle Park, N.C.

[21] Appl. No.: 866,865

[22] Filed: Apr. 10, 1992

[51] Int. Cl.<sup>5</sup> ..... H04K 1/00

[52] U.S. Cl. .... 380/37; 375/1; 380/34

[58] Field of Search ..... 375/1; 380/34, 37, 36, 380/49, 50

[56] References Cited

U.S. PATENT DOCUMENTS

- 4,052,565 10/1977 Baxter et al.
4,134,071 1/1979 Ohnsorge
4,293,953 10/1981 Gutleber
4,455,662 6/1984 Gutleber
4,470,138 9/1984 Gutleber
4,568,915 2/1986 Gutleber
4,644,560 2/1987 Torre et al.
4,901,307 2/1990 Gilhousen et al.
4,930,140 5/1990 Cripps et al.
4,933,952 6/1990 Albrieux et al.
4,984,247 1/1991 Kaufmann et al.
5,022,049 6/1991 Abrahamson et al.
5,048,057 9/1991 Saleh et al.
5,048,059 9/1991 Dent
5,056,109 10/1991 Gilhousen et al.
5,060,266 10/1991 Dent
5,091,942 2/1992 Dent
5,101,501 3/1992 Gilhousen et al.
5,103,459 4/1992 Gilhousen et al.
5,109,390 4/1992 Gilhousen et al.
5,136,612 8/1992 Bi
5,151,919 9/1992 Dent
5,159,608 10/1992 Falconer et al.

FOREIGN PATENT DOCUMENTS

- 336832 10/1989 European Pat. Off.
2172777 9/1986 United Kingdom

OTHER PUBLICATIONS

Tzannes, N. S., Communication and Radar Systems, N.J.: Prentice-Hall, Inc., 1985, pp. 227-239.

Stremmer, F. G., Introduction to Communication Systems, Mass.: Addison-Wesley Publishing Co., 1982, pp. 406-418.

"Introduction to Spread-Spectrum Antimultipath Techniques and Their Application to Urban Digital Radio", G. Turin, Proceedings of the IEEE, vol. 68, No. 3, Mar. 1980.

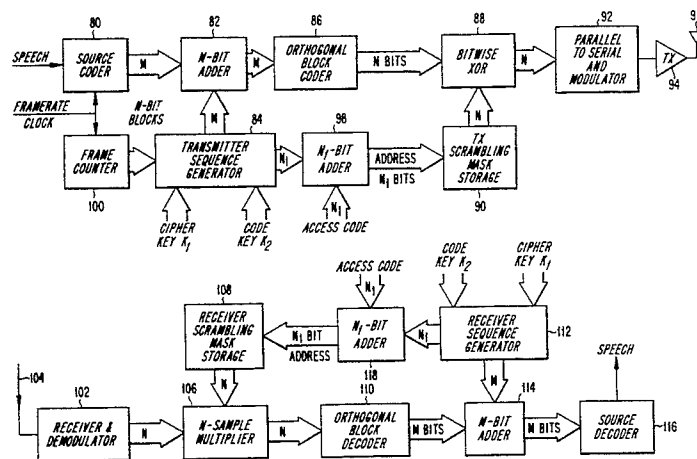
(List continued on next page.)

Primary Examiner—Tod R. Swann
Attorney, Agent, or Firm—Burns, Doane, Swecker & Mathis

[57] ABSTRACT

Individual information signals encoded with a common block error-correction code are assigned a unique scrambling mask, or signature sequence, taken from a set of scrambling masks having selected correlation properties. The set of scrambling masks is selected such that the correlation between the modulo-2 sum of two masks with any codeword in the block code is a constant magnitude, independent of the mask set and the individual masks being compared. In one embodiment, when any two masks are summed using modulo-2 arithmetic, the Walsh transformation of that sum results in a maximally flat Walsh spectrum. For cellular radio telephone systems using subtractive CDMA demodulation techniques, a two-tier ciphering system ensures security at the cellular system level by using a pseudorandomly generated code key to select one of the scrambling masks common to all of the mobile stations in a particular cell. Also, privacy at the individual mobile subscriber level is ensured by using a pseudorandomly generated ciphering key to encipher individual information signals before the scrambling operation.

67 Claims, 9 Drawing Sheets



## OTHER PUBLICATIONS

"A Communication Technique for Multipath Channels", R. Price et al., *Proceedings of the IRE*, Mar. 1958, pp. 555-570.

"Fading Channel Communications", P. Monsen, *IEEE Communications Magazine*, Jan. 1980, pp. 16-25.

Proakis, J. G., *Digital Communications*, N.Y.: McGraw-Hill 1989, pp. 728-739.

"Origins of Spread-Spectrum Communications", Scholtz, *IEEE Transactions on Communications*, vol. COM-30, No. 5, May 1982, pp. 18-21.

"Very Low Rate Convolutional Codes for Maximum Theoretical Performance of Spread-Spectrum Multiple-Access Channels" A Viterbi, *IEEE Journal on Selected Areas in Communications*, vol. 8, No. 4, May 1990.

MacWilliams, F., *The Theory of Error-Correcting Codes, Part I and II*, N.Y.: North-Holland, 1988, pp. 93-124, 451-465.

"A Class of Low-Rate Nonlinear Binary Codes", A. Kerdock, *Information and Control*, vol. 20, pp. 182-187 (1972).

Tatsuro Masamura, "Spread Spectrum Multiple Access System with Intrasystem Interference Cancellation," *Transactions on the Institute of Electronics, Information & Communication Engineers*, vol. E 71, No. 3, Mar. 1988, pp. 224-231.

Mahesh K. Varanasi et al., "An Iterative Detector for Asynchronous Spread-Spectrum Multiple-Access Systems," *Proceedings of the IEEE Global Telecommunications Conference*, vol. 1, Nov. 28-Dec. 1, 1988, pp. 556-560.

Ryuji Kohno et al., "Adaptive Cancellation of Interference in Direct-Sequence Spread-Spectrum Multiple Access Systems," *Proceedings of the IEEE/IEICE Global Telecommunications Conference*, vol. 1, Nov. 15-18, 1987, pp. 630-634.

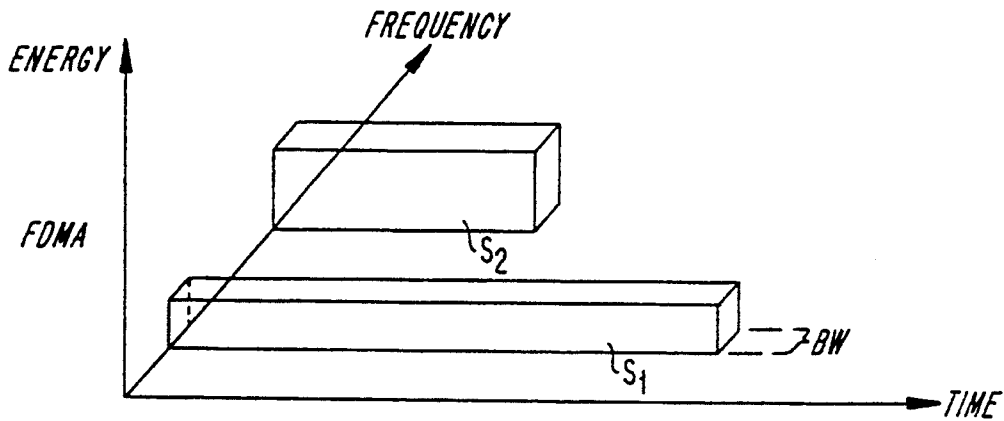


Fig. 1a

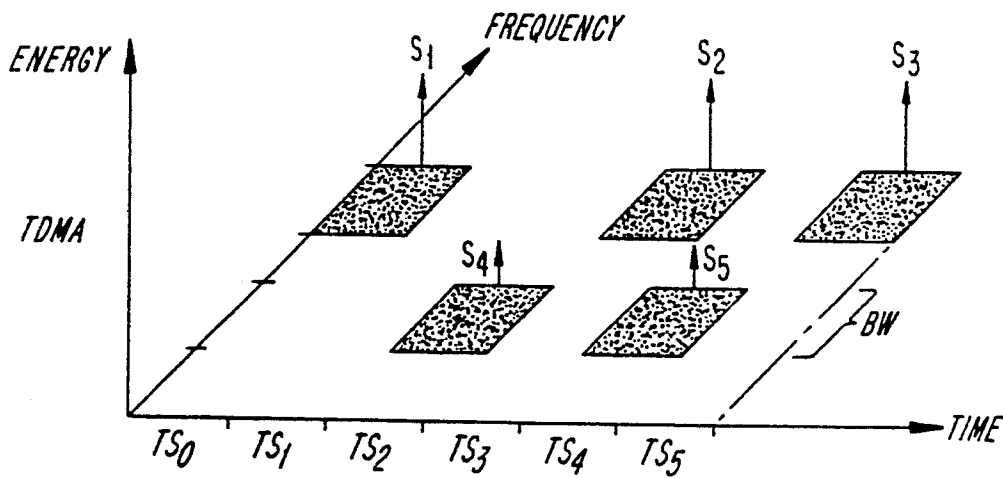


Fig. 1b

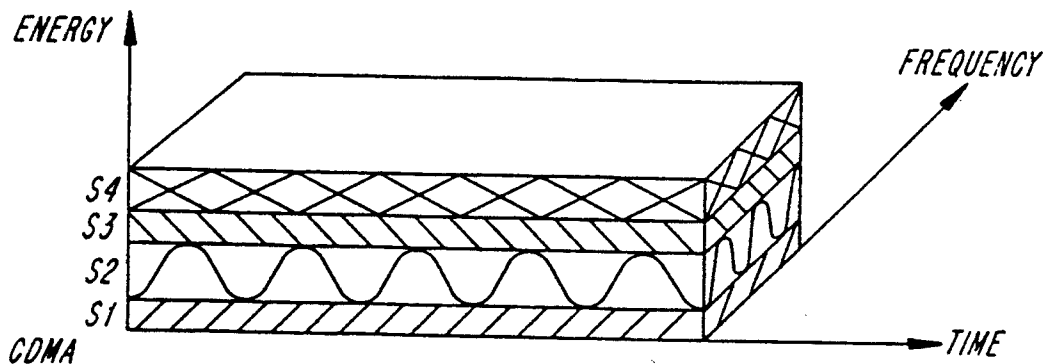


Fig. 1c

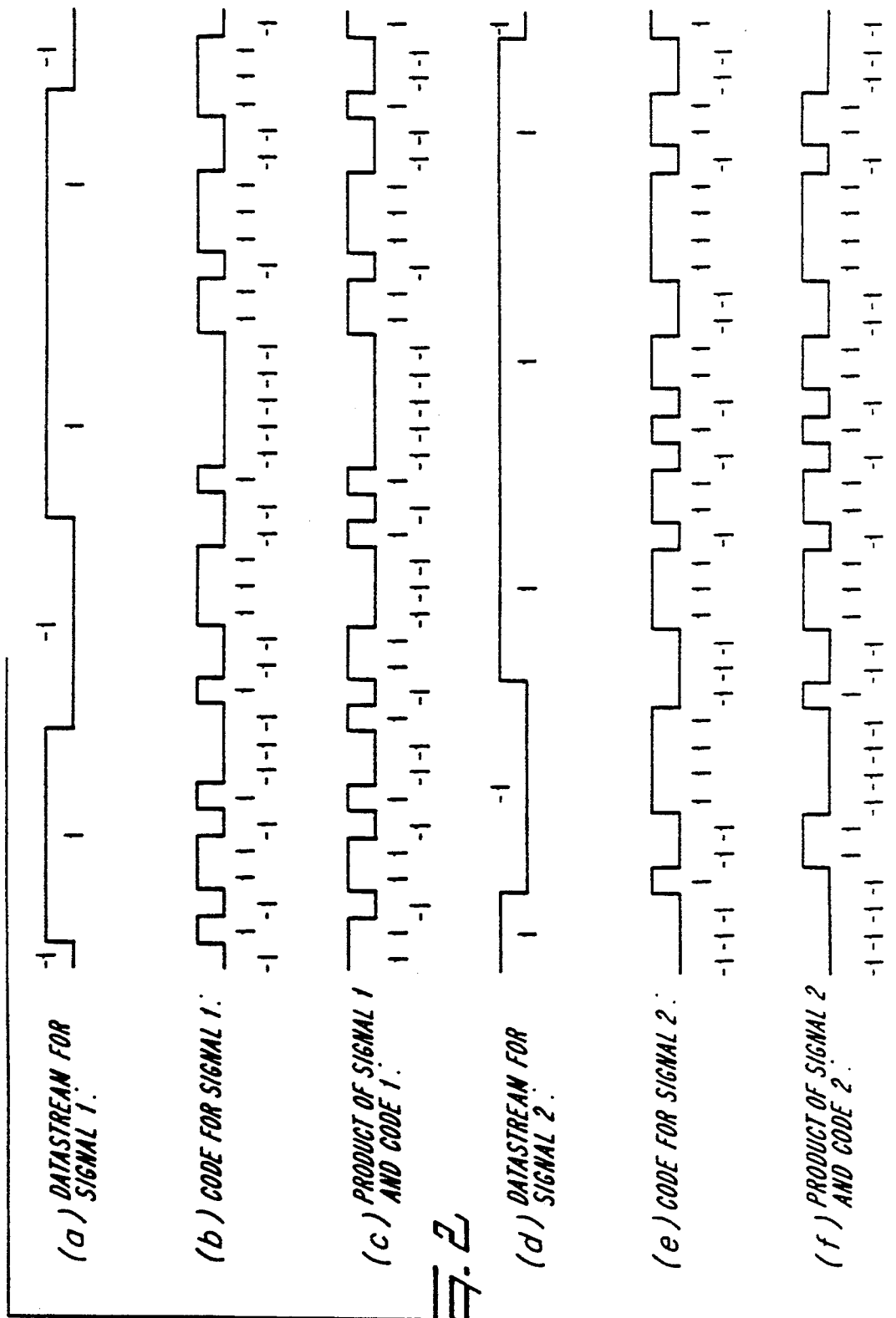
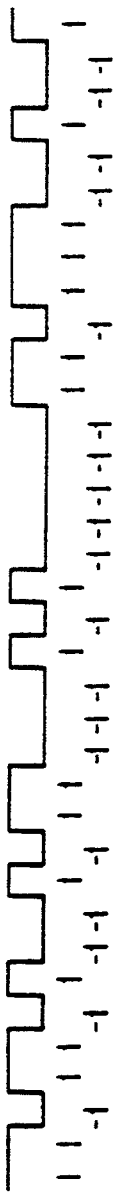


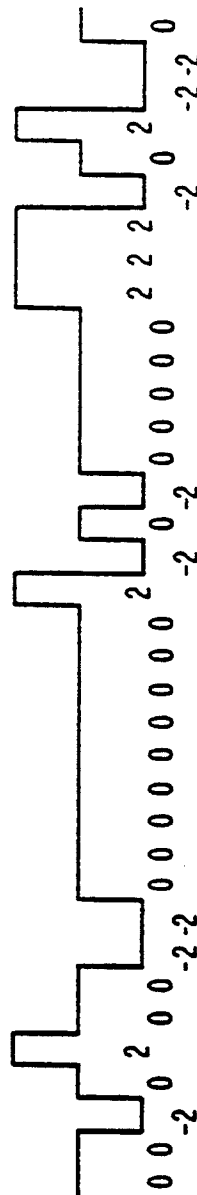
FIG. 2



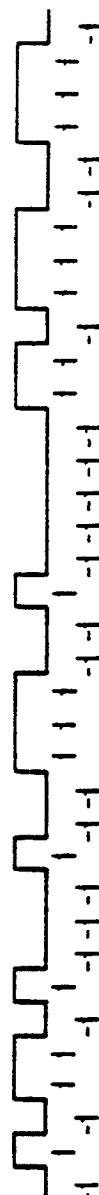
(a) PRODUCT OF SIGNAL 1 AND CODE 1.



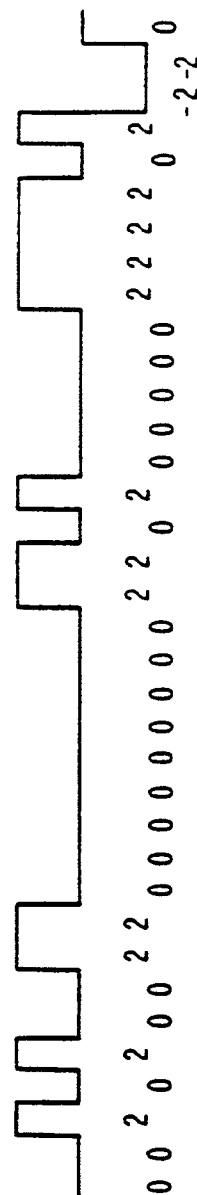
(b) PRODUCT OF SIGNAL 2 AND CODE 2.



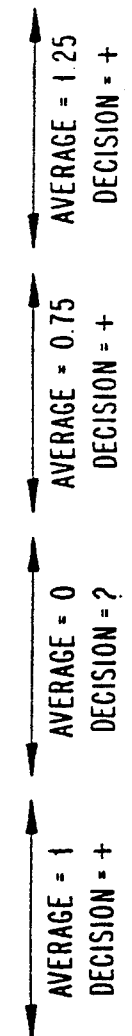
(c) SUM OF CODED SIGNALS 1 AND 2.



(d) CODE FOR SIGNAL 1.



(e) PRODUCT OF SUM WITH SIGNAL 1'S CODE.



(f)

-i 9.3

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.