US006314289B1

(12) United States Patent
Eberlein et al.

(10) Patent No.: **US 6,314,289 B1**
(45) Date of Patent: **Nov. 6, 2001**

(54) **APPARATUS AND METHOD FOR TRANSMITTING INFORMATION AND APPARATUS AND METHOD FOR RECEIVING INFORMATION**

(75) Inventors: **Ernst Eberlein**, Grossenseebach; **Marco Breiling**, Erlangen; **Jan Stoessel**, Nürnberg; **Heinz Gerhäuser**, Waischenfeld, all of (DE)

(73) Assignee: **Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.**, Munich (DE)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,881,241   11/1989 Pommier .

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

0 572 171 A1   5/1993 (EP) .

OTHER PUBLICATIONS

Samir Kallel, "Complementary Punctured Convolutional (CPC) Codes and Their Applications", IEEE Transactions on Communications, vol. 43, No. 6, Jun. 1999, pp 2005–2009.

(List continued on next page.)

Primary Examiner—William Trost
Assistant Examiner—Congvan Tran
(74) Attorney, Agent, or Firm—Dougherty & Clements LLP

(57) **ABSTRACT**

An apparatus for transmitting information comprises a bitstream source for providing a bitstream representing the information, a redundancy adding encoder for generating an encoded bitstream, which is arranged to output, for a first number of input bits, a second number of output bits, the second number of output bits having at least twice as many output bits as the first number of input bits, wherein the second number of output bits includes two portions of output bits, each portion of output bits individually allowing the retrieval of information represented by the first number of input bits, and the first portion of output bits being coded based on the bitstream in a different way with respect to the second portion of output bits. The apparatus further comprises a partitioner for partitioning the second number of output bits into the two portions of output bits and a transmitter for transmitting the output bits of the first portion via a first channel and the output bits of the second portion via a second channel, the second channel being spatially different from the first channel. An inventive receiving apparatus combines the signals received via the first and second channels and uses both channel signals for channel decoding by removing redundancy. Thus, the transmitting receiving system is suitable for providing time and/or space diversity and, in the optimal case, provides a C/N value which is greater than 4.3 dB with respect to a two-channel system comprising a duplicator in the transmitter and a channel-controlled switch in the receiver.

35 Claims, 4 Drawing Sheets
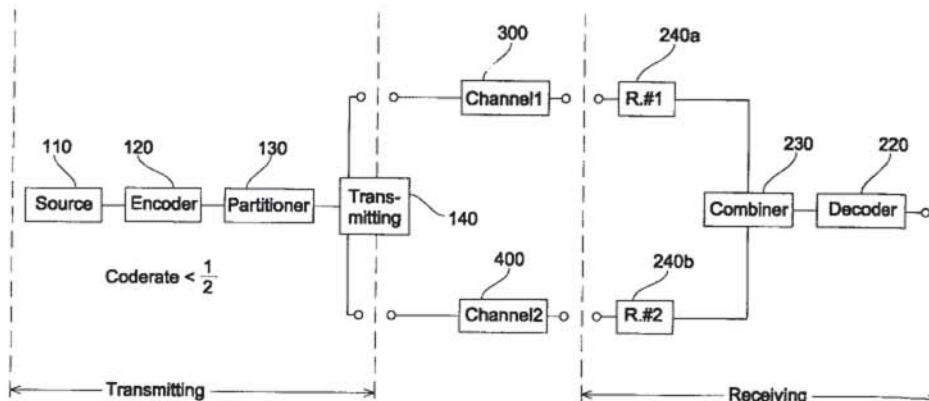
U.S. PATENT DOCUMENTS

5,103,459	*	4/1992	Gilhousen et al.	375/200
5,258,987	*	11/1993	Wei	371/43
5,319,673		6/1994	Briskman .	
5,485,485		1/1996	Briskman .	
5,581,575	*	12/1996	Zehavi et al.	375/200
5,592,471		1/1997	Briskman .	
5,617,333	*	4/1997	Oyamada et al.	364/524 A
5,657,325		8/1997	Lou et al. .	
5,659,569	*	8/1997	Padovani et al.	370/479
5,841,813		11/1998	van Nee .	
5,896,368	*	4/1999	Dalman et al.	370/335
5,956,088	*	9/1999	Shen et al.	348/385
6,134,696	*	10/2000	Morelos-Zaragoza et al.	714/790
6,144,711	*	11/2000	Raleigh et al.	375/347
6,163,577	*	12/2000	Ekudden et al.	375/242

OTHER PUBLICATIONS

Brian Kroeger, "Robust Modem and Coding Techniques for FM Hybrid IBOC DAB", USA Digital Radio Home Page, www.usadr.com, pp 1–14.

Benelli G., "Two New Coding Techniques for Diversity Communication Systems", IEEE Transactions on Communications, Sep. 1, 1990, pp. 1530–1538, vol. 38, No. 9, New York, US.

Alamouti S M, A simple transmit diversity techique for wireless communications, IEEE Journal on Selected Areas in Communications, Oct. 1998, pp. 1451–1458, vol. 16 No. 8.

ETS 300 401, ETS I—European Telecommunications Standards Institute Valbonne, France, Jan. 1997, pp 149–158.

"Punctured Convolutional Codes of Rate (n–l)n and Simplified Maximum Likelihood Decoding" J. Bibb Cain et al, IEEE Transactions on Information Theory, vol. IT–25, No. 1, Jan. 1979.

"Channel Coding with Multilevel/Phase Signals", Gottfried Ungerboeck, IEEE Transactions on Information Theory, vol. IT–28, No. 1, pp 55–66, Jan. 1982.
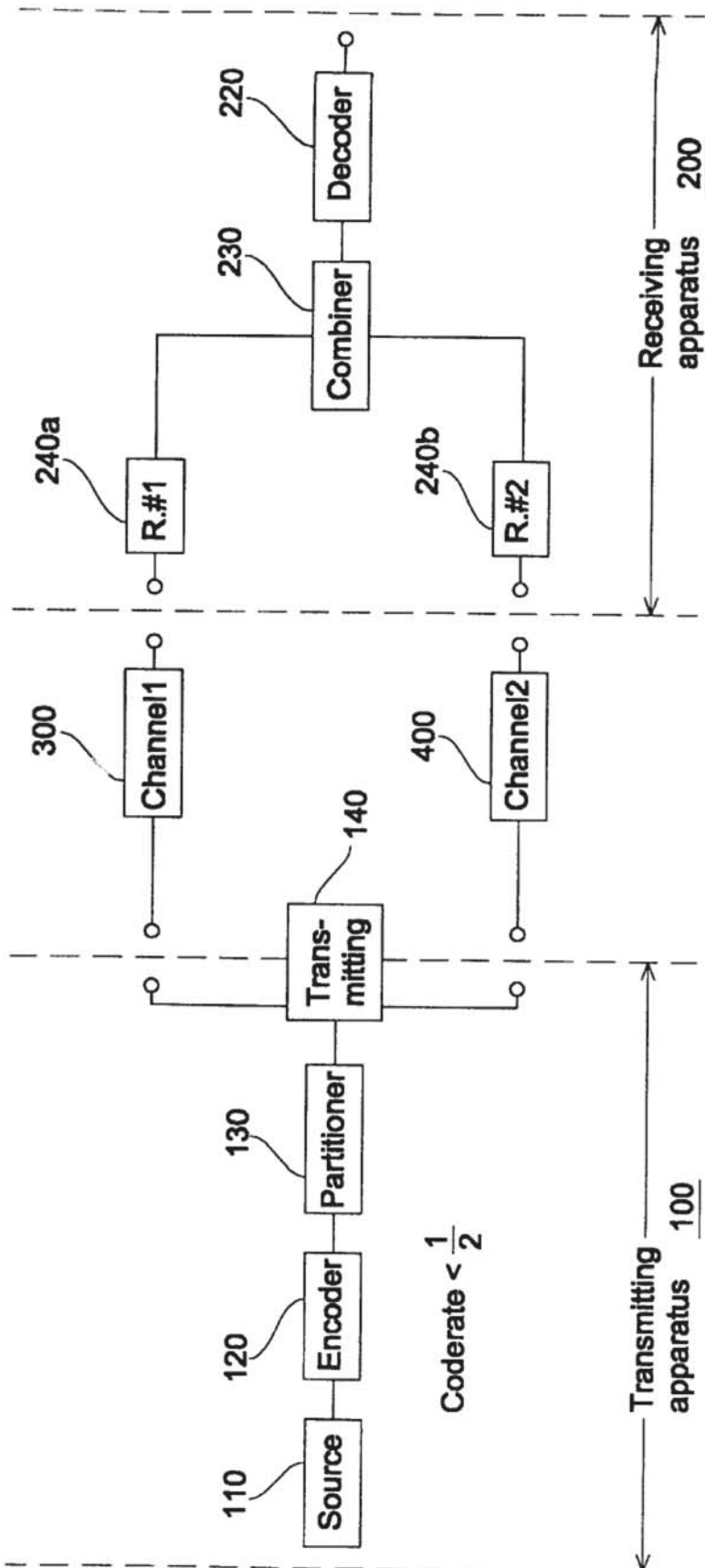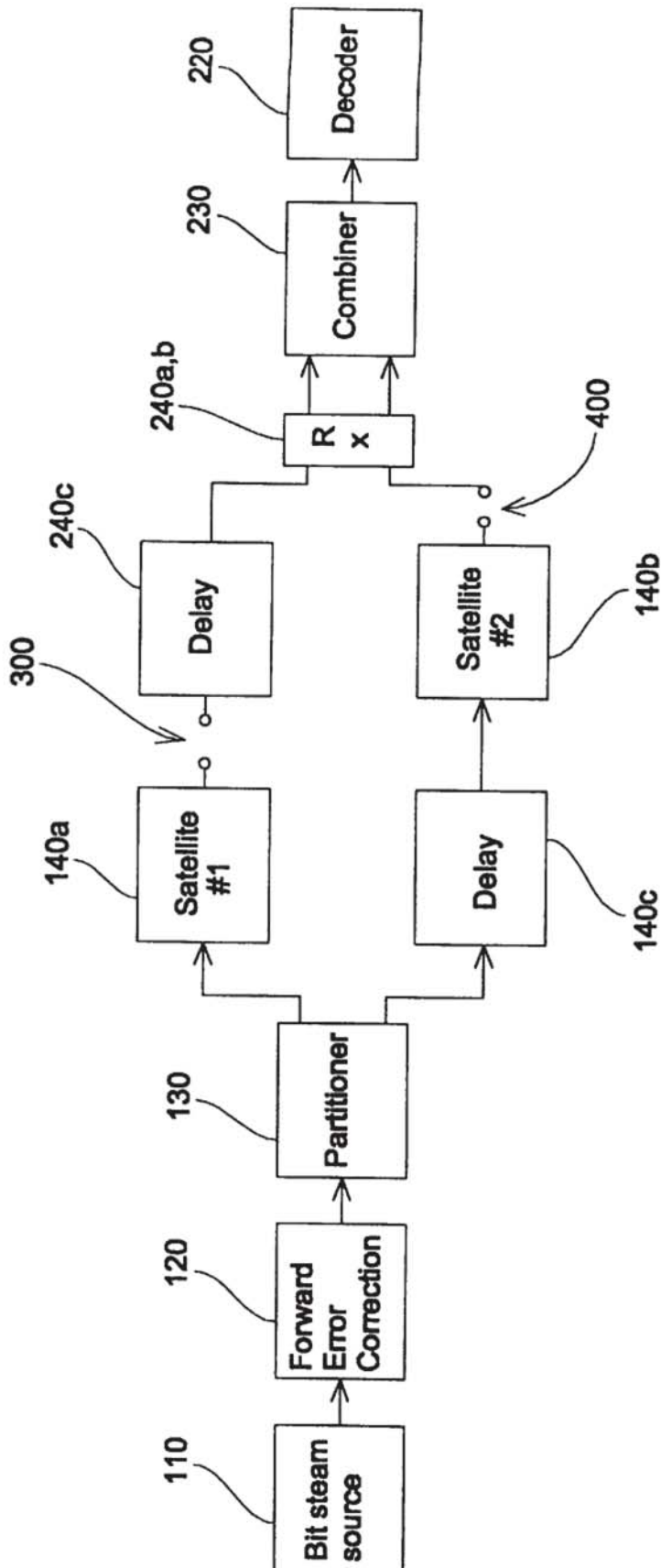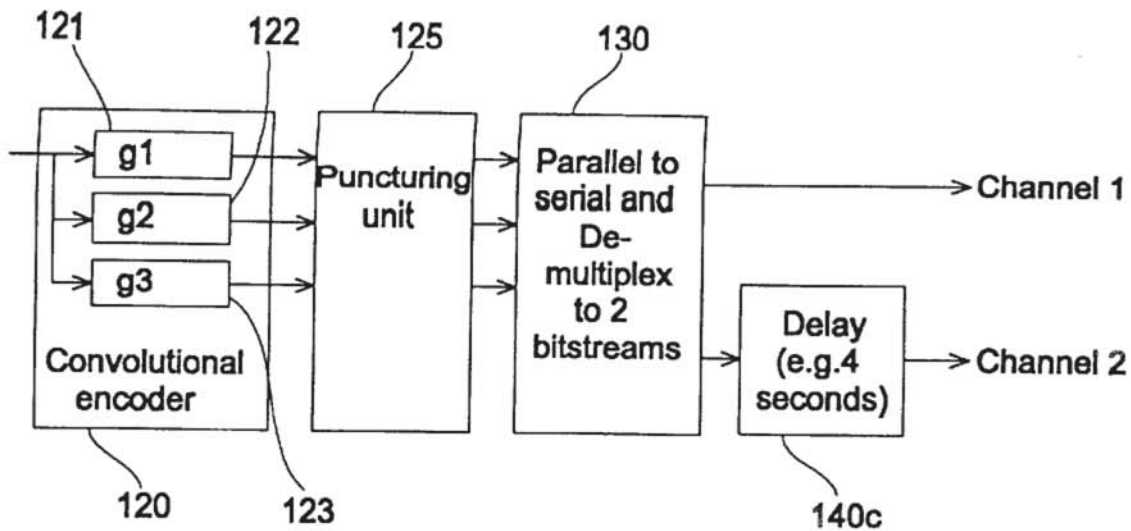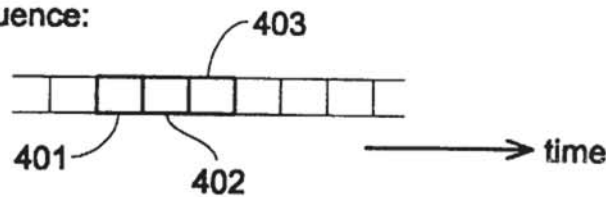
* cited by examiner

Fig. 1

Fig. 2

121   122   125   130

g1

g2

g3

Convolutional
encoder

Puncturing
unit

Parallel to
serial and
De-
multiplex
to 2
bitstreams

Delay
(e.g.4
seconds)

→ Channel 1

→ Channel 2

120   123   140c

Fig. 3

Input bit sequence: 403

401   402   → time

After convolutional encoder:

411   412

		E	E	E			
		E	X	L			
		L	L	L			

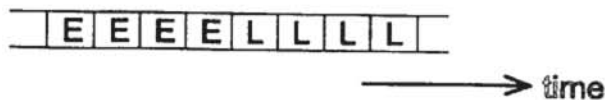413   → time
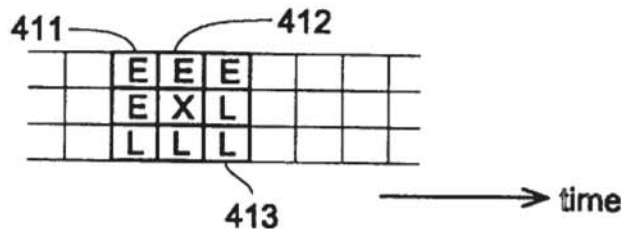
E=Bit transmitted over early satellite
L=Bit transmitted over late satellite
X=not transmitted (punctured) bit

After parallel-to-serial converter:

| E | E | E | E | L | L | L | L |

→ time

After demultiplexer:

410

| E | E | E | E |

→ time

| L | L | L | L |

420

Fig. 4

DOCKET ALARM
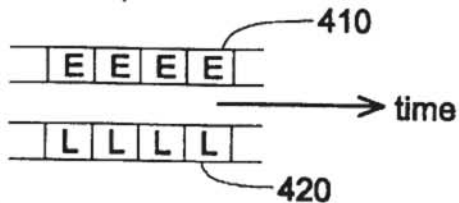
Explore Litigation Insights

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.

fastcase®
Smarter legal research.