

FILE HISTORY
US 5,659,891

PATENT: 5,659,891
INVENTORS: Hays, William D.
Cameron, Dennis
Roehr, Walter

TITLE: Multicarrier techniques in bandlimited
channels

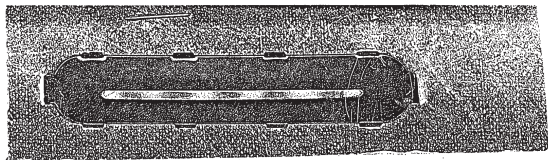
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ISSUED: 19 AUG 1997

COMPILED: 13 JUN 2013

08/480718

455	Class
103	Subclass

ISSUE CLASSIFICATION



5659891

UTILITY SERIAL NUMBER 08/480718	PATENT DATE AUG 19 1997	PATENT NUMBER
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SERIAL NUMBER 08/480,718	FILING DATE 06/07/95	CLASS 455	SUBCLASS 103	GROUP ART UNIT 2611
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5659891

L. J. ROEHR

APPLICANTS

WILLIAM D. HAYS, JACKSON, MS; DENNIS CAMERON, JACKSON, MS; WALTER ROEHR, RESTON, VA.

CONTINUING DATA***
VERIFIED

None lead

FOREIGN/PCT APPLICATIONS***
VERIFIED

None lead

FOREIGN FILING LICENSE GRANTED 11/30/95

Foreign priority claimed 35 USC 119 conditions met	<input type="checkbox"/> yes <input checked="" type="checkbox"/> no	AS FILED	STATE OR COUNTRY	SHEETS DRWGS.	TOTAL CLAIMS	INDEP. CLAIMS	FILING FEE RECEIVED	ATTORNEY'S DOCKET NO.
Verified and Acknowledged	<i>Lee</i>	→	MS	9	8	3	\$860.00	03680.0143

ADDRESS

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WASHINGTON DC 20005-3315

TITLE

MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS

U.S. DEPT. OF COMM./ PAT. & TM—PTO-436L (Rev.12-94)

PARTS OF APPLICATION FILED SEPARATELY		Applications Examiner <i>Ridner</i>	
NOTICE OF ALLOWANCE MAILED		CLAIMS ALLOWED	
<i>2-14-97</i>		Total Claims	Print Claim
LEE NGUYEN Assistant Examiner		5	1
ISSUE FEE		DRAWING	
Amount Due	Date Paid	Sheets Drwg.	Figs. Drwg.
<i>\$290.00</i>	<i>5/11/97</i>	<i>9/1</i>	<i>11</i>
Label Area		Print Fig.	<i>1</i>
		ISSUE BATCH NUMBER	<i>J12</i>
PREPARED FOR ISSUE			
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(FACE)

5,659,891

MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS

Transaction History

Date	Transaction Description
7/21/1995	Notice Mailed--Application Incomplete--Filing Date Assigned
8/9/1995	Request for Foreign Priority (Priority Papers May Be Included)
9/6/1995	Preliminary Amendment
10/3/1995	Information Disclosure Statement (IDS) Filed
10/3/1995	Information Disclosure Statement (IDS) Filed
11/9/1995	Miscellaneous Incoming Letter
11/13/1995	Application Is Now Complete
12/5/1995	Application Captured on Microfilm
12/18/1995	Case Docketed to Examiner in GAU
1/17/1996	Mail Miscellaneous Communication to Applicant
1/17/1996	Miscellaneous Communication to Applicant - No Action Count
2/5/1996	Non-Final Rejection
2/9/1996	Mail Non-Final Rejection
8/9/1996	Response after Non-Final Action
8/9/1996	Request for Extension of Time - Granted
8/21/1996	Date Forwarded to Examiner
10/28/1996	Final Rejection
10/29/1996	Mail Final Rejection (PTOL - 326)
1/21/1997	Amendment after Final Rejection
1/28/1997	Date Forwarded to Examiner
2/4/1997	Mail Notice of Allowance
2/4/1997	Notice of Allowance Data Verification Completed
2/4/1997	Mail Examiner's Amendment
2/4/1997	Examiner's Amendment Communication
3/3/1997	Mailroom Date of Drawing(s)
3/7/1997	Drawing(s) Matched to Application
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3/25/1997	Drawing(s) Processing Completed
4/3/1997	Mailroom Date of Drawing(s)
4/10/1997	Drawing(s) Matched to Application
4/10/1997	Drawing(s) Received at Publications
4/30/1997	Drawing(s) Processing Completed
5/1/1997	Issue Fee Payment Verified
7/14/1997	Issue Notification Mailed
8/19/1997	Recordation of Patent Grant Mailed

08/ 08/480718

PATENT APPLICATION



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APPROVED FOR LICENSE

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INITIALS _____

Date Entered or Counted

CONTENTS

Date Received or Mailed

Date Entered or Counted	Description	Date Received or Mailed
	1. Application _____ papers.	
	2. LET RE-DEC	11/2/95
	3. Dec Dir	9/21/95
	4. Information Disclosure Statement	8-9-95
	5. Am Amdt A	9-6-95
	6. Status Letter	Nov 9 1995
	7. Letter	1/17/96
	8. Prior Art w/ref	10/3/95
2/5/96	9. 3 mos. Req.	2-9-96 M.L.
	10. Ext. of Time (3) / Amdt B	8/9/96
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	12. Amdt B (INPA)	1/2/97
2/3/97	13. Notice of Allow	2-4-97
3/7/97	14. _____	3/3/97
	15. Notice of Drawing Requirement	3/25/97
4/10/97	16. _____ 3 _____ 2	4/13/97
	17. PTO Exam AUG 1 9 1997	
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POSITION	ID NO.	DATE
CLASSIFIER		8 7-13-95
EXAMINER	504	7-19-95
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CORPS CORR.		
SPEC. HAND	48	11/9/95
FILE MAINT.		7-20-95
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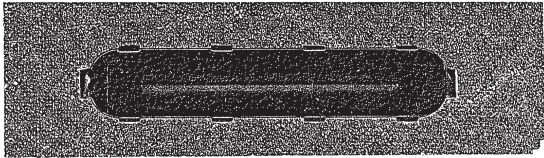
INDEX OF CLAIMS

Claim	Final	Original	Date
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Claim	Final	Original	Date
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SYMBOLS
 ✓ Rejected
 = Allowed
 - (Through numeral) Canceled
 * Restricted
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 I Interference
 A Appeal
 O Objected

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SEARCHED			
Class	Sub.	Date	Exmr.
455	103	1/26/96	Lee
	104		
	17		
	46		
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	260		
375	260	1/28/96	Lee
370	69.1	1/31/96	Lee
	70		
	38		
	40		
455	45	"	"
370	121	"	"
340	825.44	"	"
Update	Search	2/1/97	Lee

INTERFERENCE SEARCHED			
Class	Sub.	Date	Exmr.
455	103, 45	2/1/97	Lee
370	339, 343		

SEARCH NOTES		
	Date	Exmr.
Don Vo (375)	1/28/96	Lee
Chan Kwip (370)	1/30/96	Lee
Ben Sefourek (370, 455)	1/31/96	Lee
Faile (455)	1/31/96	Lee
Zimmerman (340)	1/31/96	Lee

(RIGHT OUTSIDE)

FILE 'USPAT' ENTERED AT 12:46:04 ON 15 OCT 96

* WELCOME TO THE *
* U. S. PATENT TEXT FILE *

=> s multicarrier or multi-carrier

110 MULTICARRIER
188216 MULTI
254738 CARRIER
118 MULTI-CARRIER
(MULTI(W)CARRIER)
L1 198 MULTICARRIER OR MULTI-CARRIER
=> d ll 1-10

1. 5,563,909, Oct. 8, 1996, Radio communication system; Isao Nakazawa, 375/224; 342/196; 375/347 [IMAGE AVAILABLE]
 2. 5,561,686, Oct. 1, 1996, Radio information communication system using **multi**-**carrier** spread spectrum transmission system; Hiroshi Kobayashi, et al., 375/200 [IMAGE AVAILABLE]
 3. 5,559,830, Sep. 24, 1996, Equalization system for AM compatible digital receiver; Mark J. Dapper, et al., 375/230, 232 [IMAGE AVAILABLE]
 4. 5,557,612, Sep. 17, 1996, Method and apparatus for establishing communication in a multi-tone data transmission system; John A. C. Bingham, 370/71, 124 [IMAGE AVAILABLE]
 5. 5,555,257, Sep. 10, 1996, Cellular/satellite communications system with improved frequency re-use; Paul W. Dent, 370/95.1; 342/352; 379/58; 455/13.3, 54.1, 63 [IMAGE AVAILABLE]
 6. 5,551,070, Aug. 27, 1996, Cartesian **multicarrier** feedback; Ulf Skarby, et al., 455/126; 330/149; 375/261; 455/103, 119 [IMAGE AVAILABLE]
 7. 5,550,812, Aug. 27, 1996, System for broadcasting and receiving digital data, receiver and transmitter for use in such system; Norbert J. L. Philips, 370/19, 69.1; 375/362; 455/182.2 [IMAGE AVAILABLE]
 8. 5,548,813, Aug. 20, 1996, Phased array cellular base station and associated methods for enhanced power efficiency; Philippe M. Charas, et al., 455/33.2; 343/890; 455/53.1 [IMAGE AVAILABLE]
 9. 5,548,671, Aug. 20, 1996, Programmable, differential wavelength discriminator; Chi Wu, et al., 385/37, 45 [IMAGE AVAILABLE]
 10. 5,548,582, Aug. 20, 1996, **Multicarrier** frequency hopping communications system; Americo Brajal, et al., 370/18, 20, 23; 375/202 [IMAGE AVAILABLE]
- =>

US PAT NO: 4,858,225 [IMAGE AVAILABLE]

L3: 16 of 21

SUMMARY:

BSUM(8)

According . . . bandwidth B.sub.T while the remaining bandwidth B.sub.T -B.sub.x may be channelized into a multiplicity of narrow VBVC channels suitable for ****multicarrier**** traffic with a varying number of different carriers. In its operation, each channel is subsequently routed to a defined downlink.

DETDESC:

DETD(10)

A . . . carrier, variable bit rate traffic in uplink plan 20 occupies a useful bandwidth B.sub.x 22 from f.sub.T1 to f.sub.x1 while ****multicarrier**** traffic occupies a bandwidth B.sub.T -B.sub.x from f.sub.x2 to f.sub.T2. In this example, ****multicarrier**** traffic is assigned to two connectivity paths 23 and 24 each containing traffic destined to the same downlink beam.

DETDESC:

DETD(11)

The . . . with the M-th channelization level of passband 32. Under these circumstances, the adjacent channel interference (ACI) between single carrier and ****multicarrier**** traffic is suppressed more than 39 dB. The center frequency of passband 32 is $f.sub.RC = (f.sub.R3 + f.sub.R4)/2$. It is referred.

DETDESC:

DETD(41)

If . . . according to the relationship $f.sub.X1 - (f.sub.LO + B'.sub.X) = f.sub.R2$. In this way, all single carrier traffic remains within passband 31 while all ****multicarrier**** traffic is within passband 32. Traffic within the bandwidth 32 emerges from port 47 of the paralleling circuit 46. Output.

CLAIMS:

CLMS(7)

7. . . . variable bandwidth variable center-frequency satellite communications system as recited in claim 6 wherein the filter banks of adjacent subchannels have ****asymmetric**** transmission amplitude characteristics at the edges thereof.

US PAT NO: 4,757,495 [IMAGE AVAILABLE]

L3: 17 of 21

ABSTRACT:

The . . . quality, a requested data rate, or a value indicating the relative user weighting of speech quality and data rate. A ****multi**-**carrier**** multi-mode modulation scheme is employed for data transmission, with this scheme having the ability to fully utilize the remaining bandwidth, . . .

SUMMARY:

BSUM(26)

The first component is a ****multi**-**carrier****, multi-mode, ensemble modem as disclosed in U.S. patent application Ser. No. 06-736,200 filed May 20, 1985 entitled "Ensemble Modem Structure. . .

DETDESC:

DETD(61)

The . . . Duplex protocol approach is that the full transmission capacity of the link is available at all times to respond to ****asymmetric**** data transmission requirements.

CLAIMS:

CLMS(33)

33. . . .
for data transmission, said evaluating means being operatively associated with the selecting means for said selecting of the data sub-band, and ****multicarrier**** data transmitting means for transmitting data in the data sub-band on a plurality of carriers.

US PAT NO: 4,328,902 [IMAGE AVAILABLE]

L3: 20 of 21

SUMMARY:

BSUM(4)

The Muller and Masser patents are examples of prior art interlocking carriers which have ****asymmetrical**** interlocking arrangements that are both difficult to fabricate and time consuming to assemble. The Cornelius patent requires that the carriers.

SUMMARY:

BSUM(5)

It . . . desirable and it is an object of this invention to provide carrier units which may be readily interlocked into a ****multi**carrier**** assembly.

US PAT NO: 3,898,566 [IMAGE AVAILABLE]

L3: 21 of 21

TITLE: Method and apparatus for reducing distortion in ****multicarrier**** communication systems

SUMMARY:

BSUM(2)

The . . . patent application using harmonically related coherent carriers for transmitting a plurality of multiplexed signals such as television programs in a ****multicarrier**** communications system were deemed to be sufficiently great to outweigh the possible disadvantage of a theoretically predicted increase in crossmodulation.

SUMMARY:

BSUM(9)

The present invention thus provides a method of reducing distortion such as crossmodulation between modulated carriers in a ****multicarrier**** communication system by establishing a coherent harmonic frequency relationship between the carriers, combining the carriers to transmit a signal which.

DETDESC:

DETD(11)

In . . . forms of both FIG. 1a and FIG. 1b are symmetrical about .pi. radians, no consideration has yet been given to ****asymmetry**** as must be done in more complex cases. However, it will be noted that in FIG. 1b the peak-to-peak excursion.

DETDESC:

DETD(41)

Again . . . and +9.73 for a peak-to-peak excursion of 21.63. The reduction factor in this case is $21.63/50 = 0.432$ and the ****asymmetry****

biasing is $(11.90-9.73)/2 = 1.08$.

CLAIMS:

CLMS(1)

What we claim is:

1. The method of reducing distortion in a ****multicarrier**** CATV cable communication system comprising the steps of:
 - a. establishing a harmonically related coherent frequency relationship between the carriers of. . . .

CLAIMS:

CLMS(3)

3. The method of reducing distortion in a ****multi**--**carrier**** communication system in which a plurality of said carriers is individually modulated and then combined to form a vector sum. . . .

CLAIMS:

CLMS(4)

4. The method of reducing distortion in a ****multi**--**carrier**** communication system in which a plurality of said carriers is individually modulated and then combined to form a vector sum. . . .

CLAIMS:

CLMS(5)

5. The method of reducing distortion in a ****multi**--**carrier**** communication system in which a plurality of said carriers is individually modulated and then combined to form a vector sum. . . .

CLAIMS:

CLMS(6)

6. In a ****multi**--**carrier**** communication system, the improvement comprising;
 - a. means to establish a harmonically related coherent frequency relationship between the carriers of said. . . .

CLAIMS:

CLMS(7)

7. In a ****multi**--**carrier**** CATV cable system, the improvement comprising:
 - a. means to establish a harmonically related coherent frequency relationship between the carriers of. . . .

CLAIMS:

CLMS(8)

8. In a ****multi****-****carrier**** CATV cable system, the improvement comprising:
a. means to establish a harmonically related coherent frequency relationship between the carriers of. . .

CLAIMS:

CLMS (9)

9. In a ****multi****-****carrier**** CATV cable system, the improvement comprising:
a. means to establish a harmonically related coherent frequency relationship between the carriers of. . .

CLAIMS:

CLMS (28)

28. . . . the visual effect of triple beat and other second and third order distortion in the transmitted multiplexed signal in a ****multi****-****carrier**** cable television system having the same channel frequency bandwidth for each channel, said method comprising the steps of:
a. providing. . .
=>

=> d l3 1-21

1. 5,557,612, Sep. 17, 1996, Method and apparatus for establishing communication in a multi-tone data transmission system; John A. C. Bingham, 370/71, 124 [IMAGE AVAILABLE]
2. 5,550,812, Aug. 27, 1996, System for broadcasting and receiving digital data, receiver and transmitter for use in such system; Norbert J. L. Philips, 370/19, 69.1; 375/362; 455/182.2 [IMAGE AVAILABLE]
3. 5,519,731, May 21, 1996, ADSL compatible discrete multi-tone apparatus for mitigation of T1 noise; John M. Cioffi, 375/260; 348/388, 436; 370/6, 70; 375/240, 285, 296, 340, 346; 379/93 [IMAGE AVAILABLE]
4. 5,506,141, Apr. 9, 1996, Apertured cell carrier; Arye Weinreb, et al., 435/309.1; 422/101; 435/288.4, 307.1, 308.1 [IMAGE AVAILABLE]
5. 5,479,447, Dec. 26, 1995, Method and apparatus for adaptive, variable bandwidth, high-speed data transmission of a **multicarrier** signal over digital subscriber lines; Peter S. Chow, et al., 375/260; 370/118; 375/377 [IMAGE AVAILABLE]
6. 5,461,640, Oct. 24, 1995, Method and system for optimizing an equalizer in a data transmission system; Alan Gatherer, 375/231; 364/724.2 [IMAGE AVAILABLE]
7. 5,408,260, Apr. 18, 1995, Customer premises ADSL signal distribution arrangement; Ephraim Arnon, 348/6, 12; 455/5.1 [IMAGE AVAILABLE]
8. 5,400,322, Mar. 21, 1995, Updating of bit allocations in a **multicarrier** modulation transmission system; Ronald R. Hunt, et al., 370/19, 76, 121 [IMAGE AVAILABLE]
9. 5,329,249, Jul. 12, 1994, High efficiency RF power amplifier; Stephen C. Cripps, 330/302, 306 [IMAGE AVAILABLE]
10. 5,321,542, Jun. 14, 1994, Control method and apparatus for wireless data link; Richard F. Freitas, et al., 359/172, 113, 152; 370/84 [IMAGE AVAILABLE]
11. 5,317,596, May 31, 1994, Method and apparatus for echo cancellation with discrete multitone modulation; Minnie Ho, et al., 375/232; 370/32.1; 379/410, 411 [IMAGE AVAILABLE]
12. 5,310,674, May 10, 1994, Apertured cell carrier; Arye Weinreb, et al., 435/286.1; 422/101; 435/308.1, 309.1 [IMAGE AVAILABLE]
13. 5,272,081, Dec. 21, 1993, System and methods for cell selection; Arye Weinreb, et al., 435/240.1, 240.2, 240.21, 243, 261, 948 [IMAGE AVAILABLE]
14. 5,119,042, Jun. 2, 1992, Solid state power amplifier with dynamically adjusted operating point; David L. Crampton, et al., 330/295, 136, 284, 285; 455/116, 126, 127, 129 [IMAGE AVAILABLE]
15. 5,017,885, May 21, 1991, Optical amplifier with reduced nonlinearity; Adel A. M. Saleh, 359/337, 124, 181 [IMAGE AVAILABLE]

16. 4,858,225, Aug. 15, 1989, Variable bandwidth variable center-frequency multibeam satellite-switched router; Pietro deSantis, 370/95.3, 104.1 [IMAGE AVAILABLE]
17. 4,757,495, Jul. 12, 1988, Speech and data multiplexor optimized for use over impaired and bandwidth restricted analog channels; Dwight W. Decker, et al., 370/76, 69.1 [IMAGE AVAILABLE]
18. 4,742,576, May 3, 1988, Optical communication system employing coherent detection and method; Donald H. McMahon, 359/126, 168, 182, 183, 184, 190, 191 [IMAGE AVAILABLE]
19. 4,729,949, Mar. 8, 1988, System and methods for cell selection; Arye Weinreb, et al., 435/30; 209/38, 397; 210/222, 695; 356/38, 244; 422/101; 435/34, 173.9, 288.4, 288.7, 308.1; 436/63, 177 [IMAGE AVAILABLE]
20. 4,328,902, May 11, 1982, Beverage carrier; Thomas M. North, 220/23.4, 516 [IMAGE AVAILABLE]
21. 3,898,566, Aug. 5, 1975, Method and apparatus for reducing distortion in **multicarrier** communication systems; Israel Switzer, et al., 455/4.1; 370/69.1; 455/67.3 [IMAGE AVAILABLE]

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US005659891A

United States Patent [19]
Hays et al.

[11] **Patent Number:** **5,659,891**
[45] **Date of Patent:** **Aug. 19, 1997**

[54] **MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS**

4,244,047	1/1981	Perkins	370/69
5,163,181	11/1992	Koontz	455/103
5,343,499	8/1994	Jasper et al.	375/39
5,392,452	2/1995	Davis	455/38.1

[75] Inventors: **William D. Hays; Dennis Cameron,**
both of Jackson, Miss.; **Walter Roehr,**
Reston, Va.

OTHER PUBLICATIONS

[73] Assignee: **Mobile Telecommunication Technologies,** Jackson, Miss.

47 C.F.R. § 22.106 (1994).

[21] Appl. No.: **480,718**

Primary Examiner—Reinhard J. Eisenzopf
Assistant Examiner—Lee Nguyen
Attorney, Agent, or Firm—Finnegan, Henderson, Farabow, Garrett and Dunner

[22] Filed: **Jun. 7, 1995**

[51] **Int. Cl.⁶** **H04B 1/02**

[57] **ABSTRACT**

[52] **U.S. Cl.** **455/103; 455/45; 370/339; 370/343**

A method of multicarrier modulation using co-located transmitters to achieve higher transmission capacity for mobile paging and two-way digital communication in a manner consistent with FCC emission mask limits. Co-location of the transmitters obviates the need for stringent, symmetrical subchannel interference protection and provides for a wider range of operating parameters, including peak frequency deviation, bit rate, and carrier frequencies, to obtain optimal transmission performance.

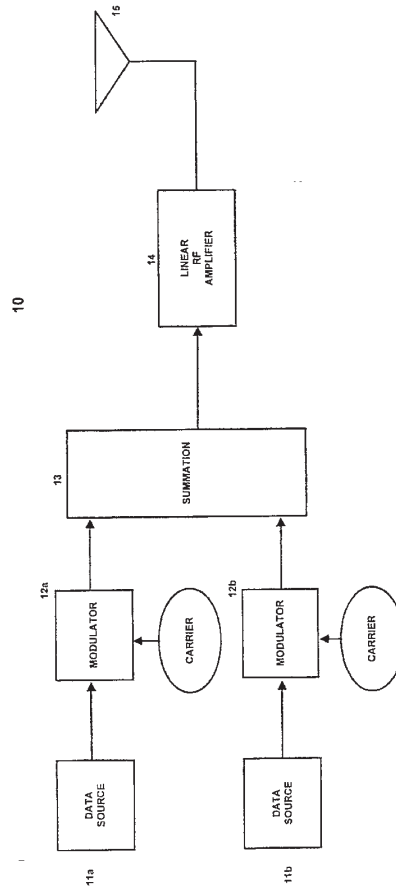
[58] **Field of Search** 455/103, 104, 455/17, 46, 59, 60, 61, 62, 49.1, 45; 375/260; 370/69.1, 70, 38, 40, 121; 340/825.44

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,488,445	1/1970	Chang	370/69.1
3,914,554	10/1975	Seidel	179/15.55 R

5 Claims, 11 Drawing Sheets



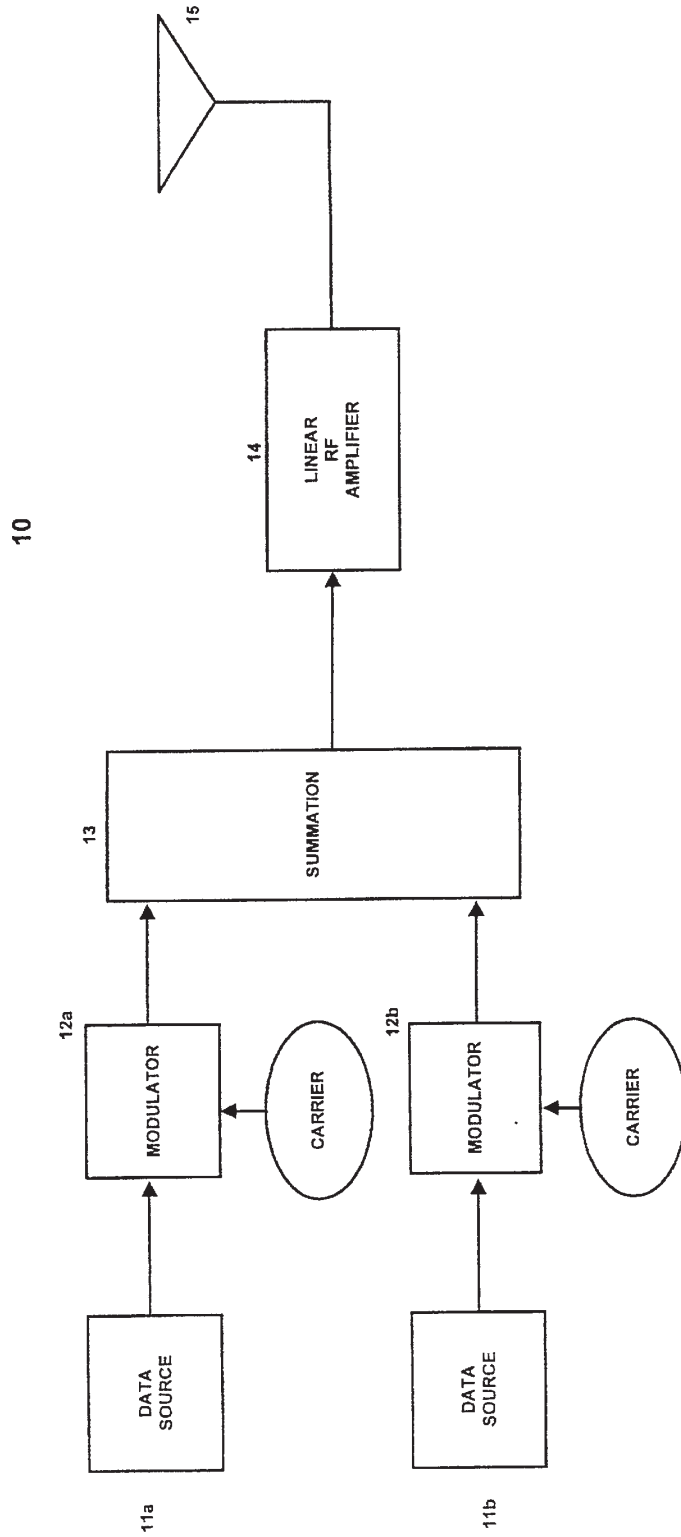


FIGURE 1

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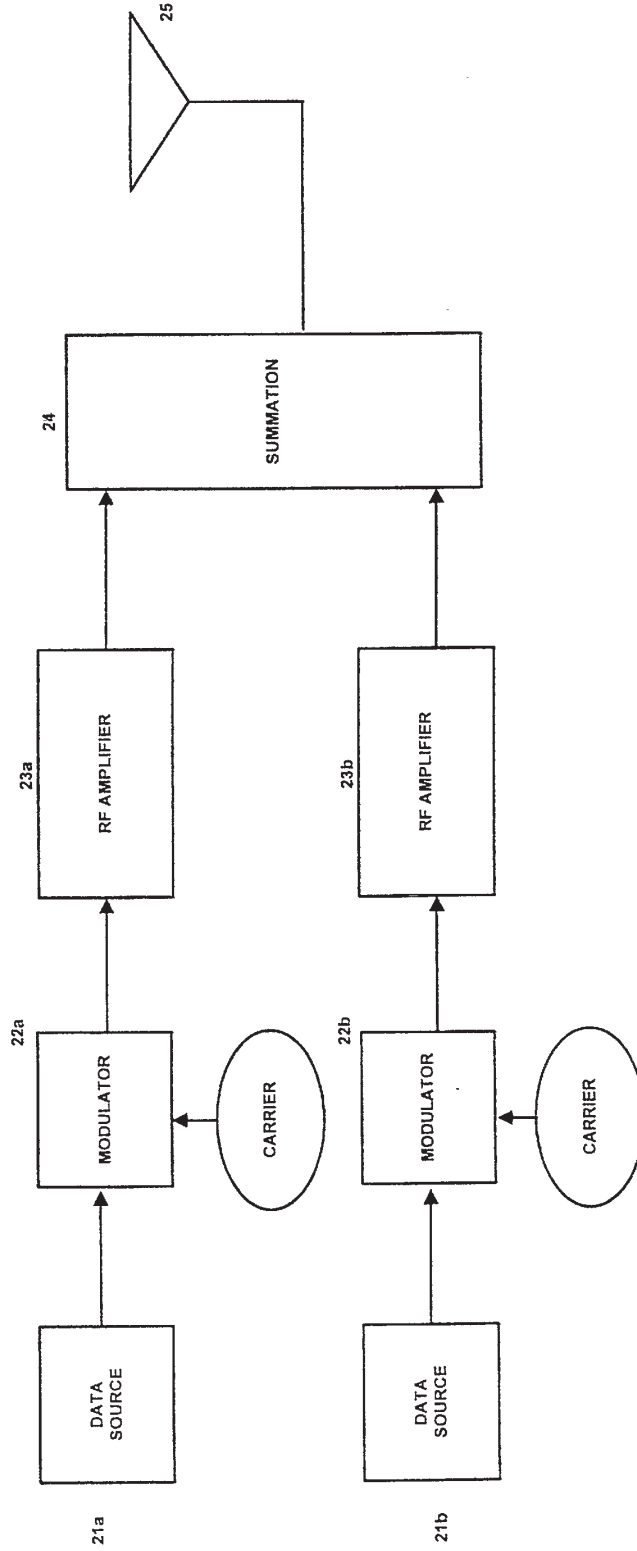


FIGURE 2

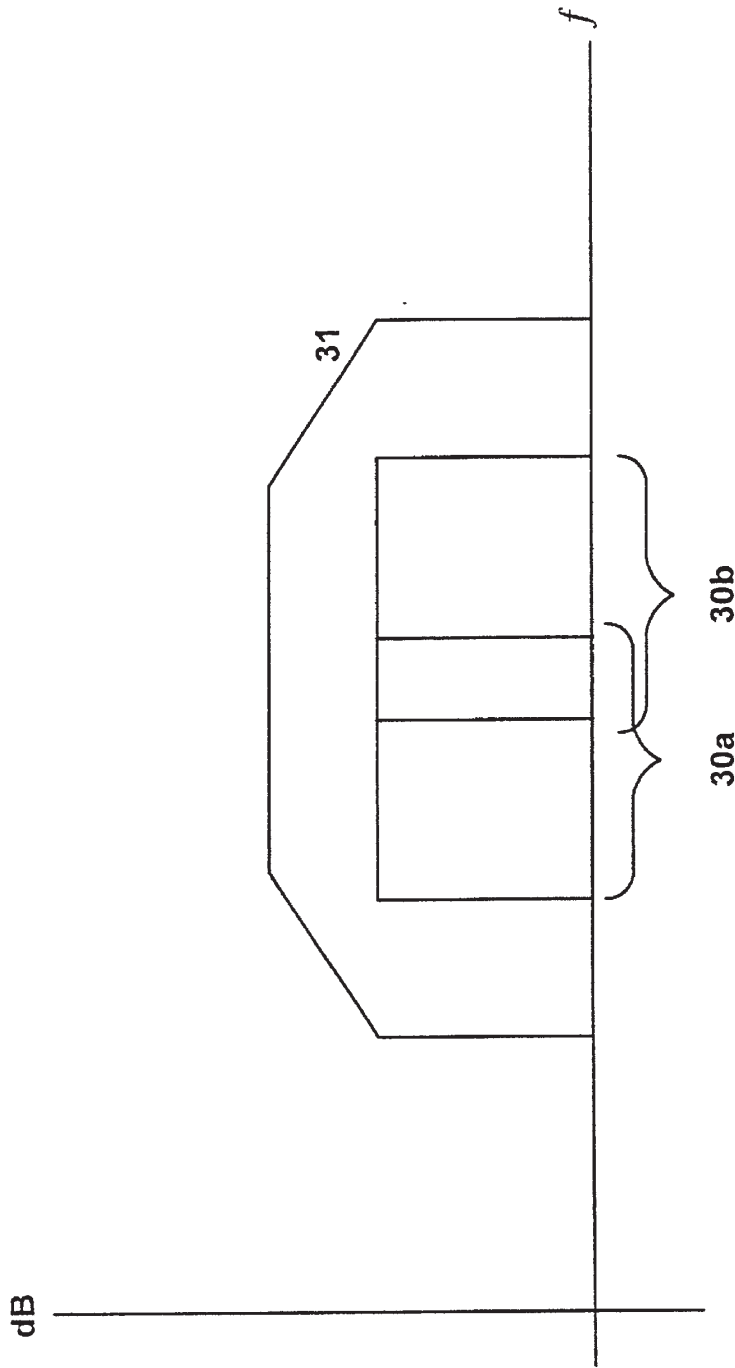


FIGURE 3A

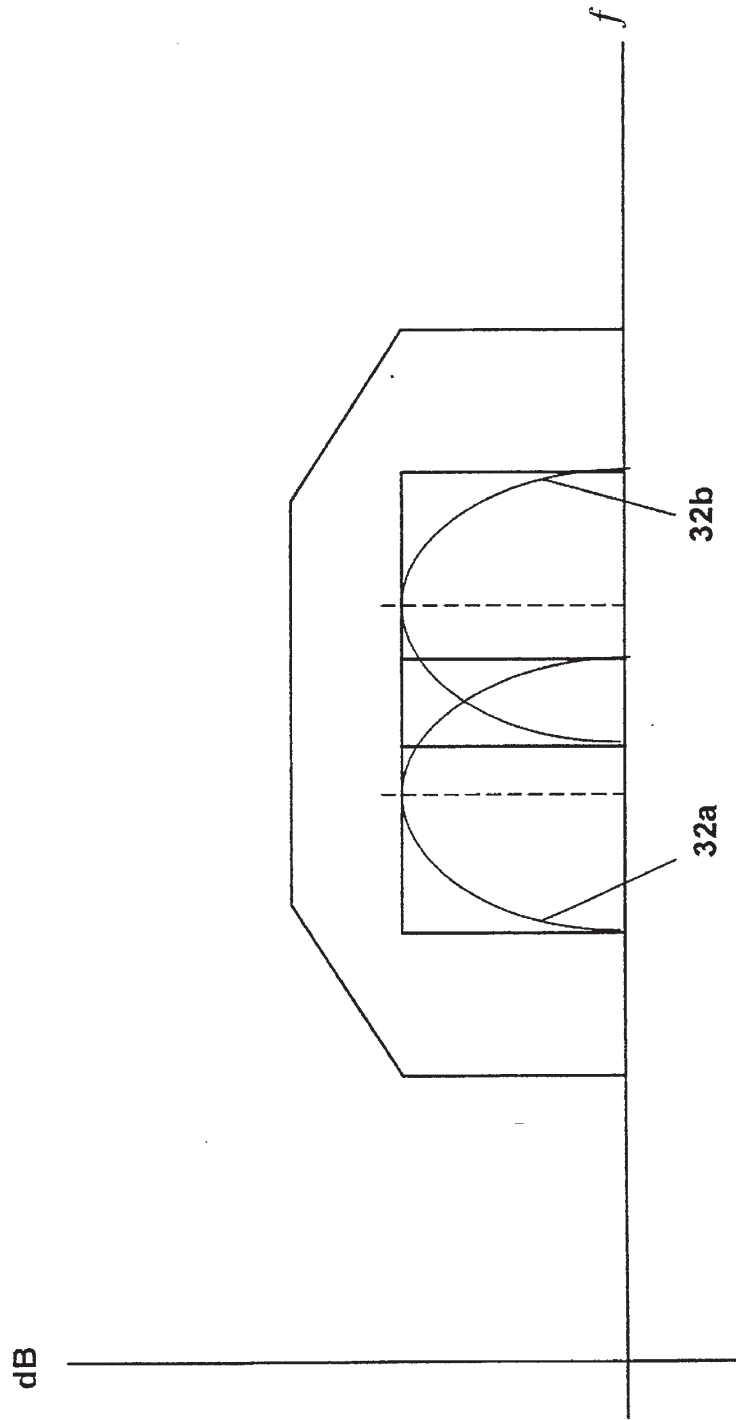


FIGURE 3B

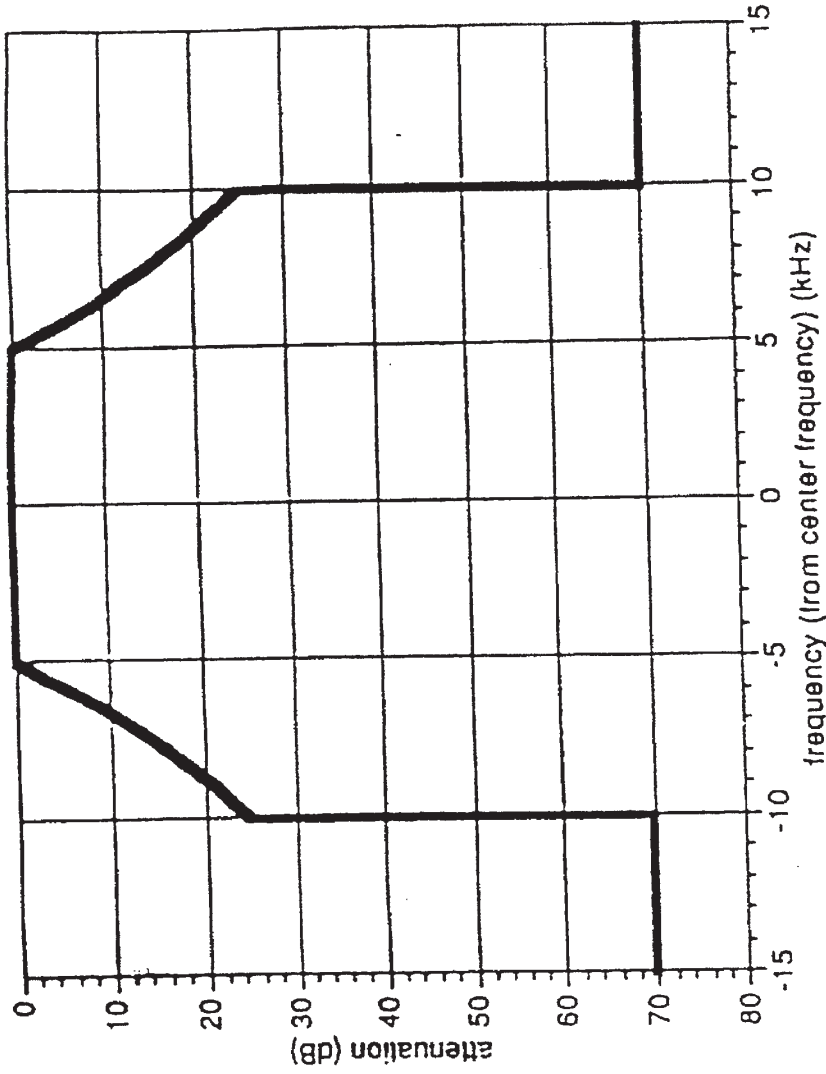
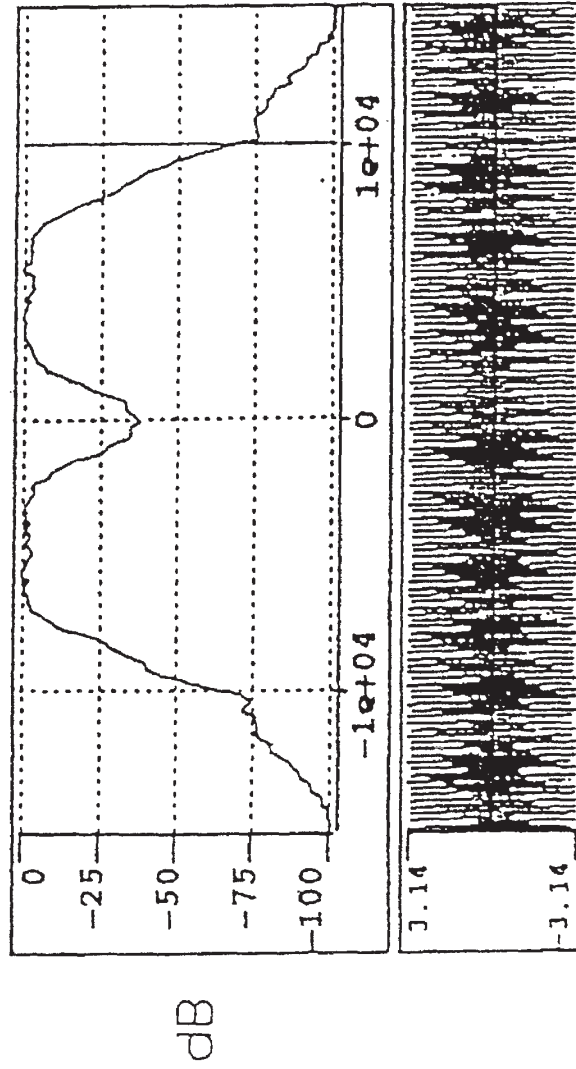


FIGURE 4

FIGURE 5A

2400 max deviation, 6k bps bit rate, 4590 Hz carrier



Freq. = 10004.9
Db = -70.0818
Phase = 1.96349

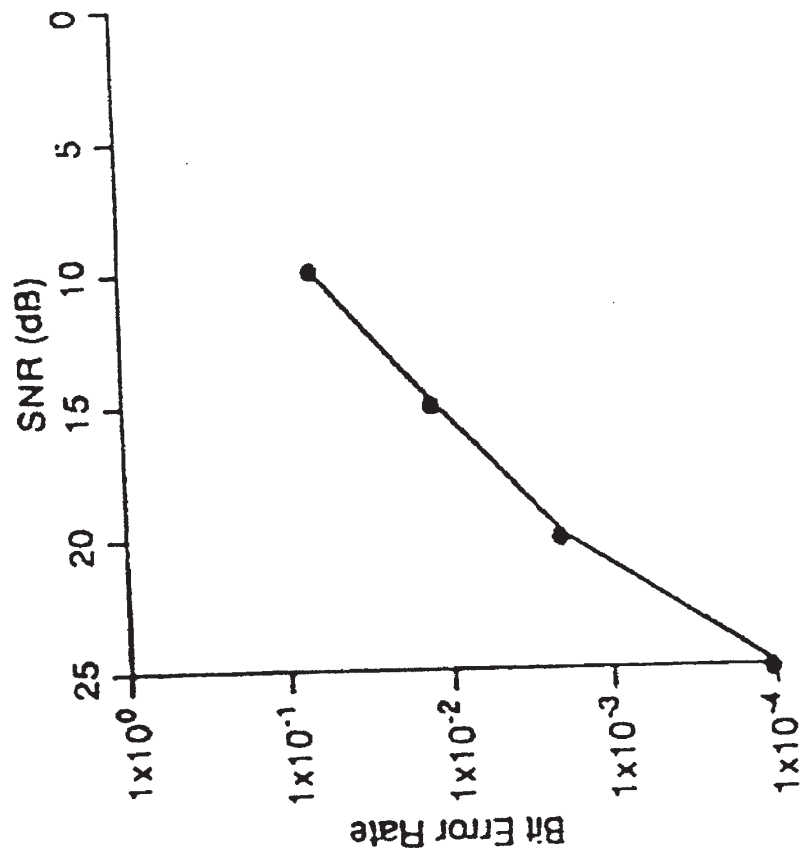
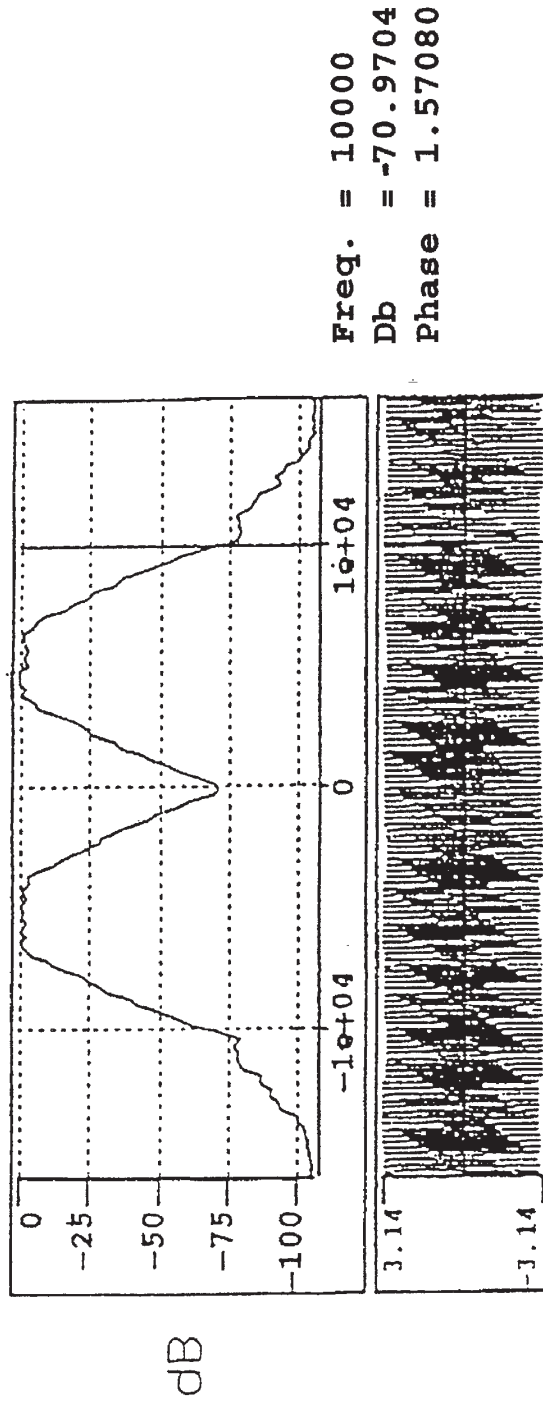


FIGURE 5B

FIGURE 6A

1800 max deviation, 6.4k bps bit rate, 5150 Hz carrier



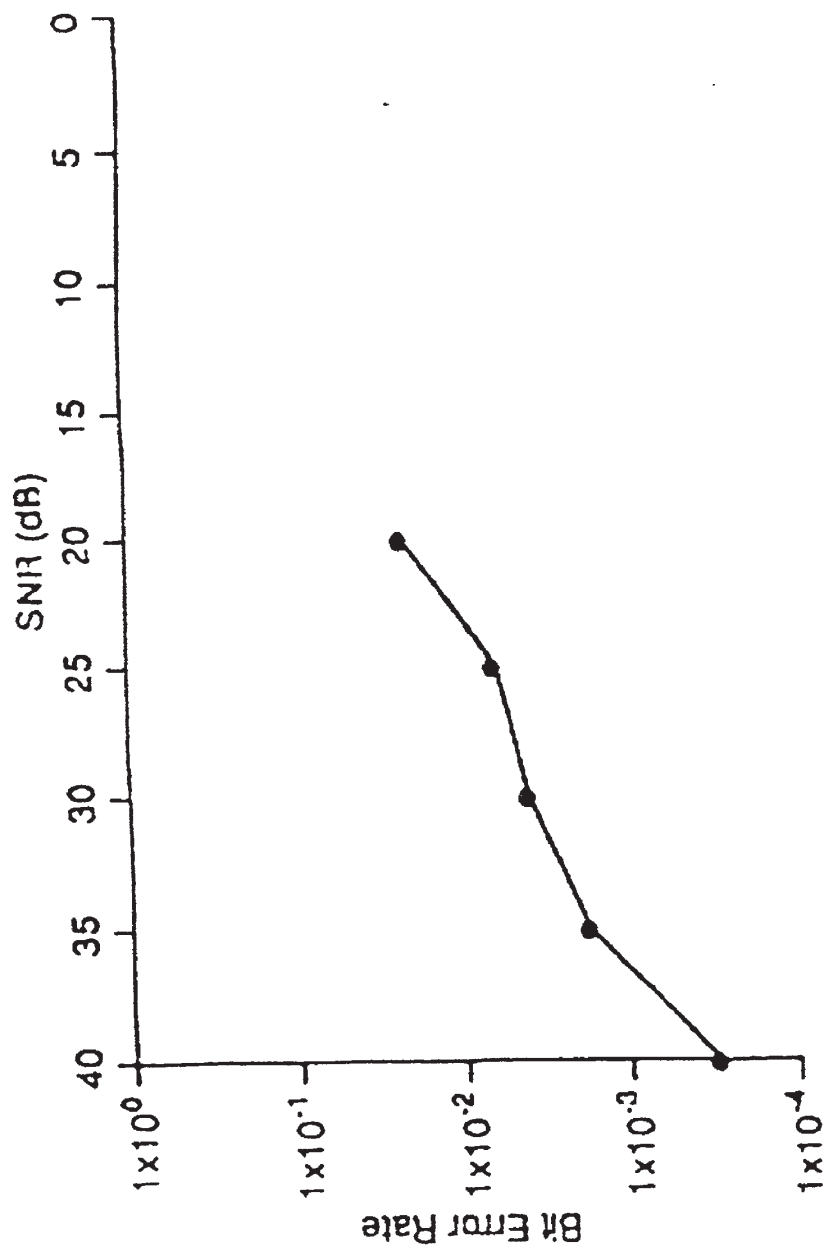
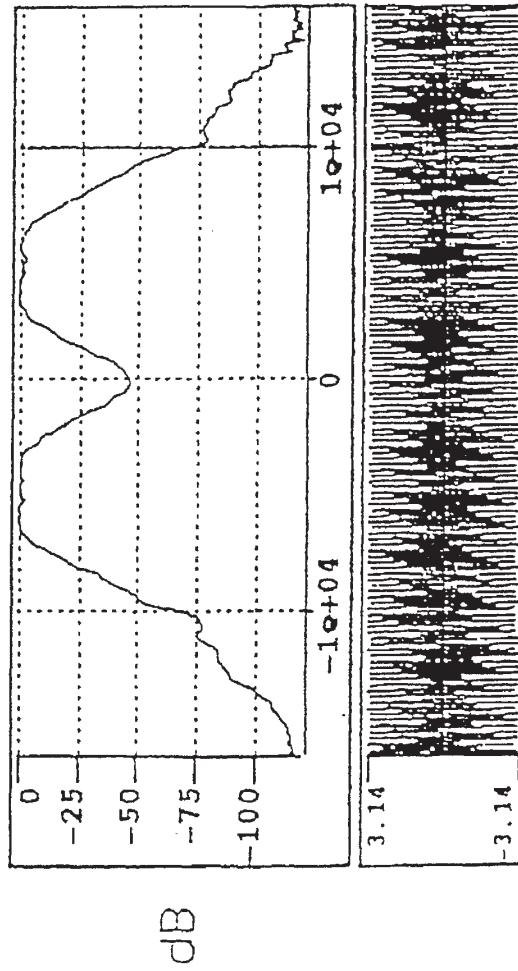


FIGURE 6B

FIGURE 7A

2100 max deviation, 6.4k bps bit rate, 4750 Hz carrier



Freq. = 10000
Db = -70.2824
Phase = 1.01049e-05

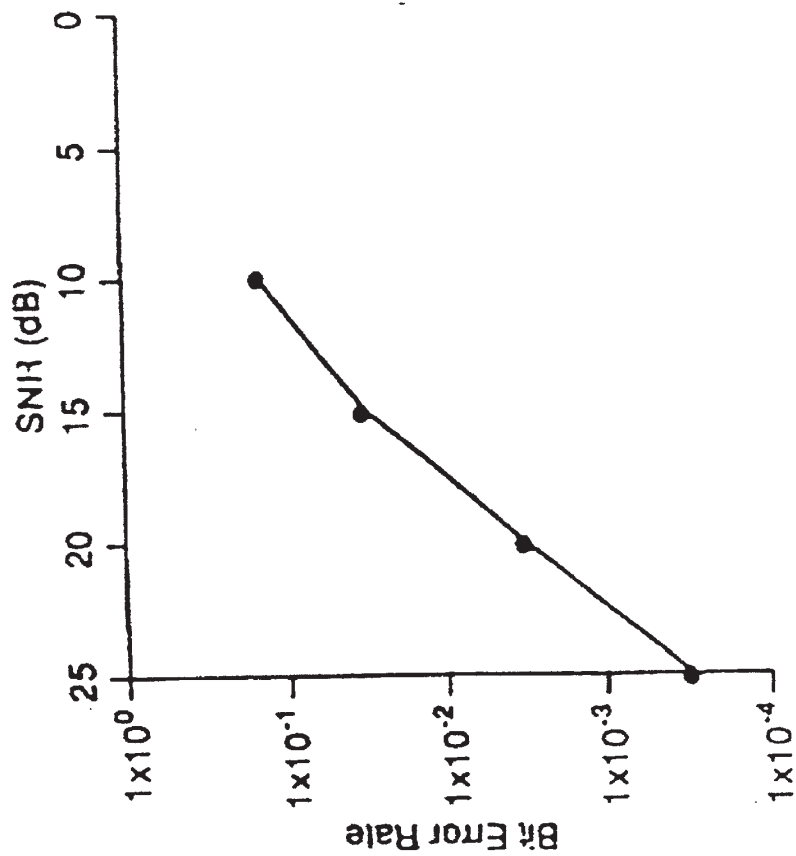


FIGURE 7B

MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS

FIELD OF THE INVENTION

The present invention relates generally to multicarrier modulation techniques, and more particularly, to a method for operating more than one carrier in a single mask-defined, bandlimited channel assigned to mobile paging use.

DISCUSSION OF RELATED ART

The rising popularity of mobile paging services has resulted in increased competition for air time on the limited number of radio-frequency channels allocated by the Federal Communications Commission (FCC) for mobile paging use. As demand begins to approach and even exceed the capacity of assigned channels to handle transmission traffic, delays in service and deterioration of transmission quality are becoming a major concern to mobile paging users and providers.

The ability of mobile paging providers to successfully address the problem of transmission saturation is limited by the finite range of air space dedicated to mobile paging use. Channels assigned by the FCC to radio paging providers typically have narrow bandwidths (e.g. 25 kHz) and are subject to stringent emission mask limitations.

One method that can be used to allow greater access to a particular channel is to increase the number of messages transmitted over the channel in a given period. This can be achieved, for example, by increasing the data rate of the transmission or by reducing the length of transmitted messages. U.S. Pat. No. 5,392,452 issued to Davis, for example, describes a high data rate transmission scheme for handling lengthy messages in a paging system. Systems employing techniques to increase transmission rates, however, are prone to higher error rates. In addition, high data rates tend to generate greater transmission interference.

Another approach to addressing the saturation problem is to increase the transmission capacity of the channel itself. Traditionally, mobile paging providers have operated only one transmission signal, or carrier, within an assigned channel. While this mode ensures simplicity of operation and compliance with FCC mask requirements, it does not provide the most efficient use of the limited frequency bandwidth available. Successful multicarrier modulation, however, is difficult to achieve without incurring unacceptable levels of interference.

The problem of interference is compounded when a receiver is attempting to acquire a signal from a distant transmitter while in close proximity to a transmitter operating on an adjacent channel. In this environment, the receiver may experience difficulty in detecting the signal from the distant source due to interference from the signal transmitted on the adjacent channel from the closer source. This is known as the "near-far" problem. This problem can be avoided by co-locating the transmitters at essentially the same geographic location.

The FCC requires signals to be confined within emission limit masks in order to prevent interference caused by signals straying or spilling into adjacent channels. FCC masks typically require the power spectral density of a signal to be attenuated at least 70 dB at the band edge. Despite these stringent constraints, some carrier overlap can be expected, even when the maximum carrier spacing consistent with the FCC mask requirements is utilized. Such overlap can result in unacceptable interference of the carriers, making it difficult for the receivers to acquire the proper carrier.

Thus, a traditional multicarrier design would commonly require the same stringent protection levels between subchannels. Specifically, when more than one carrier is operating within a single channel, each carrier is traditionally confined to a submask defining a subchannel internal to the channel. The carriers are symmetrically located within the channel such that they are evenly spaced relative to each other and to the band edges of the primary mask defining the primary channel. Although such symmetry achieves maximum inter-carrier spacing and reduces the opportunity for interference among adjacent carriers, it often necessitates the need for sophisticated receiver and transmitter schemes.

SUMMARY OF THE INVENTION

It is an object of this invention to achieve higher capacity over a bandlimited channel for paging without the need for stringent subchannel interference protection. Additional objects, advantages, and features of the invention will be set forth in part in the description that follows, and in part will be obvious from the description, or may be learned by practice of the invention. The advantages of the invention will be realized and attained by means of the instrumentalities and combinations particularly pointed out in the written description and claims herein, as well as the appended drawings.

To achieve these and other objects, advantages, and features in accordance with the purpose of the invention, as embodied and broadly described herein, the invention provides a method of operating a plurality of paging carriers in a single mask-defined, bandlimited channel comprising the step of transmitting the carriers from the same location at center frequencies within the channel such that the frequency difference between the center frequency of the outer most carriers and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

In another aspect, the invention provides a method of operating at least two paging carriers each in a corresponding subchannel of a single mask-defined, bandlimited channel comprising the step of transmitting the carriers from the same location with each carrier centrally located in a corresponding subchannel wherein the frequency difference between the center frequency of the outer most subchannels and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

In another aspect, the invention provides a method of operating a plurality of carriers in a single mask-defined, bandlimited channel to achieve higher transmission capacity over the channel in a mobile paging system having a plurality of transmitters generating a plurality of modulated carriers over a single bandlimited channel and a plurality of mobile, independent receiving units capable of receiving one of said plurality of carriers. The method comprises the steps of co-locating the plurality of transmitters such that the plurality of carriers can be emanated from the same transmission source, and transmitting the carriers over a plurality of subchannels spaced asymmetrically within the mask defining the channel.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several

embodiments of the invention and together with the description, serve to explain the principles of the invention. In the drawings,

FIG. 1 is a block diagram of a co-located multicarrier transmitter system in a linear amplifier configuration for using the present invention;

FIG. 2 is a block diagram of a co-located multicarrier transmitter system in a composite transmitter configuration for using the present invention;

FIG. 3A is a graph depicting two submasks defining two subchannels in a single, mask-defined bandlimited channel.

FIG. 3B is a graph depicting the power spectra of two carriers asymmetrically located within a single mask-defined, bandlimited channel.

FIG. 4 is a graph depicting an exemplary FCC emissions mask that requires the power spectral density to be attenuated at least 70 dB within 10 kHz from center frequency.

FIG. 5A is a graph depicting the power spectra of a system with peak deviation of 2400 Hz and data rate of 6000 bits per second (bps);

FIG. 5B is a graph depicting the performance of the system of FIG. 5A in terms of bit error rate versus the signal noise ratio (SNR);

FIG. 6A is a graph depicting the power spectra of a system with peak deviation of 1800 Hz and a data rate of 6400 bps;

FIG. 6B is a graph depicting the performance of the system of FIG. 6A in terms of bit error rate versus SNR;

FIG. 7A is a graph depicting the power spectra of a system with peak deviation of 2100 Hz and a data rate of 6400 bps; and

FIG. 7B is a graph depicting the performance of the system of FIG. 7A in terms of bit error rate versus SNR.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the presently preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Referring to FIG. 1, a co-located multicarrier transmitter system in a linear amplifier configuration 10 comprises a first and second data source, 11a and 11b, a first and second modulator, 12a and 12b, a summation circuit 13, a linear RF amplifier 14, and an antenna 15. The first and second data sources, 11a and 11b, generate a respective first and second digital bit stream which are provided to respective first and second modulators, 12a and 12b. Each modulator converts the incoming digital information into a representative modulated signal or carrier. The outputs of each modulator are then combined into a single output signal by summation circuit 13, the output of which is fed into linear RF amplifier 14. The combined output signal is then applied to antenna 15 for transmission in a bandlimited channel.

Alternatively, referring to FIG. 2, a co-located multicarrier transmitter in a composite amplifier configuration 20 comprises a first and second data source, 21a and 21b, a first and second modulator, 22a and 22b, a first and second RF amplifier, 23a and 23b, a summation circuit 24, and an antenna 25. The first and second digital bit streams generated respectively by the first and second data sources, 21a and 21b, are provided to first and second modulators, 22a and 22b, respectively. Each modulator converts the incoming digital information into a representative modulated sig-

nal or carrier. The outputs of the first and second modulators are fed into first and second RF amplifiers, 23a and 23b, respectively. The outputs of the RF amplifiers are combined into a single output signal by summation circuit 24, the output of which is applied to antenna 25 for transmission in a bandlimited channel.

Alternative embodiments of co-located transmitter systems are also possible. For example, the co-located transmitter configurations discussed above can be expanded to support more than two data sources and transmit more than two carriers in the bandlimited channel.

Because transmitter co-location does not give rise to the near-far problem to which the FCC mask requirements are directed, carrier spacings far closer than would ordinarily be allowed (e.g., 5 to 10 kHz) are achievable. Moreover, the carriers need not be symmetrically or evenly spaced within the mask defining the channel. That is, the frequency spacings between adjacent carriers, while symmetric to each other, can be smaller than the frequency spacings between the band edges of the mask and the nearest respective carrier. Indeed, carrier spacings may be irregular such that the carriers are asymmetrically located within the mask without incurring undue interference.

Referring to FIG. 3A, two submasks defining two subchannels, 30a and 30b, are asymmetrically located within a single mask-defined, bandlimited channel 31, resulting in some subchannel overlap. FIG. 3B depicts two carriers, 32a and 32b, operating respectively over two asymmetrically-located subchannels, resulting in some carrier overlap. In accordance with this asymmetry, the frequency difference between the center frequency of each carrier and the nearest band edge of the mask is greater than half the frequency difference between the center frequencies of the two carriers.

The practical implication of transmitter co-location is that a greater range of operating parameters, including the peak frequency, deviation bit rate, and carrier frequencies, are available so that multicarrier modulation in a standard bandlimited channel can be obtained without the need for stringent subchannel interference protection. In accordance with the present invention, these and other parameters can be adjusted so that the carriers generated and transmitted according to the present invention will remain within the FCC emission limits while providing optimal transmission performance.

FIG. 4 shows a FCC emissions mask which requires the power spectral density to be attenuated at least 70 dB within 10 kHz from center frequency. Co-location of the transmitters allows for signals with a greater range of deviation and baud rates to be carried in the bandlimited channel than has been otherwise thought possible in view of FCC 70 dB cutoff requirements. The present invention will be further clarified by the following examples, which are intended to be purely exemplary of the invention.

FIG. 5A is a spectra graph of a two-carrier system in which the following parameter values were selected: a peak frequency deviation of 2400 Hz, a bit rate of 6000 bps, premodulation filter cutoff frequency of 3000 Hz, and carrier frequencies set to within 4590 Hz of the center frequency. Using this operative parameter combination, the carriers remained within the FCC mask while providing an acceptable error-rate versus signal strength performance (FIG. 5B).

Alternatively, FIG. 6A is a spectra graph of a two-carrier system using a peak frequency deviation of 1800 Hz, a bit rate of 6400 bps, a premodulation filter cutoff frequency of 3200, and carrier frequencies set to within 5150 Hz of the

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center frequency. As depicted in FIG. 6B, this combination of operative parameters exhibited a higher bit error rate than the system of FIG. 5A.

FIG. 7A is a spectra graph of a two-carrier system using a peak frequency deviation of 2100 Hz, a bit rate of 6400 bps, a premodulation filter cutoff frequency of 3200, and carrier frequencies set to within 4750 Hz of the center frequency. As depicted in FIG. 7B, this combination gives significantly better performance than the system of FIG. 6A but performs slightly worse than the system of FIG. 5A.

Thus, according to the present invention, increased transmission capacity is achieved by operating more than one carrier in a standard bandlimited channel assigned for mobile paging use, such as in the Narrowband Personal Communications Service or the Part 22 Service. In the modulation technique of the present invention, carriers operating at different frequencies are fit within a single bandwidth allocation in a manner consistent with FCC mask requirements. This is achieved through the use of co-located transmitters and the selection of an optimal combination of operating parameters, including peak frequency deviation, bit rate, and carrier separation frequencies. Through the multicarrier modulation technique of the present invention, the normal transmission capacity of a standard channel can be increased without the need for stringent subchannel protection levels and complicated receiver and transmitter schemes.

The modulation technique of the present invention has particular application in metropolitan areas where the volume and concentration of transmission traffic is high and where the need for increased transmission capacity is acute. In addition, the modulation technique of the present invention may also be suited for use in areas where the incidence of unacceptable interference is high, such as international border regions. In that type of environment, transmissions from the respective bordering countries can be assigned to one of the carriers operating within the channel to reduce the risk of interference.

It will be apparent to those skilled in the art that various modification and variations can be made to present invention without departing from the spirit or scope of the invention. Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. Thus, it is intended that the specification and examples be considered

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as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. A method of operating a plurality of paging carriers in a single mask-defined, bandlimited channel comprising the step of transmitting said carriers from the same location with said carriers having center frequencies within said channel such that the frequency difference between the center frequency of the outer most of said carriers and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

2. The method of claim 1 wherein adjacent carriers overlap with each other.

3. A method of operating at least two paging carriers each in a corresponding subchannel of a single mask-defined, bandlimited channel comprising the step of transmitting said carriers from the same location with each carrier centrally located in said corresponding subchannel wherein the frequency difference between the center frequency of the outer most of said corresponding subchannels and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

4. The method of claim 3 wherein adjacent subchannels overlap with each other.

5. In a paging system having a plurality of transmitters transmitting a plurality of modulated carriers over a single mask-defined, bandlimited channel and a plurality of mobile receiving units independently receiving one of said plurality of carriers, a method of operating said plurality of carriers in said channel to achieve higher transmission capacity comprising the steps of:

co-locating said plurality of transmitters such that said plurality of carriers can be emanated from the same transmission source; and

transmitting said plurality of carriers over a plurality of subchannels spaced within the mask defining said channel wherein the frequency difference between the center frequency of the outer most carriers and the band edge of said mask is greater than half the frequency difference between the center frequencies of each adjacent carrier.

* * * * *

08/480718

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BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Re: New U.S. Patent Application
Title: MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS
Inventor: William D. Hays, Dennis Cameron and
Walter Roehr

Sir:

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3-00 2-00

We enclose the following papers for filing in the United States Patent and Trademark Office in connection with the above patent application.

1. Application - 14 pages, including Title Page, Abstract, 3 independent claims, and 8 claims total.
2. Drawings - 9 sheets of informal drawings.
3. A check for \$730.00 representing a filing fee.

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, L.L.P.

Assistant Commissioner for Patents

June 7 1995

Page 2

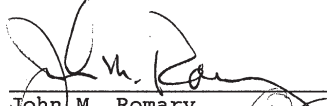
Please accord this application a serial number and filing date and return to the undersigned.

The Commissioner is hereby authorized to charge any additional filing fees due and any other fees due under 37 C.F.R. § 1.16 or § 1.17 during the pendency of this application to our Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
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Enclosures



UNITED STATES PATENT APPLICATION

OF

WILLIAM D. HAYS

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AND

WALTER ROEHR

FOR

MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS

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MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS

Field Of The Invention

The present invention relates generally to multicarrier modulation techniques, and more particularly, to a method for operating more than one carrier in a single mask-defined, bandlimited channel assigned to mobile paging use.

Discussion Of Related Art

The rising popularity of mobile paging services has resulted in increased competition for air time on the limited number of radio-frequency channels allocated by the Federal Communications Commission (FCC) for mobile paging use. As demand begins to approach and even exceed the capacity of assigned channels to handle transmission traffic, delays in service and deterioration of transmission quality are becoming a major concern to mobile paging users and providers.

The ability of mobile paging providers to successfully address the problem of transmission saturation is limited by the finite range of air space dedicated to mobile paging use. Channels assigned by the FCC to radio paging providers typically have narrow bandwidths (e.g. 25 kHz) and are subject to stringent emission mask limitations.

One method that can be used to allow greater access to a particular channel is to increase the number of messages transmitted over the channel in a given period. This can be achieved, for example, by increasing the data rate of the transmission or by reducing the length of transmitted messages.

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U.S. Patent No. 5,392,452 issued to Davis, for example, describes a high data rate transmission scheme for handling lengthy messages in a paging system. Systems employing techniques to increase transmission rates, however, are prone to higher error rates. In addition, high data rates tend to generate greater transmission interference.

Another approach to addressing the saturation problem is to increase the transmission capacity of the channel itself. Traditionally, mobile paging providers have operated only one transmission signal, or carrier, within an assigned channel. While this mode ensures simplicity of operation and compliance with FCC mask requirements, it does not provide the most efficient use of the limited frequency bandwidth available. Successful multicarrier modulation, however, is difficult to achieve without incurring unacceptable levels of interference.

The problem of interference is compounded when a receiver is attempting to acquire a signal from a distant transmitter while in close proximity to a transmitter operating on an adjacent channel. In this environment, the receiver may experience difficulty in detecting the signal from the distant source due to interference from the signal transmitted on the adjacent channel from the closer source. This is known as the "near-far" problem. This problem can be avoided by co-locating the transmitters at essentially the same geographic location.

INS A1

The FCC requires signals to be confined within emission limit masks in order to prevent interference caused by signals straying or spilling into adjacent channels. FCC masks typically require the power spectral density of a signal to be attenuated at least 70 dB at the band edge. ~~Due to the limited bandwidth of a standard channel, however, some carrier overlap can be expected in multicarrier transmission, even when the maximum carrier spacing consistent with the FCC mask requirements is utilized.~~

Such overlap can result in unacceptable interference of the carriers, making it difficult for the receivers to acquire the proper carrier.

INS A2

Thus, ^{the} a practical multicarrier environment is commonly understood to require stringent subchannel protection levels. Specifically, when more than one carrier is operating within a single channel, each carrier is traditionally confined to a submask defining a subchannel internal to the channel. The carriers are symmetrically located within the channel such that they are evenly spaced relative to each other and to the band edges of the primary mask defining the primary channel. Although such symmetry achieves maximum inter-carrier spacing and reduces the opportunity for interference among adjacent carriers, it often necessitates the need for sophisticated receiver ^{AND TRANSMITTER} schemes.

SUMMARY OF THE INVENTION

It is an object of this invention to achieve higher capacity over a bandlimited channel for paging without the need for stringent subchannel interference protection. Additional objects, advantages, and features of the invention will be set forth in part in the description that follows, and in part will be obvious from the description, or may be learned by practice of the invention. The advantages of the invention will be realized and attained by means of the instrumentalities and combinations particularly pointed out in the written description and claims herein, as well as the appended drawings.

To achieve these and other objects, advantages, and features in accordance with the purpose of the invention, as embodied and broadly described herein, the invention provides a method of operating a plurality of paging carriers in a single mask-defined, bandlimited channel comprising the step of transmitting the carriers from the same location at center

frequencies within the channel such that the frequency difference between the center frequency of the outer most carriers and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

In another aspect, the invention provides a method of operating at least two paging carriers each in a corresponding subchannel of a single mask-defined, bandlimited channel comprising the step of transmitting the carriers from the same location with each carrier centrally located in a corresponding subchannel wherein the frequency difference between the center frequency of the outer most subchannels and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

In another aspect, the invention provides a method of operating a plurality of carriers in a single mask-defined, bandlimited channel to achieve higher transmission capacity over the channel in a mobile paging system having a plurality of transmitters generating a plurality of modulated carriers over a single bandlimited channel and a plurality of mobile, independent receiving units capable of receiving one of said plurality of carriers. The method comprises the steps of co-locating the plurality of transmitters such that the plurality of carriers can be emanated from the same transmission source, and transmitting the carriers over a plurality of subchannels spaced asymmetrically within the mask defining the channel.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several embodiments of the invention and together with the description, serve to explain the principles of the invention. In the drawings,

Fig. 1 is a block diagram of a co-located multicarrier transmitter system in a linear amplifier configuration for using the present invention;

Fig. 2 is a block diagram of a co-located multicarrier transmitter system in a composite transmitter configuration for using the present invention;

Fig. 3A is a graph depicting two submasks defining two subchannels in a single mask-defined bandlimited channel.

Fig. 3B is a graph depicting the power spectra of two carriers asymmetrically located within a single mask-defined, bandlimited channel.

fig 4 a 3

Fig. 4 is a graph depicting the FCC emission limits mask for digital transmitters operating in the frequency bands ~~450.0 to 512.0 MHz and 929.0 to 932.0 MHz;~~

Fig. 5A is a graph depicting the power spectra of a system with peak deviation of 2400 Hz and data rate of 6000 bits per second (bps);

Fig. 5B is a graph depicting the performance of the system of Figure 5A in terms of bit error rate versus the signal noise ratio (SNR);

Fig. 6A is a graph depicting the power spectra of a system with peak deviation of 1800 Hz and a data rate of 6400 bps;

Fig. 6B is a graph depicting the performance of the system of Figure 6A in terms of bit error rate versus SNR;

Fig. 7A is a graph depicting the power spectra of a system with peak deviation of 2100 Hz and a data rate of 6400 bps; and

Figure 7B is a graph depicting the performance of the system of Figure 7A in terms of bit error rate versus SNR.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the presently preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Referring to Fig. 1, a co-located multicarrier transmitter system in a linear amplifier configuration 10 comprises a first and second data source, 11a and 11b, a first and second modulator, 12a and 12b, a summation circuit 13, a linear RF amplifier 14, and an antenna 15. The first and second data sources, 11a and 11b, generate a respective first and second digital bit stream which are provided to respective first and second modulators, 12a and 12b. Each modulator converts the incoming digital information into a representative modulated signal or carrier. The outputs of each modulator are then combined into a single output signal by summation circuit 13, the output of which is fed into linear RF amplifier 14. The combined output signal is then applied to antenna 15 for transmission in a bandlimited channel.

Alternatively, referring to Fig. 2, a co-located multicarrier transmitter in a composite amplifier configuration 20 comprises a first and second data source, 21a and 21b, a first and second modulator, 22a and 22b, a first and second RF amplifier, 23a and 23b, a summation circuit 24, and an antenna 25. The first and second digital bit streams generated respectively by the first and second data sources, 21a and 21b, are provided to first and second modulators, 22a and 22b, respectively. Each modulator converts the incoming digital information into a representative modulated signal or carrier. The outputs of the first and second modulators are fed into first and second RF amplifiers, 23a and 23b, respectively. The outputs of the RF amplifiers are combined into a single output signal by summation circuit 24, the output of which is applied to antenna 25 for transmission in a bandlimited channel.

Alternative embodiments of co-located transmitter systems are also possible. For example, the co-located transmitter configurations discussed above can be expanded to support more than two data sources and transmit more than two carriers in the bandlimited channel.

Because transmitter co-location does not give rise to the near-far problem to which the FCC mask requirements are directed, carrier spacings far closer than would ordinarily be allowed (e.g., 5 to 10 kHz) are achievable. Moreover, the carriers need not be symmetrically or evenly spaced within the mask defining the channel. That is, the frequency spacings between adjacent carriers, while symmetric to each other, can be smaller than the frequency spacings between the band edges of the mask and the nearest respective carrier. Indeed, carrier spacings may be irregular such that the carriers are asymmetrically located within the mask without incurring undue interference.

Referring to Fig. 3A, two submasks defining two subchannels, 30a and 30b, are asymmetrically located within a single mask-defined, bandlimited channel 31, resulting in some subchannel overlap. Fig. 3B depicts two carriers, 32a and 32b, operating respectively over two asymmetrically-located subchannels, resulting in some carrier overlap. In accordance with this asymmetry, the frequency difference between the center frequency of each carrier and the nearest band edge of the mask is greater than ~~the~~ half the frequency difference between the center frequencies of the two carriers.

a The practical implication of transmitter co-location is that a greater range of operating parameters, including the peak frequency, ^{dev. rate} bit rate, and carrier frequencies, are available so that multicarrier modulation in a standard bandlimited channel can be obtained without the need for stringent subchannel interference protection. In accordance with the present invention, these and other parameters can be adjusted so that the carriers generated and transmitted according to the present invention will remain within the FCC emission limits while providing optimal transmission performance.

Fig. 4 shows a FCC emissions mask which requires the power spectral density to be attenuated at least 70 dB within 10 kHz from center frequency. Co-location of the transmitters allows for signals with a greater range of deviation and baud rates to be carried in the bandlimited channel than has been otherwise thought possible in view of FCC 70 dB cutoff requirements. The present invention will be further clarified by the following examples, which are intended to be purely exemplary of the invention.

Fig. 5A is a spectra graph of a two-carrier system in which the following parameter values were selected: a peak frequency deviation of 2400 Hz, a bit rate of 6000 bps, premodulation filter cutoff frequency of 3000 Hz, and carrier frequencies set to within 4590 Hz of the center frequency. Using this operative parameter combination, the carriers remained within the FCC mask while providing an acceptable error-rate versus signal strength performance (Fig. 5B).

Alternatively, Fig. 6A is a spectra graph of a two-carrier system using a peak frequency deviation of 1800 Hz, a bit rate of 6400 bps, a premodulation filter cutoff frequency of 3200, and carrier frequencies set to within 5150 Hz of the center frequency. As depicted in Fig. 6B, this combination of operative parameters exhibited a higher bit error rate than the system of Fig. 5A.

Fig. 7A is a spectra graph of a two-carrier system using a peak frequency deviation of 2100 Hz, a bit rate of 6400 bps, a premodulation filter cutoff frequency of 3200, and carrier frequencies set to within 4750 Hz of the center frequency. As depicted in Fig. 7B, this combination gives significantly better performance than the system of Figure 6A but performs slightly worse than the system of Fig. 5A.

Thus, according to the present invention, increased transmission capacity is achieved by operating more than one carrier in a standard bandlimited channel assigned for mobile paging use, such as in the Narrowband Personal Communications Service or the Part 22 Service. In the modulation technique of the present invention, carriers operating at different frequencies are fit within a single bandwidth allocation in a manner consistent with FCC mask requirements. This is achieved through the use of co-located transmitters and the selection of an optimal combination of operating parameters, including peak

frequency deviation, bit rate, and carrier separation frequencies. Through the multicarrier modulation technique of the present invention, the normal transmission capacity of a standard channel can be increased without the need for stringent subchannel protection levels and complicated receiver ^{and transmitter} schemes.

The modulation technique of the present invention has particular application in metropolitan areas where the volume and concentration of transmission traffic is high and where the need for increased transmission capacity is acute. In addition, the modulation technique of the present invention ^{may also be} ~~is also well~~ suited for use in areas where the incidence of unacceptable interference is high, such as international border regions. In that type of environment, transmissions from the respective bordering countries can be assigned to one of the carriers operating within the channel to reduce the risk of interference.

It will be apparent to those skilled in the art that various modification and variations can be made to present invention without departing from the spirit or scope of the invention. Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. Thus, it is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

WHAT IS CLAIMED IS:

1. A method of operating a plurality of paging carriers in a single mask-defined, bandlimited channel comprising the step of transmitting said carriers from the same location with said carriers having center frequencies within said channel such that the frequency difference between the center frequency of the outer most of said carriers and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

2. The method of claim 1 wherein adjacent carriers overlap with each other.

3. A method of operating at least two paging carriers each in a corresponding subchannel of a single mask-defined, bandlimited channel comprising the step of transmitting said carriers from the same location with each carrier centrally located in said corresponding subchannel wherein the frequency difference between the center frequency of the outer most of said subchannels and the band edge of the mask defining said channel is more than half the frequency difference between the center frequencies of each adjacent carrier.

4. The method of claim 3 wherein adjacent subchannels overlap with each other.

5. In a paging system having a plurality of transmitters transmitting a plurality of modulated carriers over a single mask-defined, bandlimited channel and a plurality of mobile receiving units independently receiving one of said plurality of carriers, a method of operating said plurality of carriers in said channel to achieve higher transmission capacity comprising the steps of

co-locating said plurality of transmitters such that said plurality of carriers can be emanated from the same transmission source; and

transmitting said plurality of carriers over a plurality of subchannels spaced asymmetrically within the mask defining said channel.

6. The method according to claim 5 wherein said transmitting step includes operating said plurality of carriers in a mask defining said bandlimited channel requiring at least 70 dB suppression at the band edge.

7. The method according to claim 5 further comprising the step of selecting peak frequency deviations, bit rates, and carrier frequencies of said modulated carriers for optimal transmission performance.

8. The method according to claim 5 wherein the frequency difference between the center frequency of the outer most carriers and the band edge of said mask is greater than half the frequency difference between the center frequencies of each adjacent carrier.

Add
B

ABSTRACT OF THE DISCLOSURE

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A method of multicarrier modulation using co-located transmitters to achieve higher transmission capacity for mobile paging and two-way digital communication in a manner consistent with FCC emission mask limits. Co-location of the transmitters obviates the need for stringent, symmetrical subchannel interference protection and provides for a wider range of operating parameters, including peak frequency deviation, bit rate, and carrier frequencies, to obtain optimal transmission performance.

MULTI CARRIER TRANSMITTERS

LINEAR AMPLIFIER TRANSMITTER 10

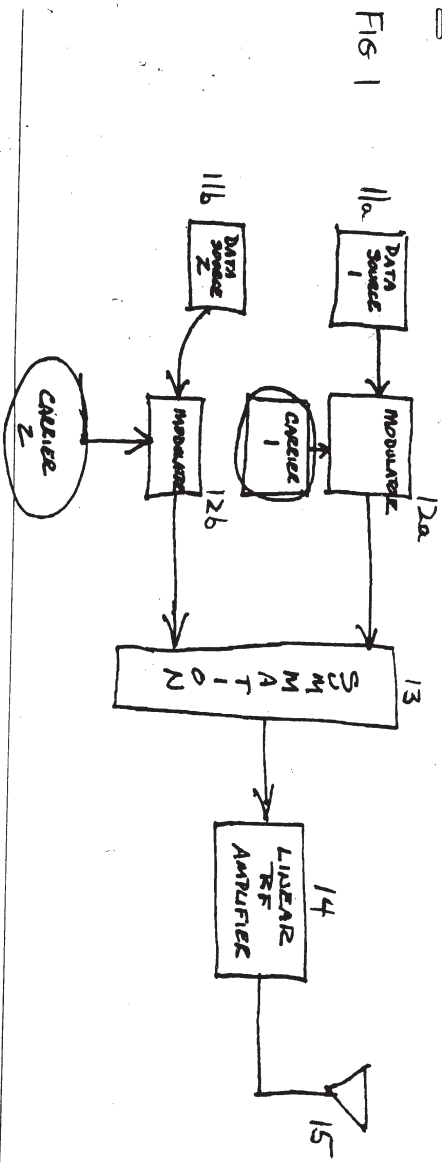


FIG 1

COMPOSITE TRANSMITTER

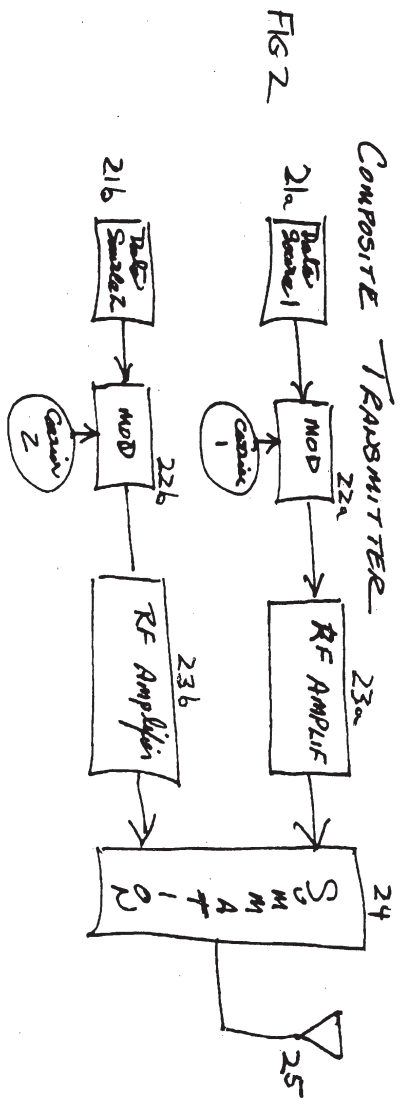
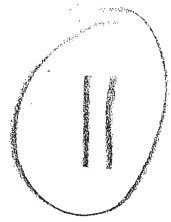


FIG 2



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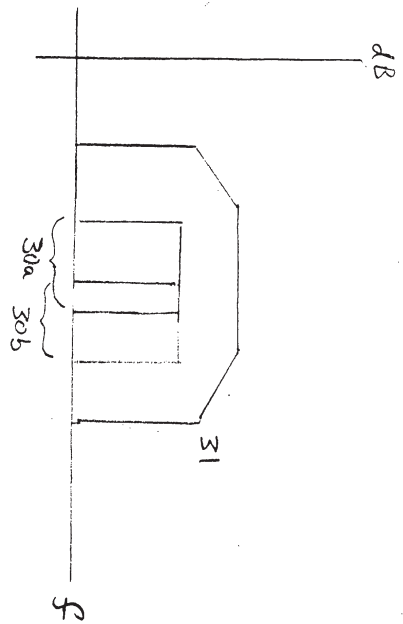


FIG 34

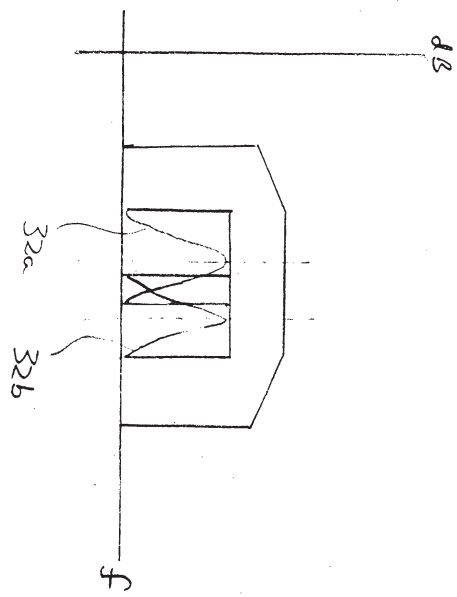


FIG 3R

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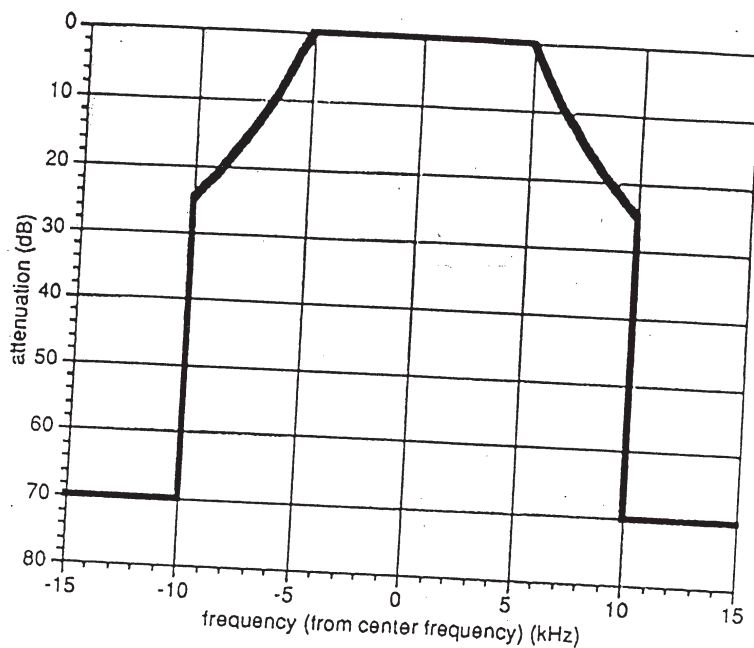
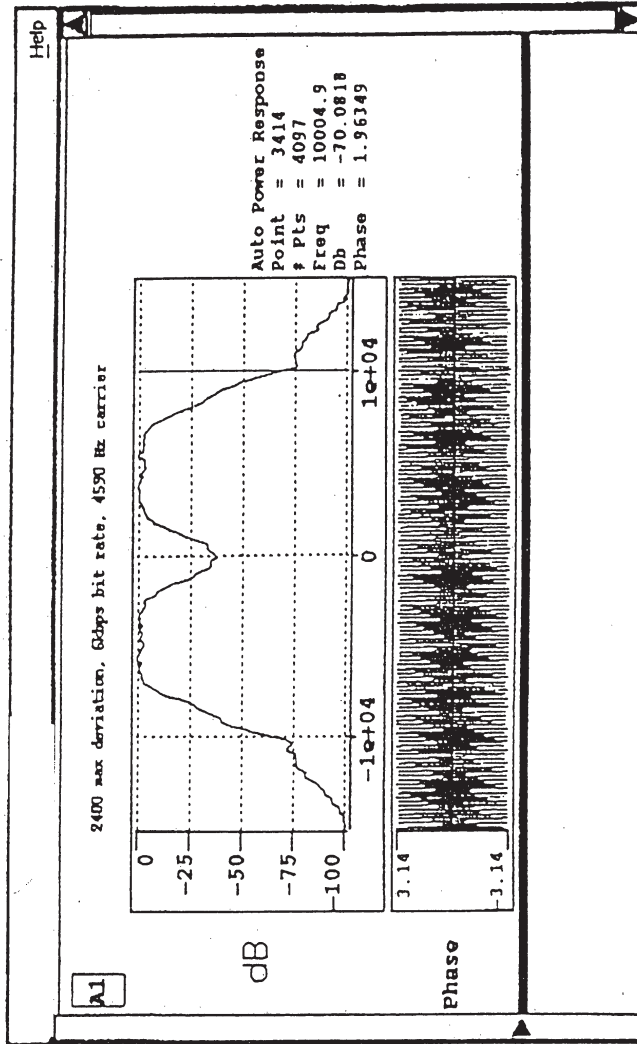


FIG 4

FIG 5A



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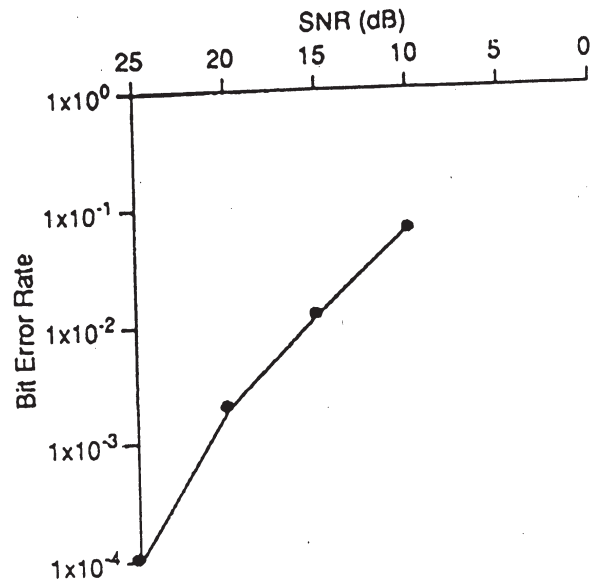
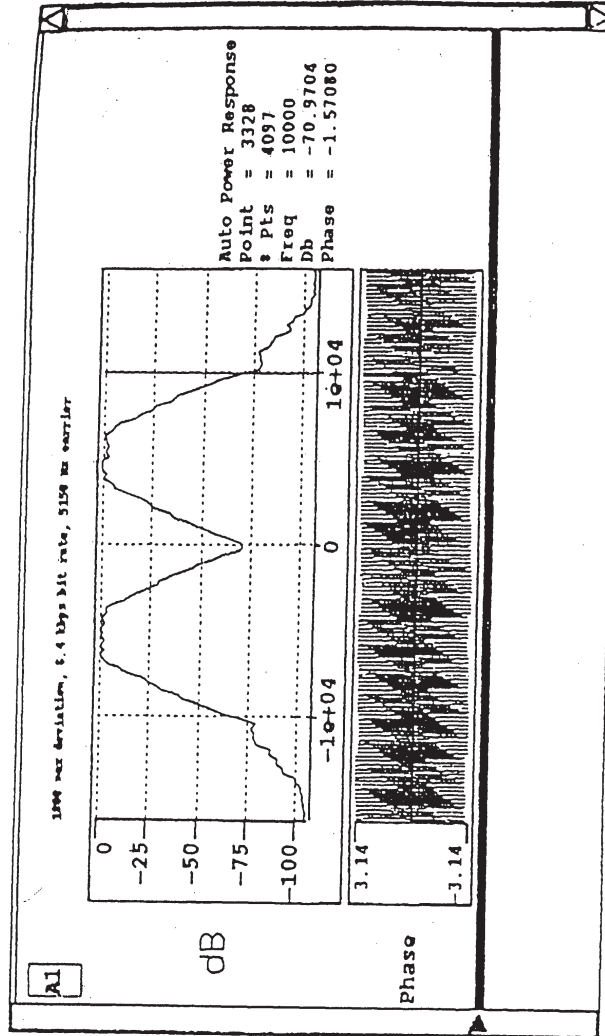


FIG 5B

FIG 6A



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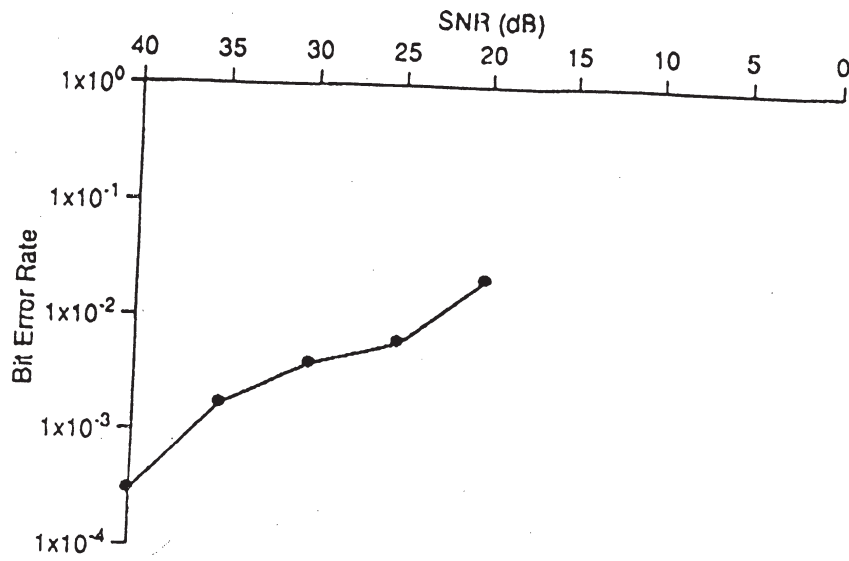


FIG 6B

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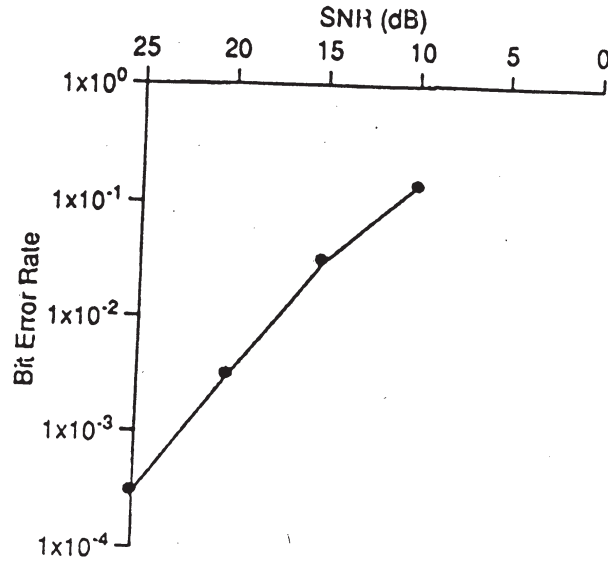
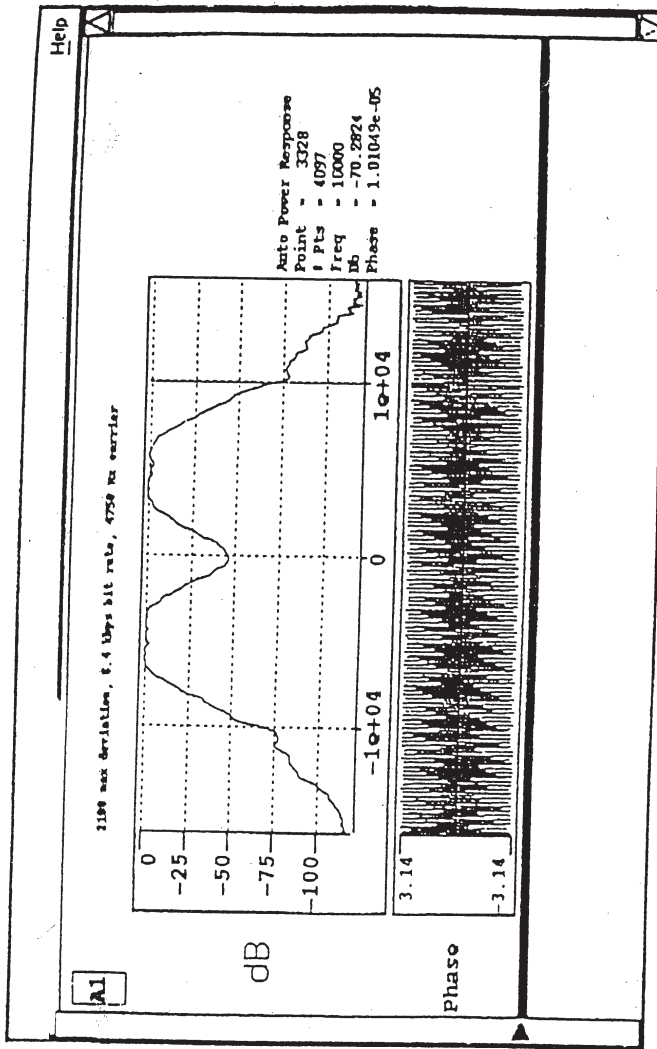


FIG 7B

FIG 7A



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MULTI CARRIER TRANSMITTERS

LINEAR AMPLIFIER TRANSMITTER 10

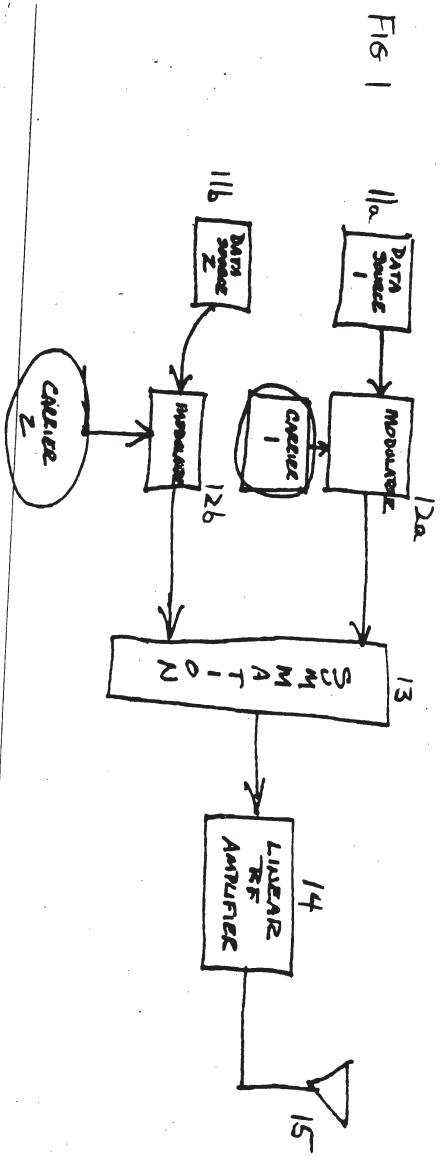
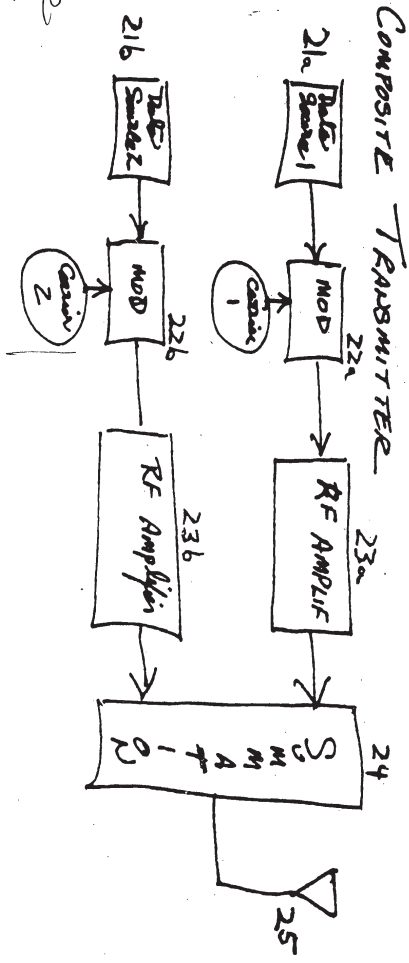


FIG 1

COMPOSITE TRANSMITTER



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153/03

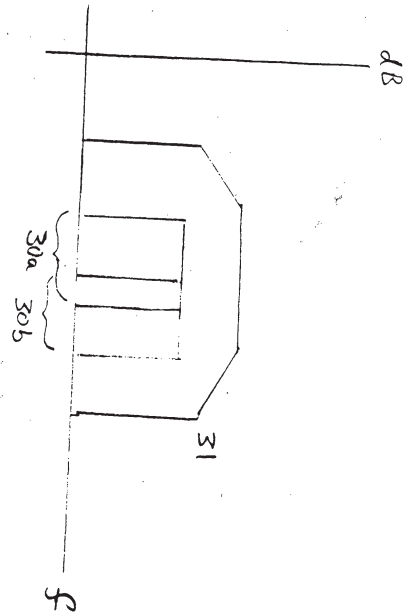


FIG 34

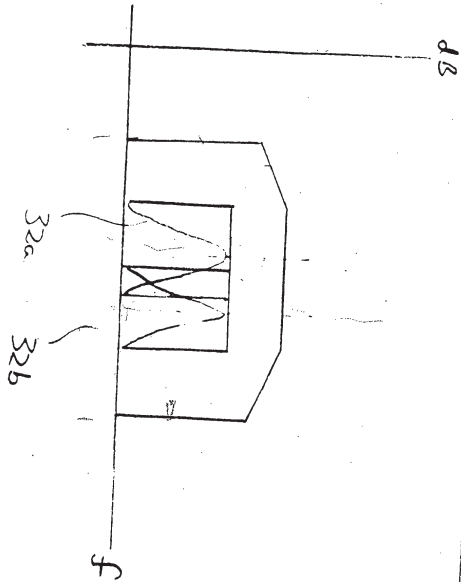


FIG 3R

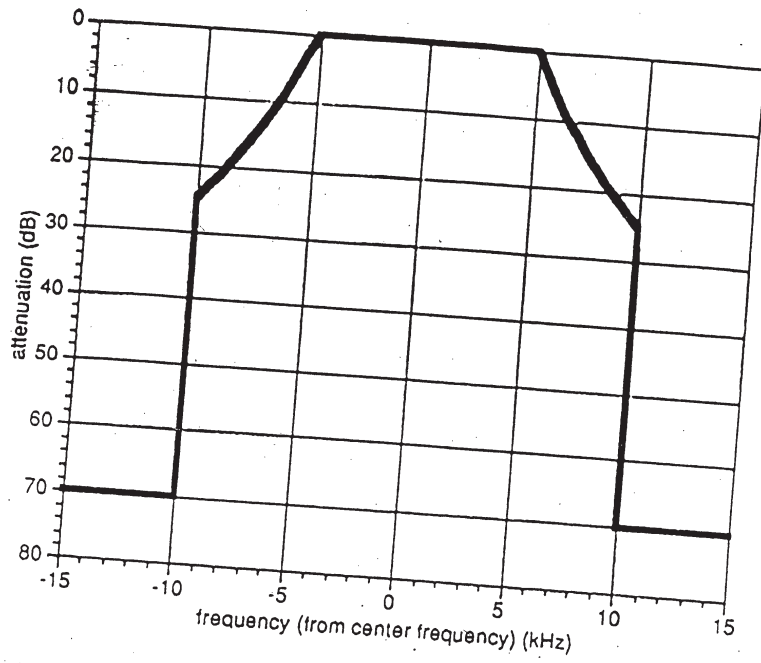
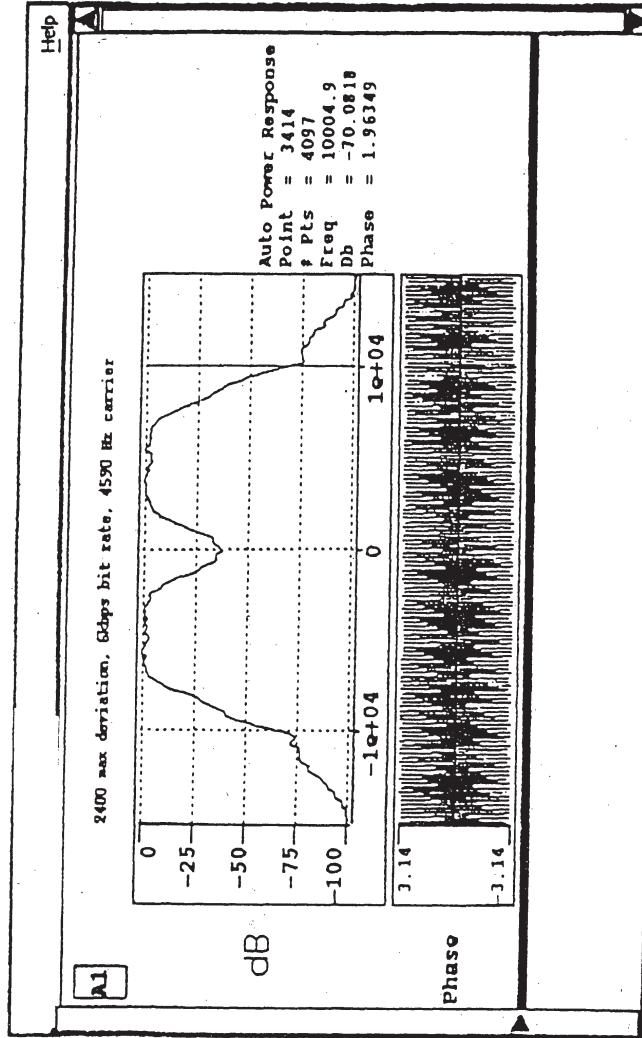


FIG 4

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FIG 5A



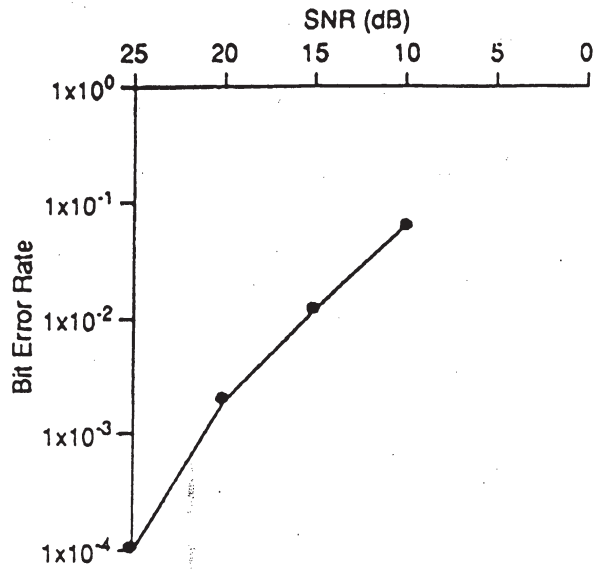
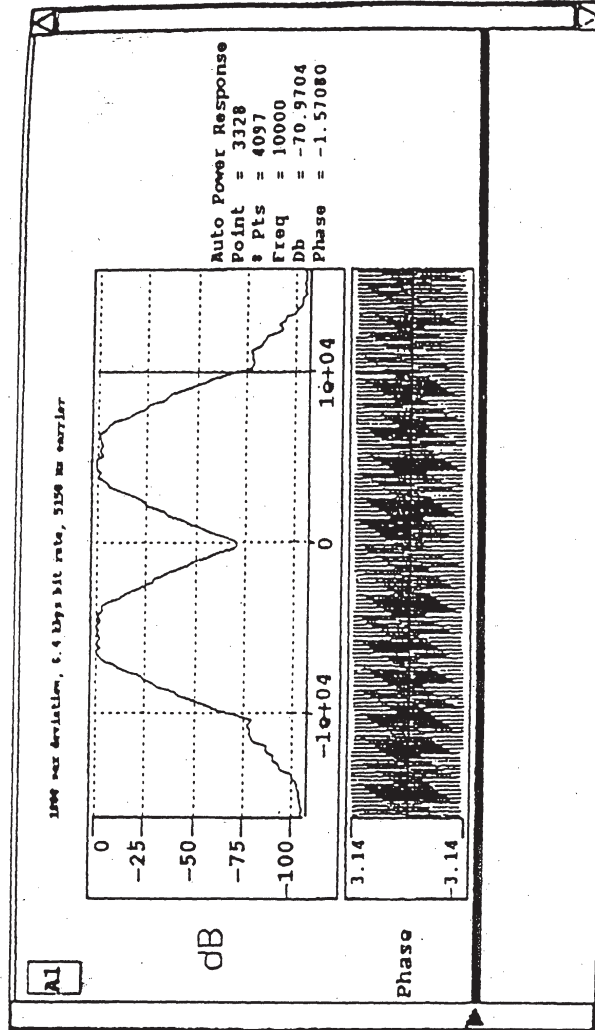


FIG 5B

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FIG 6A



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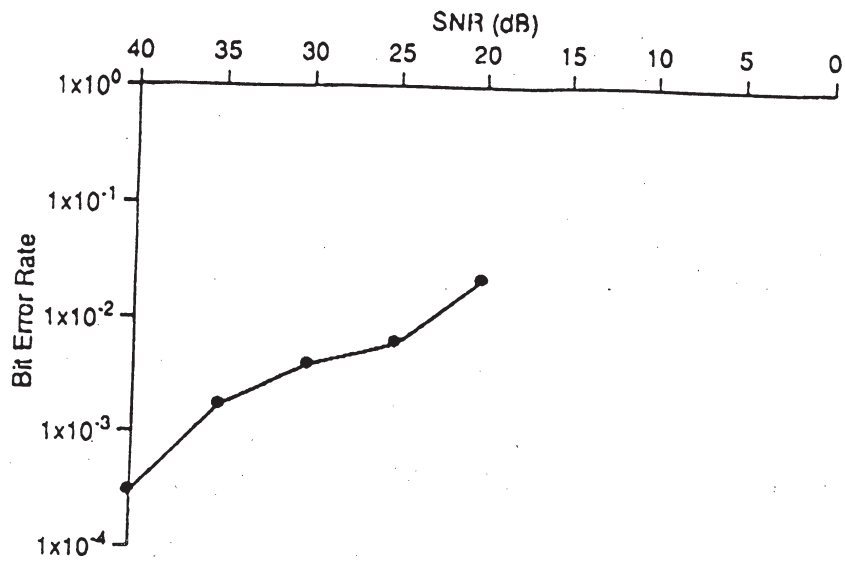


FIG 6B

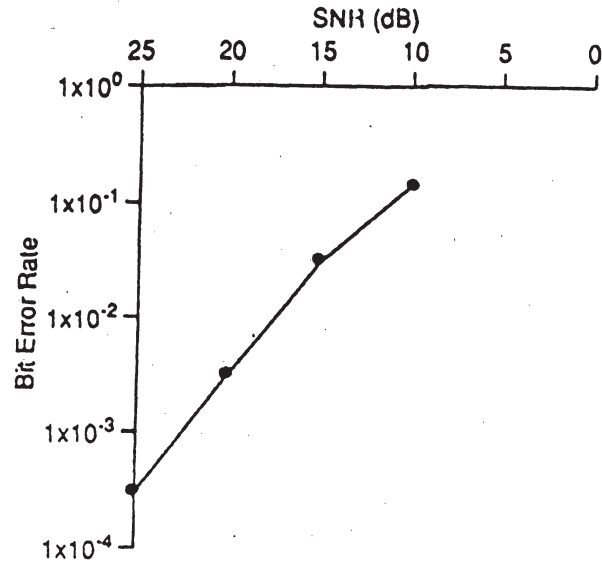
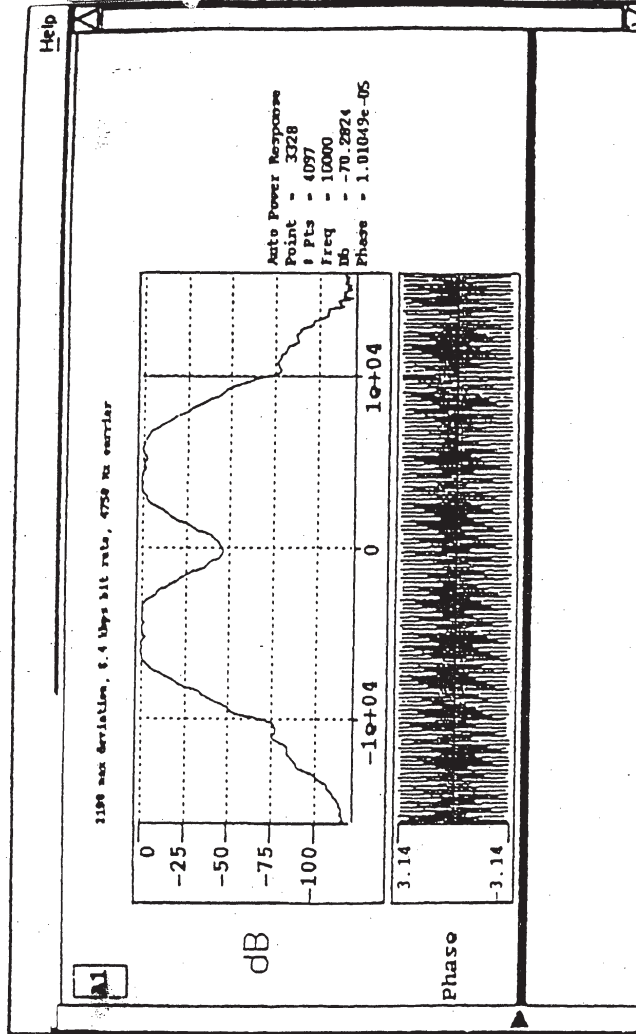


FIG 7B

FIG 7A





UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
 Address: COMMISSIONER OF PATENTS AND TRADEMARKS
 Washington, D.C. 20231

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
--------------------	-------------	-----------------------	------------------------

08/480,718 06/07/95 HAYS W 03680.0143

0212/0721
 FINNEGAN HENDERSON FARABOW GARRETT &
 DUNNER
 1300 I STREET NW
 WASHINGTON DC 20005-3315

DATE MAILED: 0000

**NOTICE TO FILE MISSING PARTS OF APPLICATION
 FILING DATE GRANTED**

07/21/95

An Application Number and Filing Date have been assigned to this application. However, the items indicated below are missing. The required items and fees identified below must be timely submitted **ALONG WITH THE PAYMENT OF A SURCHARGE** for items 1 and 3-6 only of \$ 130 for large entities or \$ 65 for small entities who have filed a verified statement claiming such status. The surcharge is set forth in 37 CFR 1.16(e).

If all required items on this form are filed within the period set below, the total amount owed by applicant as a large entity, small entity (verified statement filed), is \$ 130.

Applicant is given **ONE MONTH FROM THE DATE OF THIS LETTER, OR TWO MONTHS FROM THE FILING DATE** of this application, **WHICHEVER IS LATER**, within which to file all required items and pay any fees required above to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

1. The statutory basic filing fee is: missing insufficient. Applicant as a large entity small entity, must submit \$ _____ to complete the basic filing fee.
2. Additional claim fees of \$ _____ as a large entity, small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
3. The oath or declaration:
 - is missing.
 - does not cover the newly submitted items.

An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date is required.
4. The oath or declaration does not identify the application to which it applies. An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
5. The signature(s) to the oath or declaration is/are: missing; by a person other than the inventor or a person qualified under 37 CFR 1.42, 1.43, or 1.47. A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
6. The signature of the following joint inventor(s) is missing from the oath or declaration:

_____ An oath or declaration listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.
7. The application was filed in a language other than English. Applicant must file a verified English translation of the application and a fee of \$ _____ under 37 CFR 1.17(k), unless this fee has already been paid.
8. A \$ _____ processing fee is required since your check was returned without payment. (37 CFR 1.21(m)).
9. Your filing receipt was mailed in error because your check was returned without payment.
10. The application does not comply with the Sequence Rules. See attached Notice to Comply with Sequence Rules 37 CFR 1.821-1.825.
11. Other.

Direct the response to Box Missing Part and refer any questions to the Customer Service Center at (703) 308-1202.

A copy of this notice MUST be returned with the response.

OFFICE COPY

SRL



~~AB~~ ~~12/1~~

BOX MISSING PARTS
PATENT

Attorney Docket No.: 03680.0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of)	
William D. Hays, et al.)	
Serial No. 08/480,718	)	Group Art Unit: Unassigned
Filed: June 7, 1995	)	Examiner: Unassigned
For: MULTICARRIER TECHNIQUES)	
IN BANDLIMITED CHANNELS)	

Assistant Commissioner for Patents
Washington, D.C. 20231

Attention: Manager, Application Branch

Sir:

**RESPONSE TO NOTICE TO FILE
MISSING PARTS OF APPLICATION**

In response to the communication of July 21, 1995, the period of response having been extended one month by the concurrent filing of a request for extension of time and fee payment, Applicants submit a Declaration/Power of Attorney for filing in the above-identified application, the required fee of \$130.00, and a copy of the Notice of Missing Parts.

Please associate the enclosed declaration with the above identified application.

If there are any other fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 06-0916. If a fee is required for an extension of

LAW OFFICES
HINNEGAN, HENDERSON,
FARABOW, GARRETT
& DUNNER, L.L.P.
1300 I STREET, N.W.
WASHINGTON, DC 20005
202-408-4000


BOX MISSILE PARTS
Attorney Docket No.: 03680.0143
Serial No. 08/480,718

time under 37 C.F.R. § 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By:


Howard A. Kwon
Reg. No. 36,350

Dated: September 21, 1995

LAW OFFICES
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FARABOW, GARRETT
& DUNNER, L.L.P.
1300 I STREET, N.W.
WASHINGTON, DC 20005
202-408-4000

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS the specification of which [] is attached and/or [X] was filed as United States Application Serial No. 08/480,718 on June 7, 1995 and was amended on September 6, 1995.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119	
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

U.S. APPLICATIONS			STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBER ASSIGNED (if any)			

I hereby appoint the following attorney and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER**, Reg. No. 22,540; Douglas B. Henderson, Reg. No. 20,291; Ford F. Farabow, Jr., Reg. No. 20,630; Arthur S. Garrett, Reg. No. 20,338; Donald R. Dunner, Reg. No. 19,073; Brian G. Brunsvold, Reg. No. 22,593; Tipton D. Jennings, IV, Reg. No. 20,645; Jerry D. Voight, Reg. No. 23,020; Laurence R. Hefter, Reg. No. 20,827; Kenneth E. Payne, Reg. No. 23,098; Herbert H. Mintz, Reg. No. 26,691; C. Larry O'Rourke, Reg. No. 26,014; Albert J. Santorelli, Reg. No. 22,610; Michael C. Elmer, Reg. No. 25,857; Richard H. Smith, Reg. No. 20,609; Stephen L. Peterson, Reg. No. 26,325; John M. Romary, Reg. No. 26,331; Bruce C. Zotter, Reg. No. 27,680; Dennis P. O'Reilly, Reg. No. 27,932; Allen M. Sokal, Reg. No. 26,695; Robert D. Bajefsky, Reg. No. 25,387; Richard L. Stroup, Reg. No. 28,478; David W. Hill, Reg. No. 28,220; Thomas L. Irving, Reg. No. 28,619; Charles E. Lipsey, Reg. No. 28,165; Thomas W. Winland, Reg. No. 27,605; Basil J. Lewis, Reg. No. 28,818; Martin I. Fuchs, Reg. No. 28,508; E. Robert Yoches, Reg. No. 30,120; Barry W. Graham, Reg. No. 29,924; Susan Haberman Griffen, Reg. No. 30,907; Richard B. Racine, Reg. No. 30,415; Thomas H. Jenkins, Reg. No. 30,857; Robert E. Converse, Jr., Reg. No. 27,432; Clair X. Mullen, Jr., Reg. No. 20,348; Christopher P. Foley, Reg. No. 31,354; John C. Paul, Reg. No. 30,413; Roger D. Taylor, Reg. No. 28,992; David M. Kelly, Reg. No. 30,953; Kenneth J. Meyers, Reg. No. 25,146; Carol P. Einaudi, Reg. No. 32,220; Walter Y. Boyd, Jr., Reg. No. 31,738; Steven M. Anzalone, Reg. No. 32,095; Jean B. Fordis, Reg. No. 32,984; Barbara C. McCurdy, Reg. No. 32,120; James K. Hammond, Reg. No. 31,964; Richard V. Burgujian, Reg. No. 31,744; J. Michael Jakes, Reg. No. 32,824; and Howard A. Kwon - Reg. No. 36,350. Please address all correspondence to **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER** 1300 I Street, N.W., Washington, D.C. 20005, Telephone No. (202) 408-4000.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1-00

FULL NAME OF FIRST INVENTOR	INVENTOR'S SIGNATURE	DATE
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POST OFFICE ADDRESS		
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FULL NAME OF SECOND INVENTOR	INVENTOR'S SIGNATURE	DATE
Dennis Cameron	<i>Dennis Cameron</i>	9/18/95
RESIDENCE	COUNTRY OF CITIZENSHIP	
29 Polo Drive, Jackson, MS 39211	U.S.A.	
POST OFFICE ADDRESS		
P. O. Box 2469 Jackson, MS 39225-2469		

FULL NAME OF THIRD INVENTOR	INVENTOR'S SIGNATURE	DATE
Walter Roehr		
RESIDENCE	COUNTRY OF CITIZENSHIP	
	U.S.A.	
POST OFFICE ADDRESS		

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled: MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS the specification of which is attached and/or was filed as United States Application Serial No. 08/480,718 on June 7, 1995 and was amended on September 6, 1995.

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COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119	
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/> Yes	<input type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

U.S. APPLICATIONS			STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE		PATENTED	PENDING	ABANDONED
PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBER ASSIGNED (if any)			

I hereby appoint the following attorney and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER**, Reg. No. 22,540, Douglas B. Henderson, Reg. No. 20,291; Ford F. Farabow, Jr., Reg. No. 20,630; Arthur S. Garrett, Reg. No. 20,338; Donald R. Dunner, Reg. No. 19,073; Brian G. Brunsvold, Reg. No. 22,593; Tipton D. Jennings, IV, Reg. No. 20,645; Jerry D. Voight, Reg. No. 23,020; Laurence R. Hefter, Reg. No. 20,827; Kenneth E. Payne, Reg. No. 23,098; Herbert H. Mintz, Reg. No. 26,691; C. Larry O'Rourke, Reg. No. 26,014; Albert J. Santorelli, Reg. No. 22,610; Michael C. Elmer, Reg. No. 25,857; Richard H. Smith, Reg. No. 20,609; Stephen L. Peterson, Reg. No. 26,325; John M. Romary, Reg. No. 26,331; Bruce C. Zotter, Reg. No. 27,680; Dennis P. O'Reilley, Reg. No. 27,932; Allen M. Sokal, Reg. No. 26,695; Robert D. Bajefsky, Reg. No. 25,387; Richard L. Stroup, Reg. No. 28,478; David W. Hill, Reg. No. 28,220; Thomas L. Irving, Reg. No. 28,619; Charles E. Lipsey, Reg. No. 28,165; Thomas W. Winland, Reg. No. 27,605; Basil J. Lewris, Reg. No. 28,818; Martin I. Fuchs, Reg. No. 28,508; E. Robert Yoches, Reg. No. 30,120; Barry W. Graham, Reg. No. 29,924; Susan Haberman Griffen, Reg. No. 30,907; Richard B. Racine, Reg. No. 30,415; Thomas H. Jenkins, Reg. No. 30,857; Robert E. Converse, Jr., Reg. No. 27,432; Clair X. Mullen, Jr., Reg. No. 20,348; Christopher P. Foley, Reg. No. 31,354; John C. Paul, Reg. No. 30,413; Roger D. Taylor, Reg. No. 28,992; David M. Kelly, Reg. No. 30,953; Kenneth J. Meyers, Reg. No. 25,146; Carol P. Einaudi, Reg. No. 32,220; Walter Y. Boyd, Jr., Reg. No. 31,738; Steven M. Anzalone, Reg. No. 32,095; Jean B. Fordis, Reg. No. 32,984; Barbara C. McCurdy, Reg. No. 32,120; James K. Hammond, Reg. No. 31,964; Richard V. Burgujian, Reg. No. 31,744; J. Michael Jakes, Reg. No. 32,824; and Howard A. Kwon - Reg. No. 36,350. Please address all correspondence to **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER** 1300 I Street, N.W., Washington, D.C. 20005, Telephone No. (202) 408-4000.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF FIRST INVENTOR	INVENTOR'S SIGNATURE	DATE
William D. Hays		
RESIDENCE		COUNTRY OF CITIZENSHIP
		U.S.A.
POST OFFICE ADDRESS		

FULL NAME OF SECOND INVENTOR	INVENTOR'S SIGNATURE	DATE
Dennis Cameron		
RESIDENCE		COUNTRY OF CITIZENSHIP
		U.S.A.
POST OFFICE ADDRESS		

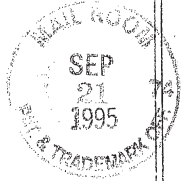
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FULL NAME OF THIRD INVENTOR	INVENTOR'S SIGNATURE	DATE
Walter Roehr	<i>[Signature]</i>	11 Sept 95
RESIDENCE		COUNTRY OF CITIZENSHIP
11317 South Shore Rd		U.S.A.
POST OFFICE ADDRESS		
RESTON VA 22090		

VA

11000-115

AN



PATENT
Attorney Docket No. 03680.0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of)	
William D. HAYS et al.)	
Serial No. 08/480,718	)	Group Art Unit: Unassigned
Filed: June 7, 1995	)	Examiner: Unassigned
For: MULTICARRIER TECHNIQUES)	
IN BANDLIMITED CHANNELS)	

Assistant Commissioner for Patents
Washington, D.C. 20231

REQUEST FOR EXTENSION OF TIME

Sir:

Applicants hereby petition for a one month extension of time to respond to the Notice of Missing Parts dated July 21, 1995.

A check in the amount of \$110.00 is enclosed to cover the cost of the extension of time.

If there are any other fees due in connection with the filing of this paper, please charge the fees to our Deposit Account No. 06-0916. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By: Howard A. Kwon
Howard A. Kwon
Reg. No. 36,350

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WASHINGTON, DC 20005
202-408-4000

270 BA 10/05/95 08480718

1 115 110.00 CR

Dated: September 21, 1995



130.00-105 AN

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
 Address: COMMISSIONER OF PATENTS AND TRADEMARKS
 Washington, D.C. 20231

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
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08/480,718 06/07/95 HAYS W 03680.0143

0212/0721
 FINNEGAN HENDERSON FARABOW GARRETT &
 DUNNER
 1300 I STREET NW
 WASHINGTON DC 20005-3315

DATE MAILED: 0000

**NOTICE TO FILE MISSING PARTS OF APPLICATION
 FILING DATE GRANTED**

07/21/95

An Application Number and Filing Date have been assigned to this application. However, the items indicated below are missing. The required items and fees identified below must be timely submitted **ALONG WITH THE PAYMENT OF A SURCHARGE** for items 1 and 3-6 only of \$ 130 for large entities or \$ 65 for small entities who have filed a verified statement claiming such status. The surcharge is set forth in 37 CFR 1.16(e).

If all required items on this form are filed within the period set below, the total amount owed by applicant as a large entity, small entity (verified statement filed), is \$ 130.

Applicant is given **ONE MONTH FROM THE DATE OF THIS LETTER, OR TWO MONTHS FROM THE FILING DATE** of this application, **WHICHEVER IS LATER**, within which to file all required items and pay any fees required above to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

1. The statutory basic filing fee is: missing insufficient. Applicant as a large entity small entity, must submit \$ _____ to complete the basic filing fee.
2. Additional claim fees of \$ _____ as a large entity, small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
3. The oath or declaration:
 - is missing.
 - does not cover the newly submitted items.*

An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date is required.
4. The oath or declaration does not identify the application to which it applies. An oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
5. The signature(s) to the oath or declaration is/are: missing; by a person other than the inventor or a person qualified under 37 CFR 1.42, 1.43, or 1.47. A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
6. The signature of the following joint inventor(s) is missing from the oath or declaration: _____ An oath or declaration listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.
7. The application was filed in a language other than English. Applicant must file a verified English translation of the application and a fee of \$ _____ under 37 CFR 1.17(k), unless this fee has already been paid.
8. A \$ _____ processing fee is required since your check was returned without payment. (37 CFR 1.21(m)).
9. Your filing receipt was mailed in error because your check was returned without payment.
10. The application does not comply with the Sequence Rules. See attached Notice to Comply with Sequence Rules 37 CFR 1.821-1.825.
11. Other.

Direct the response to Box Missing Part and refer any questions to the Customer Service Center at (703) 308-1202.

A copy of this notice MUST be returned with the response.

COPY TO BE RETURNED WITH RESPONSE



A/N
LOC 0300

PATENT
Attorney Docket No.: 03680.0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#A
12-24-95
M.L.

In re Application of:)	
William D. Hays et al.)	
Serial No.: 08/480,718	)	Group Art Unit: Unassigned
Filed: June 7, 1995	)	Examiner: Unassigned
For: MULTICARRIER TECHNIQUES)	
IN BANDLIMITED CHANNELS)	

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. § 1.97(b)

Pursuant to 37 C.F.R. §§ 1.56 and 1.97(b), Applicants bring to the attention of the Examiner the document listed on the attached PTO 1449. This Information Disclosure Statement is being filed within three months of the filing date of the above-referenced application.

A copy of the listed document is attached. Also enclosed is a graph providing a second interpretation of the applicable FCC Part 22 regulations. These submissions are intended to clarify that the graph of Fig. 4 of the application is a representative illustration and is not the only possible representation of an emissions mask defined by those regulations.

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Attorney D et No.: 03680.0143
Serial No.: 08/480,718

Applicants respectfully request that the Examiner consider the listed document and indicate that it was considered by making appropriate notations on the attached form.

This submission does not represent that a search has been made or that no better art exists and does not constitute an admission that the listed document is material or constitutes "prior art." If the Examiner applies the document as prior art against any claim in the application and Applicants determine that the cited document does not constitute "prior art" under United States law, Applicants reserve the right to present to the office the relevant facts and law regarding the appropriate status of such document.

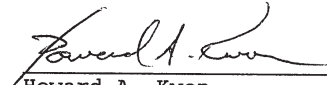
Applicants further reserve the right to take appropriate action to establish the patentability of the disclosed invention over the listed document, should the document be applied against the claims of the present application.

If there is any fee due in connection with the filing of this Statement, please charge the fee to our Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER

By:


Howard A. Kwon
Reg. No. 36,350

Date: August 9, 1995

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- 2 -

prefixed by a number specifying the necessary bandwidth in kilohertz. This figure does not necessarily indicate the bandwidth actually occupied by the emission at any instant. In those cases where Part 2 of this chapter does not provide a formula for the computation of the necessary bandwidth, the occupied bandwidth may be used in the emission designator.

§ 22.106 Emission limit.

(a) For transmitters other than those employing digital modulation techniques, the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(1) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: at least 25 decibels;

(2) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: at least 35 decibels;

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus 10 Log_{10} (mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation.

(b) For transmitters not equipped with an audio low pass filter required by the provisions of paragraphs (f) and (g) of § 22.506, and for those employing digital modulation techniques, the power of any emission shall be attenuated below the unmodulated carrier power (P) in accordance with the following schedule:

(1) For those transmitters that operate in the frequency bands of 35.0 to 44.0 MHz, 72.0 to 73.0 MHz, 75.4 to 76.0 MHz or 152.0 to 159.0 MHz.

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz up to and including 10 kHz: at least 83 Log_{10} (fd/5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz up to and including 250 percent of the authorized

bandwidth: At least 29 Log_{10} fd/11 decibels or 50 decibels, whichever is the lesser attenuation;

(iii) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least 43 plus 10 Log_{10} (output power in watts) decibels or 80 decibels, whichever is the lesser attenuation.

NOTE: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the unmodulated transmitter carrier power.

(2) For those transmitters that operate in the frequency bands 450.0 to 512.0 MHz, or 929.0 to 932.0 MHz,

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz up to and including 10 kHz: at least 83 Log_{10} (fd/5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz up to and including 250 percent of the authorized bandwidth: at least 116 Log_{10} (fd/6.1) decibels or 50 plus 10 Log_{10} (P) or 70 decibels, whichever is the lesser attenuation;

(iii) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least 43 plus 10 Log_{10} (output power in watts) decibels or 80 decibels, whichever is the lesser attenuation.

NOTE: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the unmodulated transmitter carrier power.

(3) For those transmitters that operate in the frequency bands 932-932.5/941-941.5 MHz with a 12.5 kHz bandwidth,

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 2.5 kHz up to and including 6.25 kHz: At least 53 log_{10} ($f_d/2.5$) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 6.25 kHz up to and includ-

§ 22.107

ing 9.5 kHz: At least $103 \log_{10} (f_d/3.9)$ decibels;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 9.5 kHz up to and including 15 kHz: At least $157 \log_{10} (f_d/5.3)$ decibels;

(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 kHz: At least $50 + 10 \log_{10} (P)$ or 70 decibels, whichever is the lesser attenuation.

(4) For those transmitters that operate in the frequency bands 932-932.5/941-941.5 MHz with a bandwidth greater than 12.5 kHz,

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz up to and including 10 kHz: At least $83 \log_{10} (f_d/5)$ decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz up to and including 250 percent of the authorized bandwidth: At least $116 \log_{10} (f_d/6.1)$ decibels or $50 + 10 \log_{10} (P)$ or 70 decibels, whichever is the lesser attenuation;

(iii) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least $43 + 10 \log_{10} (\text{output power in watts})$ decibels or 80 decibels, whichever is the lesser attenuation.

(c) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

[49 FR 3332, Jan. 26, 1984, as amended at 52 FR 10573, Apr. 2, 1987; 55 FR 10463, Mar. 21, 1990]

§ 22.107 Standby facilities.

(a) *Base.* Standby facilities for base stations will be authorized when the resultant reliable service area and interference contour(s) do not exceed those of the facilities which are being replaced.

(b) *Control-Repeater.* Standby control facilities will be authorized subject to non-interference to other users.

[50 FR 32203, Aug. 9, 1985]

§ 22.108 Directional antennas.

(a) *Directional antennas required.* Rural radio stations, control stations, repeater stations, and dispatch stations shall use a directional antenna with the major lobe of radiation in the horizontal plane directed toward the receiving station or the passive reflector with which the station communicates. A multi- or omni-directional antenna may be authorized if necessary where a station communicates with more than one point.

(b) *Beam width required.* Stations required to use directional antennas shall meet the standards indicated below. Maximum beam width is for the major lobe of radiation at the half power points. Suppression is the minimum attenuation required for any secondary lobe signal and is referenced to the maximum signal in the main lobe.

Frequency range	Maximum beam width (degrees)	Suppression (dB)
Below 512 MHz	80	10
512 to 1000 MHz	20	13
1500 to 2500 MHz	12	13

(c) *Temporary fixed station requirement.* Temporary fixed stations may use antenna structures not exceeding the height criteria in Part 17 of this chapter. Greater height requires FAA or FCC approval.

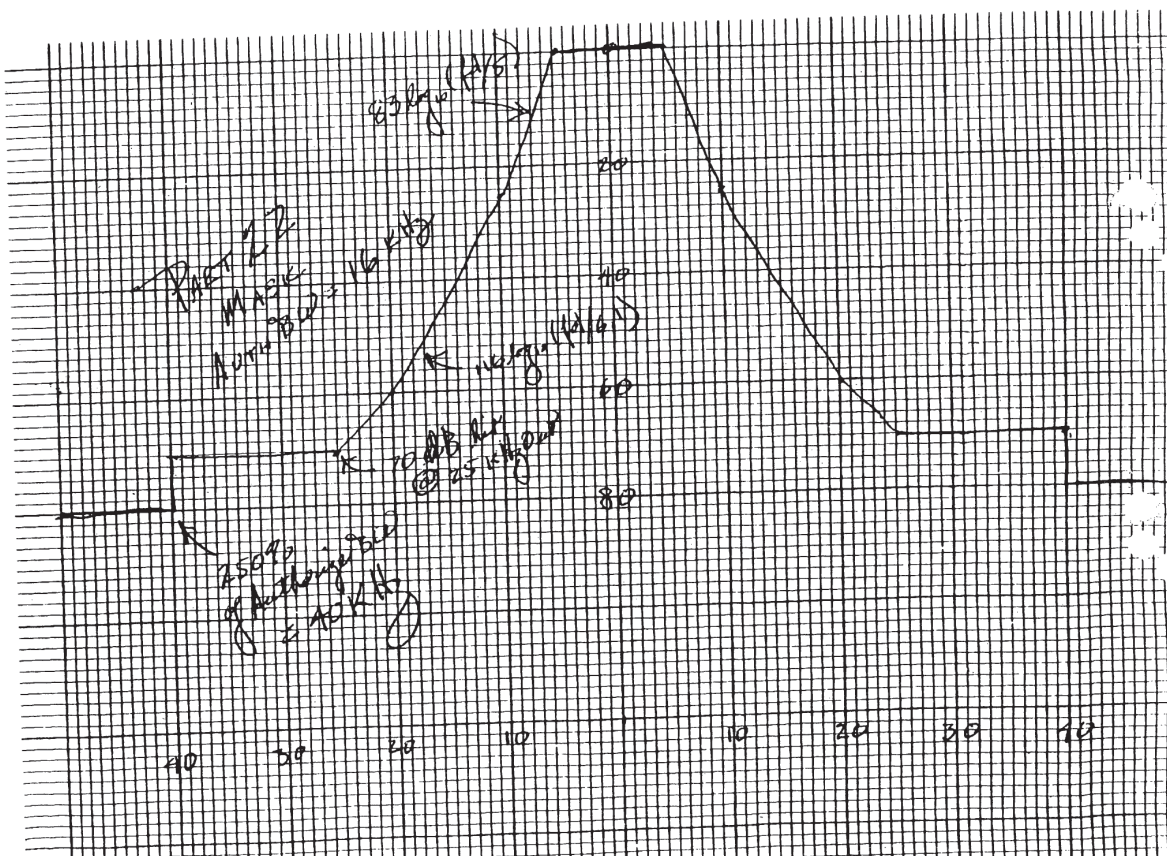
(d) All applications for station authorization (Form 401) shall include the beam width of the major lobe of the antenna pattern (polar diagram). For this purpose the beam width is defined as the arc, in degrees, including all points on the polar diagram which are within 3 decibels of the point of maximum gain (half power points). For omnidirectional antennas the beam width is defined as 360 degrees.

[49 FR 3333, Jan. 26, 1984]

§ 22.109 Antenna structure.

(a) *General provisions.* (1) Permittees and licensees shall not allow antenna structures to become a hazard to air navigation.

(2) Antenna structures shall be marked and maintained in accordance with section 303(q) of the Communica-





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AN

PATENT
Attorney Docket No. 03680.0143-00

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE #5

*Pre Amndt A
12-11-95
M.L.*

In re Application of:)	
William D. Hays et al.)	
Serial No.: 08/480,718	)	Group Art Unit: Unassigned
Filed: June 7, 1995	)	Examiner: Unassigned
For: MULTICARRIER TECHNIQUES)	
IN BANDLIMITED CHANNELS)	

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

PRELIMINARY AMENDMENT

Prior to the examination of the above application, please amend this application as follows:

IN THE SPECIFICATION:

Page 2, lines 29-31, change "Due to the limited bandwidth of a standard channel, however, some carrier overlap can be expected in multicarrier transmission" to ~~AM~~ ^{A1}Despite these stringent constraints, some carrier overlap can be expected ~~AM~~.

Page 3, lines 4-5, change "a practical multicarrier environment is commonly understood to require stringent subchannel protection levels" to ~~AM~~ ^{A2}a traditional multicarrier design would commonly require the same stringent protection levels between subchannels ~~AM~~; and

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Attorney Docket No. 003680.0143-00
Serial No.: 480,718

line 14, after "receiver" insert --and
transmitter--.

N.E. *which occurrence*
Page 4, line 22, after "receiving" insert --at least--.

A3
Page 5, lines 18-20, change "the FCC emission limits mask
for digital transmitters operating in the frequency bands 450.0
to 512.0 MHz and 929.0 to 932.0 MHz" to --an exemplary FCC
emissions mask that requires the power spectral density to be
attenuated at least 70 dB within 10 kHz from center frequency--.

Page 8, line 13, after "frequency" insert --deviation--.

Page 10, line 5, after "receiver" insert --and
transmitter--; and

line 10, change "is also well" to --may also be--.

IN THE CLAIMS:

N.E. *which occurrence*
Claim 5, line 5, after "receiving" insert --at least--.

REMARKS

The specification has been amended to provide more clarity
to the Discussion of Related Art, to conform the Brief
Description of the Drawings for Fig. 4 to the language used in
the body of the specification, and to correct a number of minor
matters in a manner fully consistent with the application as
filed. Applicants thus submit that these amendments do not
constitute new matter.

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Attorney Docket No. 003680.0143-00
Serial No.: 480,718

Accordingly, Applicants respectfully request that the
Examiner enter the amendments forthwith.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By: Howard A. Kwon
Howard A. Kwon
Reg. No. 36,350

Dated: September 6, 1995

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- 3 -

Transaction History Date 1995-10-03
Date information retrieved from USPTO Patent
Application Information Retrieval (PAIR)
system records at www.uspto.gov



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03680/0143

Attorney Docket No.: 03680/0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)
William D. Hays et al.)
Serial No.: 08/480,718) Group Art Unit: Unassigned
Filed: June 7, 1995) Examiner: Unassigned
For: MULTICARRIER TECHNIQUES)
IN BANDLIMITED CHANNELS)
Assistant Commissioner for Patents
Washington, D.C. 20231
Sir:

RECEIVED
JAN 10 AM 7:05
GROUP 260

INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. § 1.97(b)

Pursuant to 37 C.F.R. §§ 1.56 and 1.97(b), Applicants bring to the attention of the Examiner the document listed on the attached PTO 1449 and referenced in the above-identified application on page 2, lines 1-3. This Information Disclosure Statement is being filed before the mailing date of a first Office Action on the merits.

A copy of the listed document is attached.

Applicants respectfully request that the Examiner consider the listed document and indicate that it was considered by making appropriate notations on the attached form.

This submission does not represent that a search has been made or that no better art exists and does not constitute an admission that the listed document is material or constitutes "prior art." If the Examiner applies the document as prior art

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1-202-406-4000

Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

against any claim in the application and Applicants determine that the cited document does not constitute "prior art" under United States law, Applicants reserve the right to present to the office the relevant facts and law regarding the appropriate status of such document.

Applicants further reserve the right to take appropriate action to establish the patentability of the disclosed invention over the listed document, should the document be applied against the claims of the present application.

If there is any fee due in connection with the filing of this Statement, please charge the fee to our Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER

By: 

Howard A. Kwon
Reg. No. 36,350

Date: October 3, 1995

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WASHINGTON, DC 20005
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- 2 -



OMB No. 0651-0011

INFORMATION DISCLOSURE CITATION (Use several sheets if necessary)	Atty. Docket No.	Serial No.
	03680.0143	08/480,718
	Applicant	
	William D. Hays et al.	
Filing Date	Group	
June 7, 1995	Unassigned	2611

U.S. PATENT DOCUMENTS

*Examiner Initial	Document Number	Date	Name	Class	Sub Class	Filing Date If Appropriate
LEE	5,392,452	02/21/95	Davis	455	38.1	11/2/95

FOREIGN PATENT DOCUMENTS

	Document Number	Date	Country	Class	Sub Class	Translation	
						Yes	No

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

Examiner LEE LGUYEN	Date Considered 2/1/96
------------------------	---------------------------

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.



2611

12-8-95
030

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Tepp
1/3/96

PATENT
Attorney Docket No. 03680.0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
William D. Hays et al.
Serial No.: 08/480,718
Filed: June 7, 1995
For: MULTICARRIER TECHNIQUES
IN BANDLIMITED CHANNELS

Group Art Unit: Unassigned
Examiner: Unassigned

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

RECEIVED
95 DEC -5 AM 1:13
GROUP 260

STATUS INQUIRY

The above-identified application was filed in the United States Patent and Trademark Office on June 7, 1995. To date no communication has been received from the Examiner.

Please inform us of the status of this application.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT AND DUNNER, L.L.P.

By: *Howard A. Kwon*
Howard A. Kwon
Reg. No. 36,350

Dated: November 9, 1995

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**UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office**

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/480,718	06/07/95	HAYS	W 03680.0143

26M1/0117
 FINNEGAN HENDERSON FARABOW GARRETT &
 DUNNER
 1300 I STREET NW
 WASHINGTON DC 20005-3315

NGUYEN L EXAMINER	
ART UNIT	PAPER NUMBER
2611	7

DATE MAILED: 01/17/96

Please find below a communication from the EXAMINER in charge of this application.

Commissioner of Patents

REPLY TO STATUS INQUIRY

01. This letter is in reply to the status letter received in the Patent and Trademark Office on 11/09/1995, regarding application serial No. 08/480,718.
02. This application is currently pending in Art Unit 2611 and is assigned to examiner L. Nguyen. It is anticipated that it will be taken up for action prior to 01/29/1996.
03. Any further inquires regarding this application should be directed to Examiner L. Nguyen at telephone No. (703) 305-4700 or FAX No. (703) 305-9508.

Verleah D. Green
 VERLEAH D. GREEN
 OFFICE MANAGER
 GROUP 2611



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
 Address: COMMISSIONER OF PATENTS AND TRADEMARKS
 Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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08/480,718 06/07/95 HAYS

W 03680.0143

EXAMINER

26M2/0209

FINNEGAN HENDERSON FARABOW GARRETT &
 DUNNER
 1300 I STREET NW
 WASHINGTON DC 20005-3315

ART UNIT	PAPER NUMBER
----------	--------------

2611

9

DATE MAILED: 02/09/96

This is a communication from the examiner in charge of your application.
 COMMISSIONER OF PATENTS AND TRADEMARKS

This application has been examined Responsive to communication filed on _____ This action is made final.

A shortened statutory period for response to this action is set to expire 03 month(s), _____ days from the date of this letter.
 Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

- | | |
|---|---|
| 1. <input checked="" type="checkbox"/> Notice of References Cited by Examiner, PTO-892. | 2. <input type="checkbox"/> Notice of Draftsman's Patent Drawing Review, PTO-948. |
| 3. <input checked="" type="checkbox"/> Notice of Art Cited by Applicant, PTO-1449. | 4. <input type="checkbox"/> Notice of Informal Patent Application, PTO-152. |
| 5. <input type="checkbox"/> Information on How to Effect Drawing Changes, PTO-1474. | 6. <input type="checkbox"/> _____ |

Part II SUMMARY OF ACTION

1. Claims 1-8 are pending in the application.

Of the above, claims _____ are withdrawn from consideration.

2. Claims _____ have been cancelled.

3. Claims 1-2 are allowed.

4. Claims 3-7 are rejected.

5. Claims 8 are objected to.

6. Claims _____ are subject to restriction or election requirement.

7. This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.

8. Formal drawings are required in response to this Office action.

9. The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are acceptable; not acceptable (see explanation or Notice of Draftsman's Patent Drawing Review, PTO-948).

10. The proposed additional or substitute sheet(s) of drawings, filed on _____, has (have) been approved by the examiner; disapproved by the examiner (see explanation).

11. The proposed drawing correction, filed _____, has been approved; disapproved (see explanation).

12. Acknowledgement is made of the claim for priority under 35 U.S.C. 119. The certified copy has been received not been received been filed in parent application, serial no. _____; filed on _____.

13. Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.

14. Other

EXAMINER'S ACTION

PTOL-326 (Rev. 2/93)

Serial Number: 08/480,718

-2-

Art Unit: 2611

1. Claims 3-4 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

As to claim 3, lines 6-7, the term "said subchannels" lacks antecedent basis.

As to claim 4, the claim depends on claim 3 and is rejected for the same reason.

2. The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. § 103, the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 C.F.R. § 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order

Serial Number: 08/480,718

-3-

Art Unit: 2611

for the examiner to consider the applicability of potential 35 U.S.C. § 102(f) or (g) prior art under 35 U.S.C. § 103.

3. Claims 5-7 are rejected under 35 U.S.C. § 103 as being unpatentable over the prior art admitted by Applicant in view of Chang (U.S. Patent 3,488,445).

As to claim 5, pages 1-3 of the admitted prior art teaches all what is claimed, except transmitting the plurality of carriers over a plurality of subchannels spaced asymmetrically within the mask defining the channel. Chang teaches what is claimed in col. 1, lines 60-68 where asymmetry reads on overlap. It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the paging system of the admitted prior art with the teaching of Chang in order to prevent interchannel interference (col. 1, line 68).

As to claim 6, the admitted prior art as modified by Chang teaches what is claimed (admitted prior art, page 2, lines 27-29).

As to claim 7, the admitted prior art as modified by Chang teaches the steps of selecting: peak frequency deviations reads on a bandwidth extending from $0.5f_s$ to $2.5f_s$ (col. 8, lines 55-56 of Chang), bit rates (col. 2, lines 3-7 of Chang), and carrier frequencies reads on frequencies f_1 - f_3 (col. 8, lines 51-61 of Chang). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the paging

Serial Number: 08/480,718

-4-

Art Unit: 2611

system of the admitted prior art with as modified by Chang in order to approach the theoretical maximum data rate (col. 2, lines 3-7 of Chang).

4. Claims 1-2 are allowable over the prior art of record.

5. Claims 3-4 would be allowable if rewritten or amended to overcome the rejection under 35 U.S.C. 112.

6. Claim 8 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

As to claims 1, 3 and 8, the frequency difference between the center frequency of the outer most carriers and the band edge of the mask is greater than half the frequency difference between the center frequencies of each adjacent carrier, is not taught or suggested in the prior art of record.

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Perkins (U.S. Patent 4,244,047) teaches multiplexed carrier transmission through harmonic polluted medium.

Serial Number: 08/480,718

-5-

Art Unit: 2611

Seidel (U.S. Patent 3,914,554) teaches communication system employing spectrum folding.

Jasper et al. (U.S. Patent 5,343,499) teach quadrature amplitude modulation synchronization method.

Koontz (U.S. Patent 5,163,181) teaches multiple RF signal amplification method and apparatus.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lee Nguyen whose telephone number is (703) 308-5249. The examiner can normally be reached on Monday-Friday from 8:00 AM to 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Reinhard Eisenzopf, can be reached on (703) 305-4711. The fax phone number for this Group is (703) 305-9508.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 305-4700.

Lee Nguyen *lee*

February 1, 1996

Reinhard J. Eisenzopf
Reinhard J. Eisenzopf 2-5-96
Supervisory Patent Examiner
Group 260

TO SEPARATE, HOLD TOP AND BOTTOM EDGES, SNAP-APART AND DISCARD CARBON

FORM PTO-892 (REV. 2-92)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	SERIAL NO. 08/480,718	GROUP ART UNIT	ATTACHMENT TO PAPER NUMBER 9
NOTICE OF REFERENCES CITED		APPLICANT(S) Hays et al.		

U.S. PATENT DOCUMENTS

*	DOCUMENT NO.	DATE	NAME	CLASS	SUB-CLASS	FILING DATE IF APPROPRIATE
A	4244047	1/6/81	Perkins	370	69	3/20/79
B	3488445	1/6/70	Chang	370	69.1	11/14/66
C	3914554	10/21/75	Seibel	179	15.55 R	5/18/73
D	5343499	8/30/94	Tasper et al.	375	39	1/9/92
E	5163181	11/10/92	Koontz	455	103	10/21/88
F						
G						
H						
I						
J						
K						

FOREIGN PATENT DOCUMENTS

*	DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUB-CLASS	PERTINENT SHTS. DWG.	PP. SPEC.
L								
M								
N								
O								
P								
Q								

OTHER REFERENCES (Including Author, Title, Date, Pertinent Pages, Etc.)

R	
S	
T	
U	

EXAMINER LEE NGUYEN	DATE 2/1/96
------------------------	----------------

* A copy of this reference is not being furnished with this office action.
(See Manual of Patent Examining Procedure, section 707.05 (a).)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



In re Application of:)
)
 William D. HAYS et al.)
)
 Series No.: 08/480,718) Group Art Unit: 2611
)
 Filed: June 7, 1995) Examiner: L. Nguyen
)
 For: MULTICARRIER TECHNIQUES IN)
 BANDLIMITED CHANNELS)

TRANSMITTAL LETTER

Assistant Commissioner for Patents
 Washington, D.C. 20231

Sir:

Enclosed is a response to the Office Action of February 9, 1996. The items checked below are appropriate:

- Applicants hereby petition for a three month extension of time to respond to the above Office Action. The fee of \$200.00 for the Extension is enclosed.

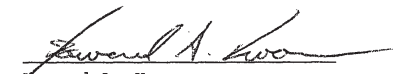
The claims are calculated below:

	Claims Remaining After Amendment		Highest Number Previously Paid	Present Extra	Rate	Additional Fee
Total	08	-	08	00	x \$ 22	\$
Indep.	03	-	02	00	x \$ 78	
[] First Presentation of Multiple Dep. Claim(s)					+ \$250	
Subtotal						\$
Reduction by 1/2 if small entity						-
TOTAL						\$

- A fee of \$_____ to cover the cost of the additional claims added by this response is enclosed.
- A fee of \$_____ to cover _____ is enclosed.
- A check for \$200.00 to cover the above fee is enclosed.

If there are any other fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 06-0916. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

Date: August 9, 1996

By: 
 Howard A. Kwon
 Registration No. 36,350
 FINNEGAN, HENDERSON, FARABOW,
 GARRETT & DUNNER, L.L.P.
 1300 I Street, N.W.
 Washington, D.C. 20005-3315
 (202) 408-4000



8-22-96
M

40. / 117 #10/B
TLR
PATENTS
Amend F
Ext E

Attorney Docket No.: 03680.0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)
)
William D. HAYS et al.)
)
Serial No.: 08/480,718) Group Art Unit: 2611 ✓
)
Filed: June 7, 1995) Examiner: L. Nguyen
)
For: MULTICARRIER TECHNIQUES)
IN BANDLIMITED CHANNELS)

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

AMENDMENT

In response to the Office Action dated February 9, 1996, the period of response having been extended for three months by the filing of a request for extension and fee payment filed concurrently herewith, please amend the application as follows:

IN THE SPECIFICATION:

Page 8, line 9, after "than" delete --the--.

IN THE CLAIMS:

Please amend claim 3 as follows:

Claim 3, line 6, after "said" insert --corresponding--.

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070 WJ 08/14/96 08480718 1 117 900.00 CK

Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

Please cancel claim 8 and add new claim 9 as follows:

9. In a paging system having a plurality of transmitters transmitting a plurality of modulated carriers over a single mask-defined, bandlimited channel and a plurality of mobile receiving units independently receiving one of said plurality of carriers, a method of operating said plurality of carriers in said channel to achieve higher transmission capacity comprising the steps of:

B/ would.
co-locating said plurality of transmitters such that said plurality of carriers can be emanated from the same transmission source; and

transmitting said plurality of carriers over a plurality of subchannels spaced within the mask defining said channel wherein the frequency difference between the center frequency of the outer most carriers and the band edge of said mask is greater than half the frequency difference between the center frequencies of each adjacent carrier. *N*

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Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

REMARKS

Specification

A minor editorial change has been made to the specification.

Claims

The Examiner has rejected claims 3-7 and objects to claim 8 insofar as it depends from claim 5. At the outset, Applicants acknowledge with appreciation the Examiner's indication that claims 1-4 and 8 are directed to allowable subject matter. Claims 3 and 4 have been amended as noted below, and claim 8 has been canceled and rewritten in independent form as new claim 9, which includes the limitations of claim 5. Applicants submit that claim 9 is therefore also in condition for allowance.

Claims 3 and 4 are rejected under 35 U.S.C. § 112, paragraph 2 as being indefinite. Applicants have amended the claims to address the Examiner's indefiniteness concerns. In view of the Examiner's indication that claims 3 and 4 are otherwise allowable, Applicants submit that the claims as amended are in condition for allowance.

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Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

Claims 5-7 are rejected under 35 U.S.C. § 103 in view of Chang and the admitted prior art. Applicants respectfully traverse the Examiner's obviousness rejections of these claims. Applicants submit that the claimed invention would not have been obvious to one of ordinary skill in the art based on the prior art of record.

Chang discloses a point-to-point wire line data transmission system that simultaneously transmits and simultaneously receives a plurality of multiplexed band-limited data signals over a line 49 using mutually orthogonal signaling channels. The Examiner believes that one of ordinary skill in the art would have arrived at Applicants' claimed "paging system" method in view of Chang's point-to-point wire line system and the admitted prior art. In reaching that determination, the Examiner expressly relies on Chang's disclosure of shaping the spectra of adjacent channels by virtue of their orthogonality so that they can overlap without producing interchannel interference. Applicants submit that Chang falls well short of the Applicants' claimed method.

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Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

Unlike the method disclosed by Chang, the multicarrier paging system modulation technique claimed by Applicants requires "a plurality of mobile receiving units independently receiving one of said plurality of carriers." Thus, Applicants' method does not involve the simultaneous receipt of multiplexed orthogonal carriers over a simple transmission line, as disclosed by Chang. Rather, in Applicants' claimed method, a plurality of carriers are broadcasted over a plurality of individual subchannels spaced asymmetrically within a bandlimited channel. As described in Applicants' specification, the frequency spacings between adjacent carriers are smaller than the frequency spacings between the band edges of the mask and the nearest respective carrier. As a result, greater spacing between adjacent subchannel carriers within the mask is achieved for broadcast paging.

There is no such teaching or suggestion in the prior art of record. Chang discloses a plurality of data signals that are orthogonally multiplexed on equally spaced carrier frequencies for transmission via odd and even channels. In this regard, no even channel is overlapped with another

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- 5 -

Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

even channel. Similarly, no odd channel is overlapped with another odd channel. The even and odd channels are instead superimposed on each other and then separated at a common receiver by an orthogonal demultiplexing method.

Chang does not disclose a "plurality of mobile receiving units independently receiving one of said plurality of carriers," as required by Applicants' claim 5. Nor does Chang disclose a method of transmitting a plurality of carriers over a plurality of "subchannels" that are asymmetrically located "within the mask defining said channel." Each "channel" of Chang of a particular orthogonality is non-overlapped with an adjacent channel of the same orthogonality. There is no teaching in Chang of "subchannels," as required by the mobile receiver paging system of claim 5. Accordingly, to receive any one channel in Chang, a mobile receiving unit would need to receive the entire frequency spectrum of all the channels. This is directly contrary to the requirements of claim 5. As noted at page 10 of Applicants' specification, the claimed method avoids the need for "complicated receiver schemes."

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Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

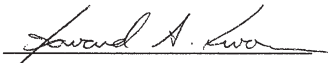
Accordingly, Applicants submit that the method of claim 5 would not have been obvious to one of ordinary skill in the art in view of the prior art of record. In addition, dependent claims 6 and 7 are allowable at least by virtue of their dependency on claim 5.

In view of the foregoing amendments and remarks, Applicants respectfully request the reconsideration and reexamination of this application and the timely allowance of the pending claims.

If any fees are due in connection with the filing of this Amendment, please charge those fees to Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By: 
Howard A. Kwon
Reg. No. 36,350

Dated: August 9, 1996

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- 7 -



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
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08/480,718 06/07/95 HAYS W 00620-0143

26M2/1029
J. LINNENBAM HENDERSON FARABOW GARRETT &
DUNNER
1300 I STREET NW
WASHINGTON DC 20005-3015

EXAMINER

ART UNIT PAPER NUMBER
2611 11

DATE MAILED: 10/29/96

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

OFFICE ACTION SUMMARY

- Responsive to communication(s) filed on 8/9/96
- This action is FINAL.
- Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 D.C. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 03 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

- Claim(s) 1-7 and 9 is/are pending in the application.
- Of the above, claim(s) _____ is/are withdrawn from consideration.
- Claim(s) 1-4 and 9 is/are allowed.
- Claim(s) _____ is/are rejected.
- Claim(s) 5-7 is/are objected to.
- Claims _____ are subject to restriction or election requirement.

Application Papers

- See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.
- The drawing(s) filed on _____ is/are objected to by the Examiner.
- The proposed drawing correction, filed on _____ is approved disapproved.
- The specification is objected to by the Examiner.
- The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
 - All Some* None of the CERTIFIED copies of the priority documents have been
 - received.
 - received in Application No. (Series Code/Serial Number) _____.
 - received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
 - *Certified copies not received: _____.
- Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

- Notice of Reference Cited, PTO-892
- Information Disclosure Statement(s), PTO-1449, Paper No(s) _____
- Interview Summary, PTO-413
- Notice of Draftsperson's Patent Drawing Review, PTO-948 substitute
- Notice of Informal Patent Application, PTO-152

-- SEE OFFICE ACTION ON THE FOLLOWING PAGES --

Serial Number: 08/480,718

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Art Unit: 2611

Part III DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103, the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 C.F.R. 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103.

2. Claims 5-7 are rejected under 35 U.S.C. 103 as being unpatentable over pages 2-3 of the prior art admitted by Applicant in view of Chang (U.S. Patent 3,488,445).

Serial Number: 08/480,718

-3-

Art Unit: 2611

As to claim 5, page 2, lines 16-29 and page 3, lines 6-14 of the admitted prior art teaches the preamble and the step of co-locating the plurality of transmitters as claimed. However, the admitted prior art fails to teach the step of transmitting the plurality of carriers over a plurality of subchannels spaced asymmetrically within the mask defining the channel. The technique of transmitting plurality of carriers in several subchannels which are spaced asymmetrically within a mask defining a band-limited channel is well known in the art, as disclosed by Chang. Chang teaches in col. 1, lines 60-69 and col. 2, lines 22-26 that each individual subchannel can be overlapped within a mask defining the band-limited channel, which reads on the asymmetrically spaced subchannels so that data rate can be enhanced (col. 1, lines 60-64). It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the paging system of the admitted prior art with the teaching of Chang in order to enhance transmission data rate, thereby conserving system's bandwidth (col. 1, lines 30-68).

As to claim 6, the admitted prior art as modified by Chang teaches what is claimed (admitted prior art, page 2, lines 27-29).

As to claim 7, the admitted prior art as modified by Chang teaches the steps of selecting: peak frequency deviations reads on a bandwidth extending from $0.5f_s$ to $2.5f_s$ (col. 8, lines 55-56 of Chang), bit rates (col. 2, lines 3-7 of Chang), and carrier

Serial Number: 08/480,718

-4-

Art Unit: 2611

frequencies reads on frequencies f1-f3 (col. 8, lines 51-61 of Chang).

Allowable Subject Matter

3. Claims 1-4 and 9 are allowable over the prior art of record.

As to claims 1, 3 and 9, a method of operating at least two paging carriers as claimed wherein the frequency difference between the center frequency of the outer most carriers and the band edge of the mask is greater than half the frequency difference between the center frequencies of each adjacent carrier, is not taught or suggested in the prior art of record.

Response to Amendment

4. Applicant's arguments filed 8/0/96 have been fully considered but they are not deemed to be persuasive.

In page 5, first paragraph of Applicant's remark, Applicant argues that the system of Chang fails to teach "a plurality of mobile receiving units independently receiving one of the plurality of carriers." as recited in Applicant's claim 5 and that Applicant's method does not involve the simultaneous receipt of multiplexed orthogonal carriers over a simple transmission line. In

Serial Number: 08/480,718

-5-

Art Unit: 2611

response, first, pages 2-3 of the admitted prior art has already taught the limitation of "a plurality of mobile receiving units independently receiving one of the plurality of carriers.". Second, the examiner only applies the well known technique of Chang in the limitation of "a plurality of carriers are transmitted over a plurality of individual subchannels spaced asymmetrically within a bandlimited channel", as shown by Chang in col. 1, lines 65-69, col. 2, lines 22-26, and col. 11, lines 55-60. In this same paragraph, Applicant further argues that "as described in Applicant's specification, the frequency spacings between adjacent carriers are smaller than frequency spacings between the band edges of the mask and the nearest respective carrier". In response to this argument, this limitation in the Applicant's specification is not recited in claim 5 as argued by Applicant. Besides, the examiner has indicated allowance ^{OF} this limitation in claims 1, 3 and 9.

In page 5, last paragraph, and the only paragraph of page 6, Applicant argues that Chang does not disclose a method of transmitting a plurality of carriers over a plurality of subchannels that are asymmetrically located within the mask defining the channel and that each channel of Chang of a particular orthogonality is non-overlapped with an adjacent channel of the same orthogonality, i.e., no odd channel is overlapped with another odd channel and no even channel is overlapped with another even

Serial Number: 08/480,718

-6-

Art Unit: 2611

channel. The limitation of "a plurality of mobile receiving units independently receiving one of said plurality of carriers" has been addressed by the examiner in the previous paragraph. Second, regarding the argument of transmitting a plurality of carriers over a plurality of subchannels that are asymmetrically located within the mask defining a channel, Chang shows in figs. 4-5 that a plurality of carriers f_1 - f_3 are transmitted over a plurality of subchannels (51-53) that are asymmetrically (overlapped) located within the mask defining the channel (f_c , col. 9, lines 1-2). As a result, there is a teaching of the admitted prior art as modified by Chang of subchannels as required by mobile unit. Regarding the argument over "a particular orthogonality is non-overlapped with an adjacent channel of the same orthogonality, i.e., no odd channel is overlapped with another odd channel and no even channel is overlapped with another even channel", the limitation of claim 5 does not recite any specific protocol of how the carriers are to be modified. Second, from fig. 4 of Chang this concept applies in the filters 44. In fact, the modulators 45 are the components which provides overlapping or asymmetry (see figs. 4-5D).

Regarding the argument in "to receive any one channel in Chang, a mobile receiving unit would need to receive the entire frequency spectrum of all the channels", the admitted prior art page 3, lines 1-3 has disclosed this teaching. In response to Applicant's piecemeal analysis of the references, one cannot show

Serial Number: 08/480,718

-7-

Art Unit: 2611

non-obviousness by attacking references individually where, as here, the rejections are based on combinations of references.

Therefore, from the responses stated above the examiner believes that the rejection of claim 5 is still proper.

5. THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 C.F.R. ° 1.136(a).

A SHORTENED STATUTORY PERIOD FOR RESPONSE TO THIS FINAL ACTION IS SET TO EXPIRE THREE MONTHS FROM THE DATE OF THIS ACTION. IN THE EVENT A FIRST RESPONSE IS FILED WITHIN TWO MONTHS OF THE MAILING DATE OF THIS FINAL ACTION AND THE ADVISORY ACTION IS NOT MAILED UNTIL AFTER THE END OF THE THREE-MONTH SHORTENED STATUTORY PERIOD, THEN THE SHORTENED STATUTORY PERIOD WILL EXPIRE ON THE DATE THE ADVISORY ACTION IS MAILED, AND ANY EXTENSION FEE PURSUANT TO 37 C.F.R. ° 1.136(a) WILL BE CALCULATED FROM THE MAILING DATE OF THE ADVISORY ACTION. IN NO EVENT WILL THE STATUTORY PERIOD FOR RESPONSE EXPIRE LATER THAN SIX MONTHS FROM THE DATE OF THIS FINAL ACTION.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lee Nguyen whose telephone number is (703) 308-5249. The examiner can normally be reached on Monday-Friday from 8:00 AM to 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Reinhard Eisenzopf, can be reached on (703) 305-4711. The fax phone number for this Group is (703) 305-9508.

Serial Number: 08/480,718

-8-

Art Unit: 2611

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 305-4700.

Lee Nguyen *lee*

October 15, 1996

Reinhard Eisenzopf
Reinhard J. Eisenzopf
Supervisory Patent Examiner
Group 260
10-26-96

The drawings submitted with this application were declared informal by the applicant. Accordingly they have not been reviewed by a draftsperson at this time. When formal drawings are submitted, the draftsperson will perform a review.

Direct any inquires concerning drawing review to the Drawing Review Branch (703) 305-8404.

Comes and Mail
BOX AF

#12/B
1/18/97
BOX AF

RESPONSE UNDER 37 C.F.R. § 1.116
EXPEDITED PROCEDURE
EXAMINING GROUP 2611



Attorney Docket No. 0680143

RECEIVED
JAN 21 97
GROUP 2600

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

1-28-97
M

In re Application of:)
William D. HAYS et al.)
Serial No.: 08/480,718) Group Art Unit: 2611
Filed: June 7, 1995) Examiner: L. Nguyen
For: MULTICARRIER TECHNIQUES)
IN BANDLIMITED CHANNELS)

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

AMENDMENT AFTER FINAL

Please, enter
this amendment

CEW
2/1/97

In response to the Final Office Action dated October
29, 1996, and pursuant to 37 C.F.R. § 1.116, Applicants
propose that this application be amended as follows:

IN THE CLAIMS:

Please cancel claims 5, 6, and 7 without prejudice.

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT
& DUNNER, L.L.P.
1300 I STREET, N.W.
WASHINGTON, DC 20005
202-408-4000

Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

REMARKS

The Examiner has rejected claims 5-7 under 35 U.S.C. § 103 as obvious over the prior art admitted by Applicants in view of Chang. The Examiner has allowed claims 1-4 and 9.

To advance prosecution of this application, Applicants cancel rejected claims 5-7, thereby placing the application in condition for allowance upon entry of this amendment. Allowance of this application is requested.

If any fees are due in connection with the filing of this Amendment, please charge those fees to Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By: 

Howard A. Kwon
Reg. No. 36,350

Dated: January 21, 1997

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT
& DUNNER, L.L.P.
1300 I STREET, N.W.
WASHINGTON, DC 20005
202-408-4000



UNITED STATES DEPARTMENT OF COMMERCE
 Patent and Trademark Office
 Address: COMMISSIONER OF PATENTS AND TRADEMARKS
 Washington, D.C. 20231

08/489,716	SERIAL NUMBER	01/17/97	FILING DATE	HAYS	FIRST NAMED APPLICANT	W	036	ATTORNEY DOCKET NO.
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26M2/0204
 FINNEGAN HENDERSON FARABOW GARRETT &
 DUNNER
 1300 I STREET NW
 WASHINGTON DC 20005-3315

EXAMINER
 HUYEN, L

261 PART UNIT PAPER NUMBER

02/04/97 13

DATE MAILED:

NOTICE OF ALLOWABILITY

PART I.

- This communication is responsive to Amendment filed 1/17/97
- All the claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice Of Allowance And Issue Fee Due or other appropriate communication will be sent in due course.
- The allowed claims are 1-4 and 9
- The drawings filed on _____ are acceptable.
- Acknowledgment is made of the claim for priority under 35 U.S.C. 119. The certified copy has been received. not been received. been filed in parent application Serial No. _____, filed on _____.
- Note the attached Examiner's Amendment.
- Note the attached Examiner Interview Summary Record, PTOL-413.
- Note the attached Examiner's Statement of Reasons for Allowance.
- Note the attached NOTICE OF REFERENCES CITED, PTO-892.
- Note the attached INFORMATION DISCLOSURE CITATION, PTO-1449.

PART II.

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" indicated on this form. Failure to timely comply will result in the ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

- Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.
- APPLICANT MUST MAKE THE DRAWING CHANGES INDICATED BELOW IN THE MANNER SET FORTH ON THE REVERSE SIDE OF THIS PAPER.
 - Drawing informalities are indicated on the NOTICE RE PATENT DRAWINGS, PTO-948, attached hereto or to Paper No. 5. CORRECTION IS REQUIRED.
 - The proposed drawing correction filed on _____ has been approved by the examiner. CORRECTION IS REQUIRED.
 - Approved drawing corrections are described by the examiner in the attached EXAMINER'S AMENDMENT. CORRECTION IS REQUIRED.
 - Formal drawings are now REQUIRED.

Any response to this letter should include in the upper right hand corner, the following information from the NOTICE OF ALLOWANCE AND ISSUE FEE DUE: ISSUE BATCH NUMBER, DATE OF THE NOTICE OF ALLOWANCE, AND SERIAL NUMBER.

Attachments:

- Examiner's Amendment
- Examiner Interview Summary Record, PTOL- 413
- Reasons for Allowance
- Notice of References Cited, PTO-892
- Information Disclosure Citation, PTO-1449
- Notice of Informal Application, PTO-152
- Notice re Patent Drawings, PTO-948
- Listing of Bonded Draftsmen
- Other

LEE NGUYEN
 (703) 308-5249

Reinhard J. Eisenzopf
 Reinhard J. Eisenzopf 2-3-97
 Supervisory Patent Examiner
 Group 260



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: Box ISSUE FEE
ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

26M2/0204

FINNEGAN HENDERSON FARABOW GARRETT &
DUNNER
1300 I STREET NW
WASHINGTON DC 20005-3315

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP/ART. UNIT	DATE MAILED
08/480,718	06/07/95	005	NGUYEN, L	2611 02/04/97
First Named Applicant	HAYS,		WILLIAM D.	

TITLE OF INVENTION MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2	03680.0143	155-103.000	112	UTILITY	NO \$1290.00	05/05/97

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.
If the SMALL ENTITY is shown as yes, verify your current SMALL ENTITY status:

- A. If the status is changed, pay twice the amount of the FEE DUE shown and notify the Patent and Trademark Office of the change in status, or
- B. If the status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:

- A. Pay FEE DUE shown above, or
- B. File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.

II. Part B of this notice should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B should be completed and returned. If you are charging the ISSUE FEE to your deposit account, section "6b" of Part B should be completed.

III. All communications regarding this application must give application number and batch number.
Please direct all communication prior to issuance to Box ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.



OHM

[Handwritten signature]

PATENT
Attorney Docket No.: 03680.0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)	
William D. HAYS et al.	)	Group Art Unit: 2611
Serial No.: 08/480,718	)	Examiner: L. Nguyen
Filed: June 7, 1995	)	NOTICE OF ALLOWANCE DATED:
	)	February 4, 1997
For: MULTICARRIER TECHNIQUES	)	Batch No.: J12
IN BANDLIMITED CHANNELS)	

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

SUBMISSION OF FORMAL DRAWINGS

Subject to the approval of the Examiner, please replace the informal drawings with the formal drawings filed herewith. If the formal drawings for any reason are not in full compliance with the pertinent statutes and regulations, please so advise the undersigned.

If any fees are due in connection with the submission of these formal drawings, please charge those fees to Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT
& DUNNER, L.L.P.
1300 I STREET, N.W.
WASHINGTON, D. C. 20005
202-408-4000

By: *[Signature]*
Howard A. Kwon
Reg. No. 36,350

Dated: March 3, 1997

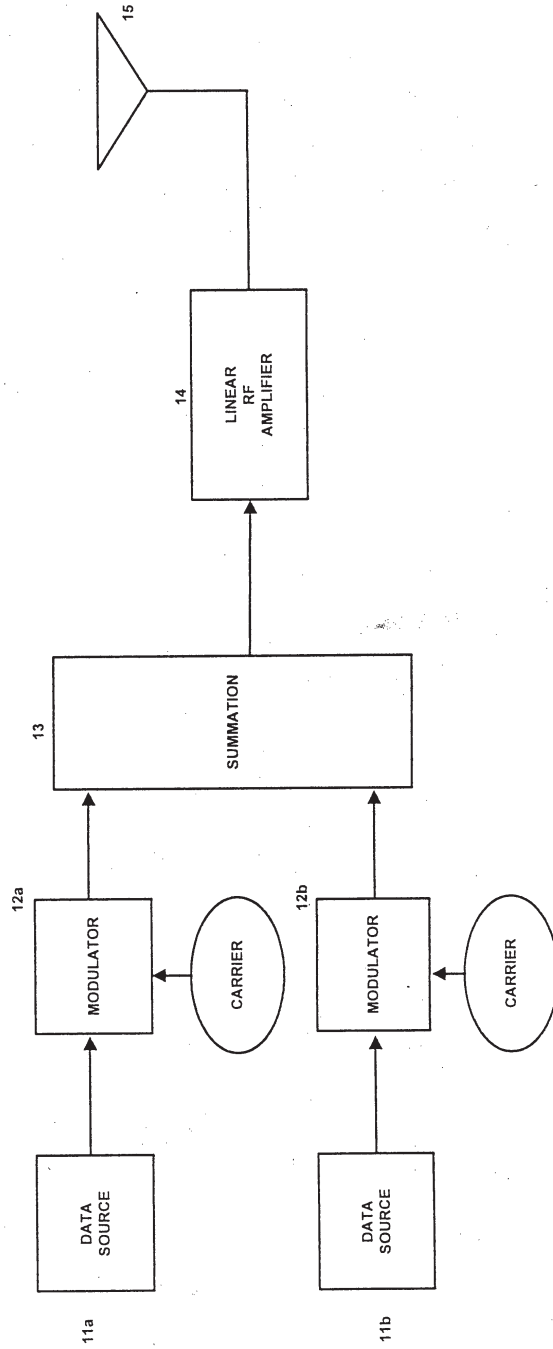


FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, I.L.P.
1300 I STREET, N.W.
WASHINGTON, D.C. 20005-3315
(202) 408-4000

SHEET 1 OF 11 DOCKET NO. 03680.0143
SERIAL NO: 08/480,718 BATCH NO.: 112

APPROVED	0.9 FIG. 1
BY	CLASS. SUPERVISOR
DRAFTSMAN	483 10 3

10



5659891

FIGURE 1

480 7/2

APPROVED	019 FIG.
BY	CLASS SUBCLASS
DATE	

20

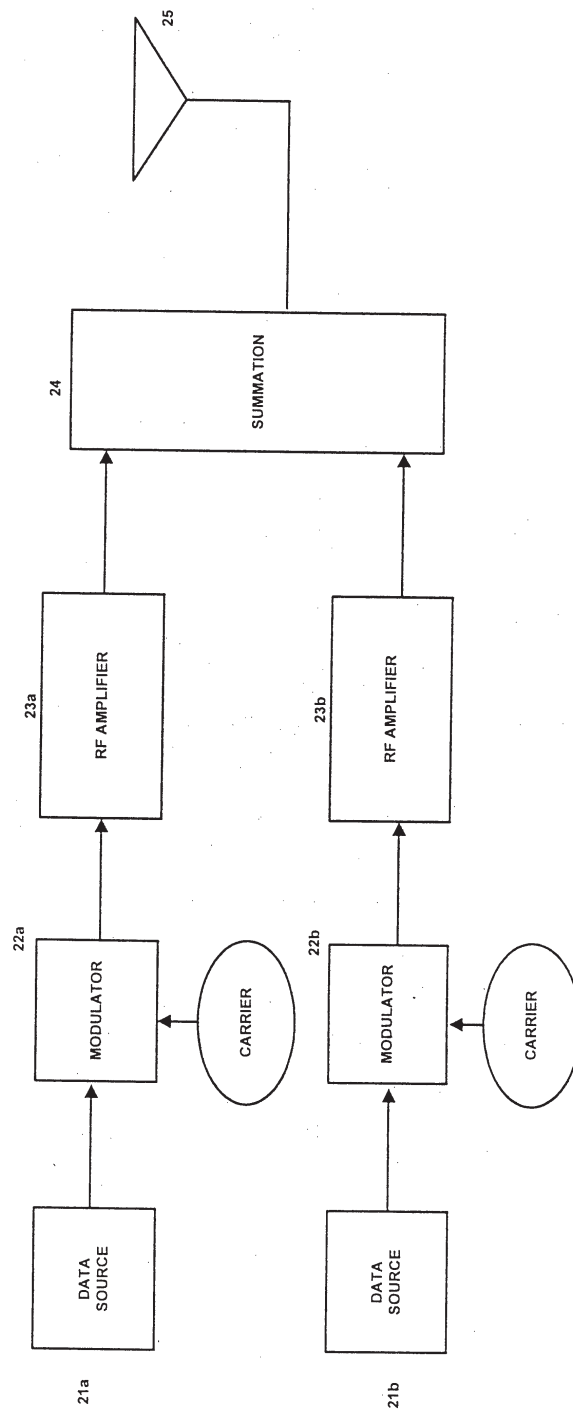


FIGURE 2

APPROVED O.C. FIG.
BY CLASS (SUB) LABS
DATE/TIME

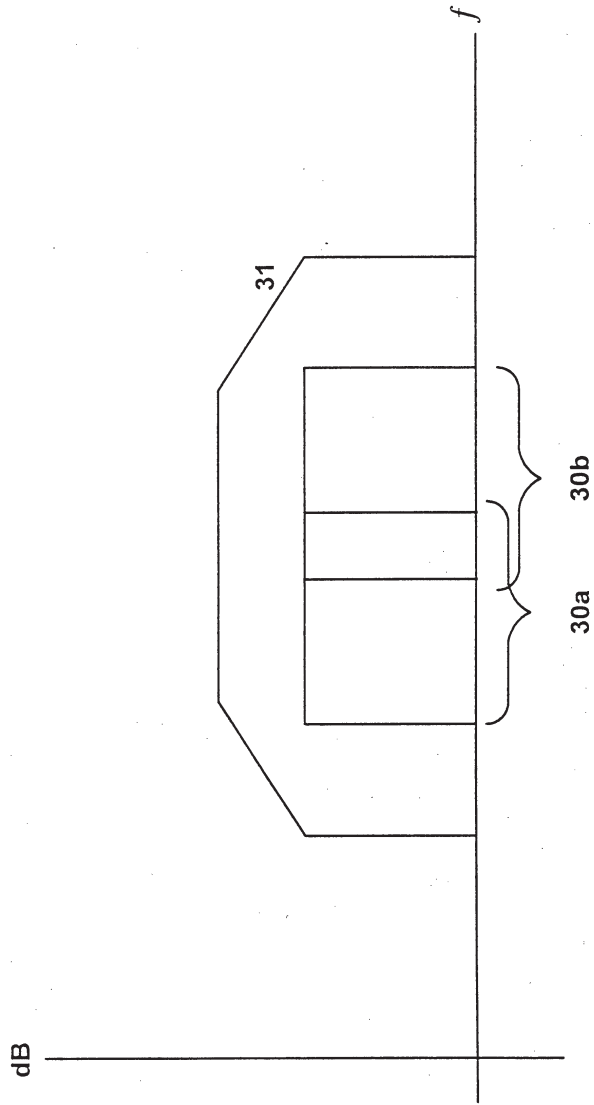


FIGURE 3A

APPROVED O.C. FIG.
BY CLASS (SUBCLERK)
DATE

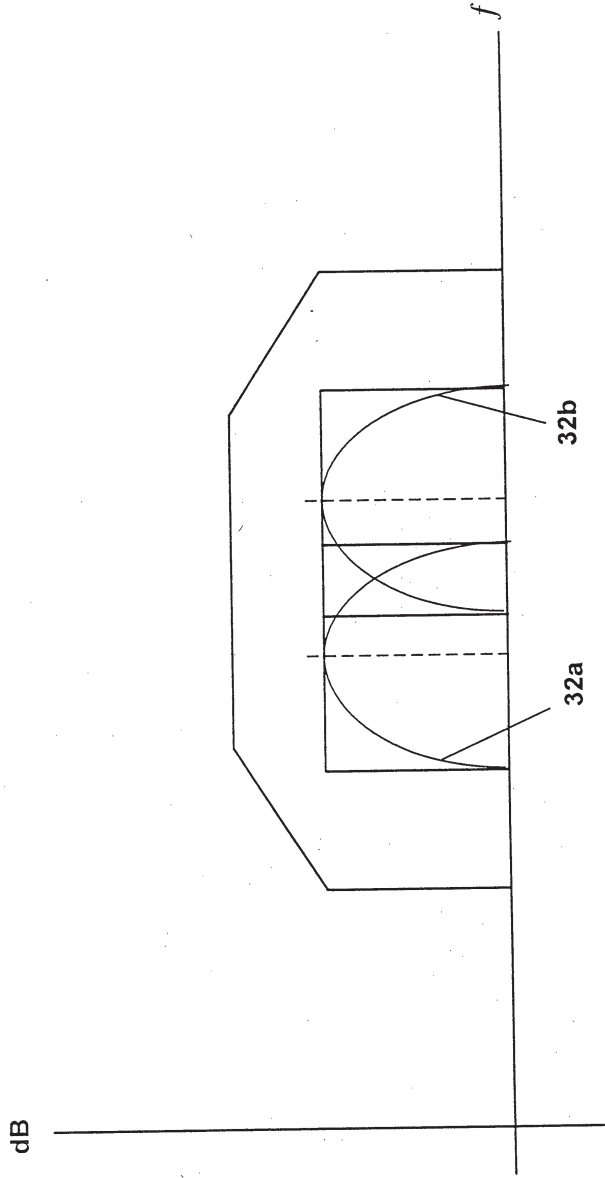


FIGURE 3B

APPROVED	O.G. FIG.
BY	CLASS SUBOLAS
DRAFTSMAN	

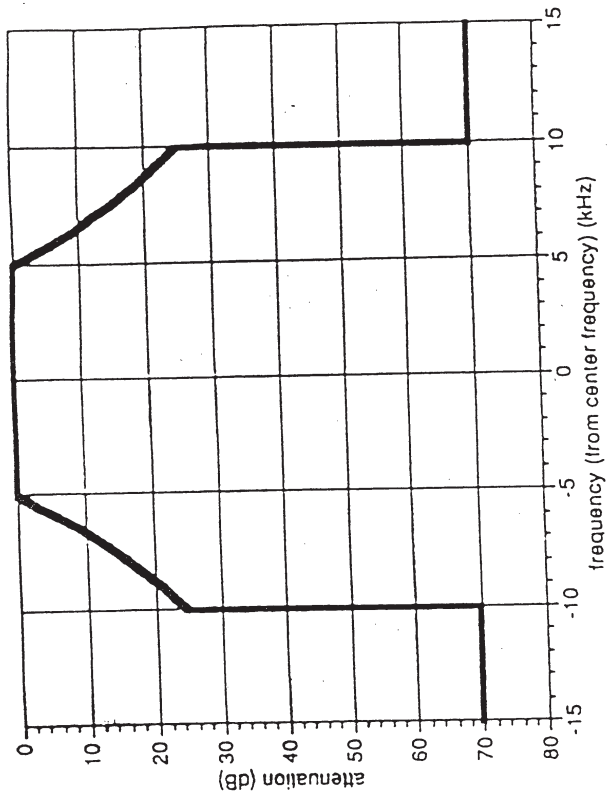
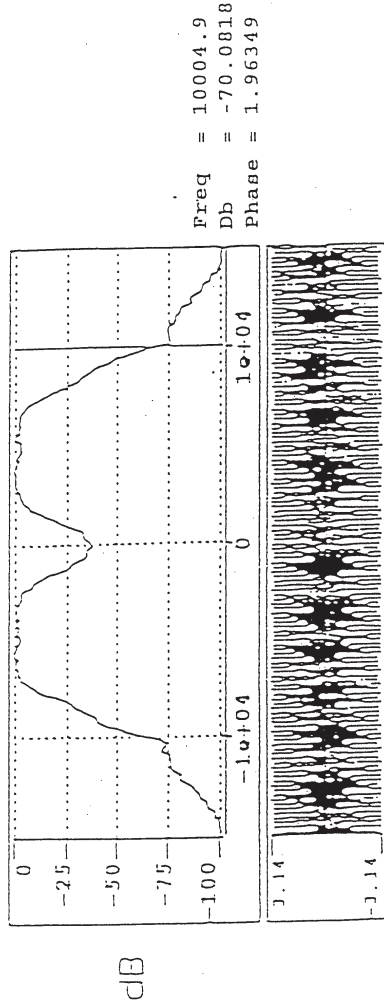


FIGURE 4

FIGURE 5A

2400 max deviation, 6k bps bit rate, 4590 Hz carrier



APPROVED	O.G. FNS.
BY	CLASS/SUBCLASS
DRAFTSMAN	

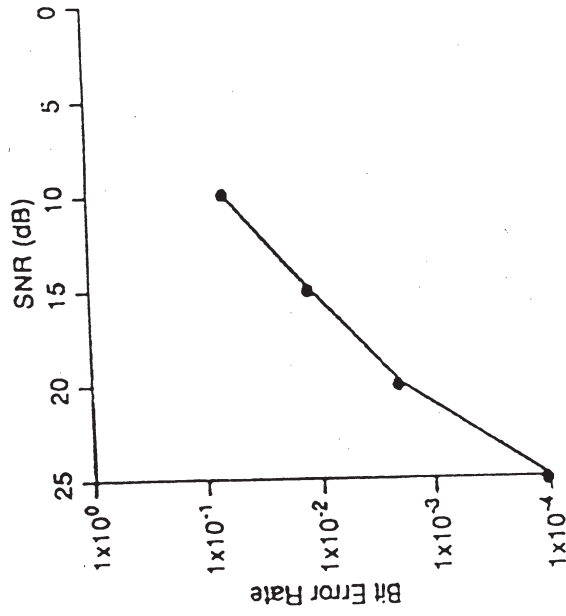
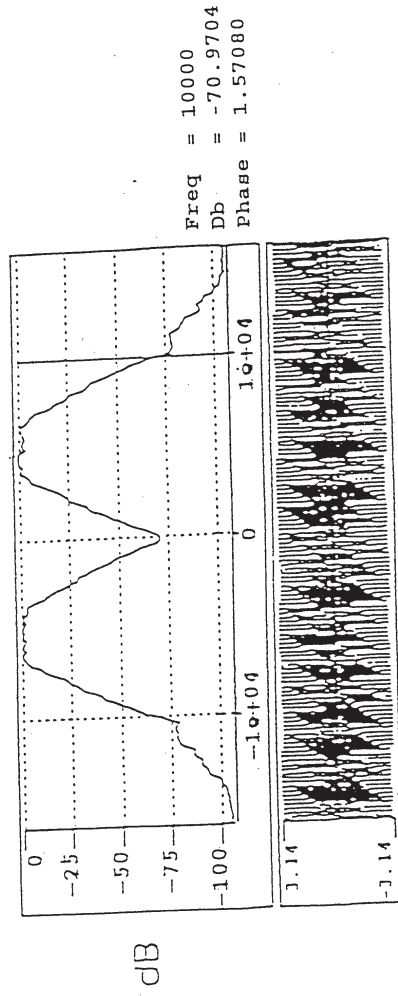


FIGURE 5B

FIGURE 6A

1800 max deviation, 6.4k bps bit rate, 5150 Hz carrier



APPROVED	O.S. PIZ.
BY	CLASS SUBCLASS
DATE/TIME	

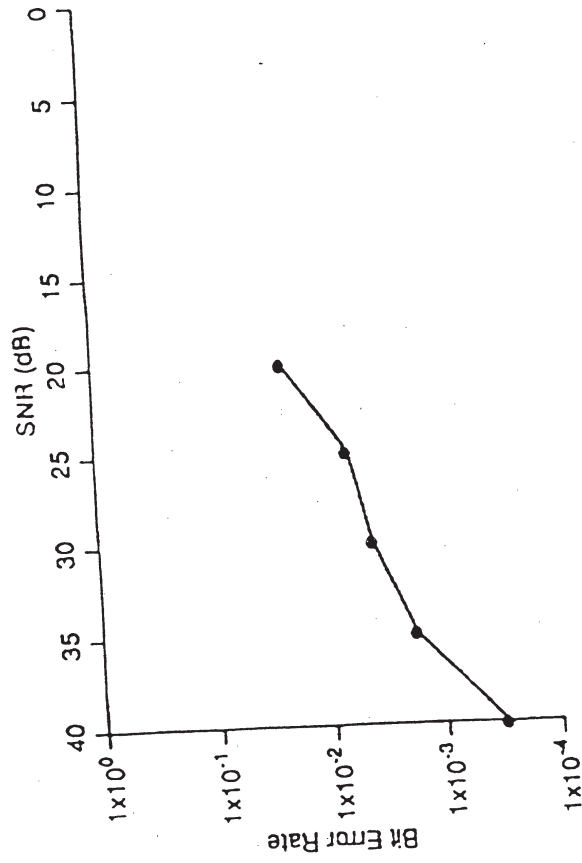
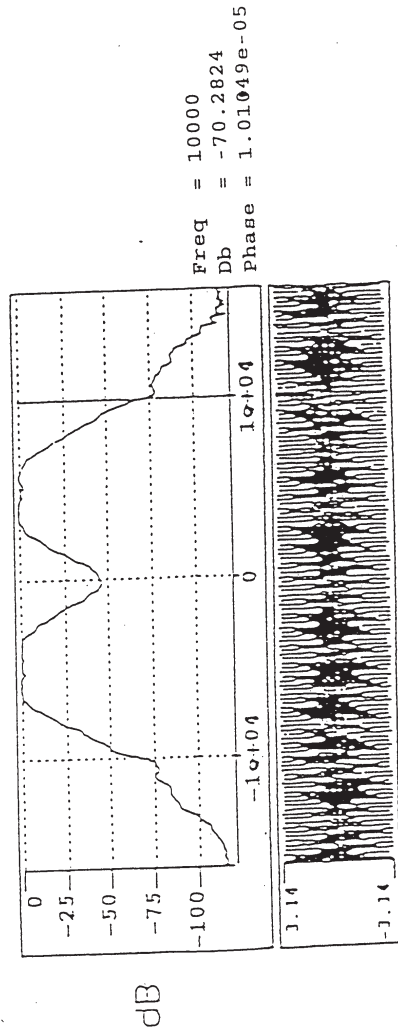


FIGURE 6B

FIGURE 7A

2100 max deviation, 6.4k bps bit rate, 4750 Hz carrier



APPROVED	O.C. FIG.
BY	PLANS SUBCLASS
DRAFTSMAN	

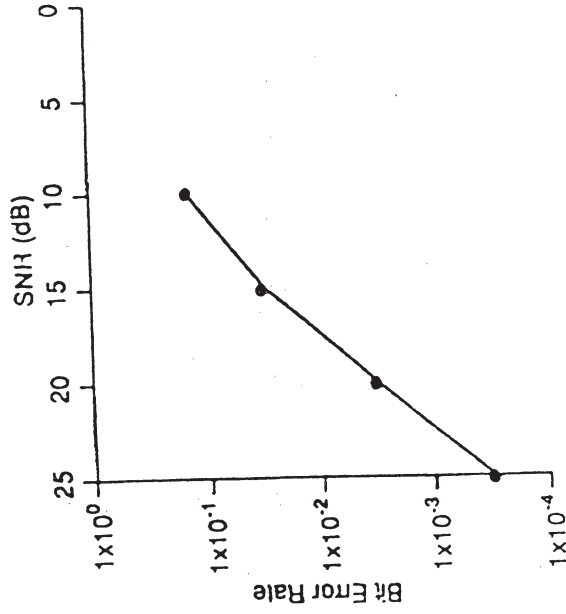


FIGURE 7B



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/480,718	06/07/95	HAYS	W 03680.0143

4102/0325
FINNEGAN HENDERSON FARABOW GARRETT &
DUNNER
1300 I STREET NW
WASHINGTON DC 20005-3315

EXAMINER	
NGUYEN, L.	
ART UNIT	PAPER NUMBER
2611	15

DATE MAILED: 03/25/97

NOTICE OF DRAWING REQUIREMENTS

Corrected/substituted drawings for the above-identified application, received in the PTO on 3/3/97, are still considered informal for the reason(s) identified on the attached Form PTO-948.

Applicant has the time remaining in the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed 2/4/97 to overcome the objections raised in the attached Form PTO-948. This response period may be extended under the provisions of 37 CFR 1.136 (a) by filing the appropriate request and fee before the end of the six month statutory period for response.

The PTO delayed in reviewing the corrected drawings. Applicant is given ONE month time limit from the date of this letter to provide corrected drawings. NO EXTENSION OF THIS TIME LIMIT MAY BE GRANTED UNDER EITHER 37 CFR 1.136(a) or (b). See MPEP 714.03. However, the response period set in the Notice of Allowability or Notice of Drawing Requirements mailed _____ may be extended under the provisions of 37 CFR 1.136(a) by filing the appropriate request and fee before the end of the six month statutory period for response.

The PTO delayed in reviewing the corrected drawings. Applicant is given ONE month time limit from the date of this letter to provide corrected drawings. NO EXTENSION OF THIS TIME LIMIT MAY BE GRANTED UNDER EITHER 37 CFR 1.136(a) or (b). See MPEP 714.03

ATTACHMENT: PTO-948

Clifton B. Randolph 3/10/97
PATENT AND TRADEMARK OFFICE DATE

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

PTO Draftpersons review all originally filed drawings regardless of whether they are designated as formal or informal. Additionally, patent Examiners will review the drawings for compliance with the regulations. Direct telephone inquiries concerning this review to the Drawing Review Branch, 703-305-8404.

The drawings filed (insert date) 3/3/97, are

A. not objected to by the Draftsperson under 37 CFR 1.84 or 1.152.

B. objected to by the Draftsperson under 37 CFR 1.84 or 1.152 as indicated below. The Examiner will require submission of new, corrected drawings when necessary. Corrected drawings must be submitted according to the instructions on the back of this Notice.

- DRAWINGS.** 37 CFR 1.84(a): Acceptable categories of drawings:
 - Black ink. Color.
 - Not black solid lines. Fig(s) _____
 - Color drawings are not acceptable until petition is granted. Fig(s) _____
- PHOTOGRAPHS.** 37 CFR 1.84(b)
 - Photographs are not acceptable until petition is granted. Fig(s) _____
 - Photographs not properly mounted (must use bristol board or photographic double-weight paper). Fig(s) _____
 - Poor quality (half-tone). Fig(s) _____
- GRAPHIC FORMS.** 37 CFR 1.84 (d)
 - Chemical or mathematical formula not labeled as separate figure. Fig(s) _____
 - Group of waveforms not presented as a single figure, using common vertical axis with time extending along horizontal axis. Fig(s) _____
 - Individuals waveform not identified with a separate letter designation adjacent to the vertical axis. Fig(s) _____
- TYPE OF PAPER.** 37 CFR 1.84(c)
 - Paper not flexible, strong, white, smooth, nonshiny, and durable. Sheet(s) _____
 - Erasures, alterations, overwritings, interlineations, cracks, creases, and folds copy machine marks not accepted. Fig(s) _____
 - Mylar, velum paper is not acceptable (too thin). Fig(s) _____
- SIZE OF PAPER.** 37 CFR 1.84(f): Acceptable sizes:

21.6 cm. X 35.6 cm. (8 1/2 by 14 inches)	21.6 cm. X 33.1 cm. (8 1/2 by 13 inches)	21.6 cm. X 27.9 cm. (8 1/2 by 11 inches)	21.0 cm. X 29.7 cm. (DIN size A4)
T 5.1 cm. (2")	2.5 cm. (1")	2.5 cm. (1")	2.5 cm.
L .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	2.5 cm.
R .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	1.5 cm.
B .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	1.0 cm.

 - All drawing sheets not the same size. Sheet(s) _____
 - Drawing sheet not an acceptable size. Sheet(s) _____
- MARGINS.** 37 CFR 1.84(g): Acceptable margins:

Paper size			
21.6 cm. X 35.6 cm. (8 1/2 X 14 inches)	21.6 cm. X 33.1 cm. (8 1/2 X 13 inches)	21.6 cm. X 27.9 cm. (8 1/2 X 11 inches)	21.0 cm. X 29.7 cm. (DIN Size A4)
T 5.1 cm. (2")	2.5 cm. (1")	2.5 cm. (1")	2.5 cm.
L .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	2.5 cm.
R .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	1.5 cm.
B .64 cm. (1/4")	.64 cm. (1/4")	.64 cm. (1/4")	1.0 cm.

 - Margins do not conform to chart above. Figs 5A, 6A, 7A
 - Sheet(s) _____
 - Top (T) Left (L) Right (R) Bottom (B)
- VIEWS.** 37 CFR 1.84(h)
 - REMINDER:** Specification may require revision to correspond to drawing changes.
 - All views not grouped together. Fig(s) _____
 - Views connected by projection lines or lead lines. Fig(s) _____
 - Partial views. 37 CFR 1.84(h) 2
 - View and enlarged view not labeled separately or properly. Fig(s) _____
 - Sectional views. 37 CFR 1.84 (h) 3
 - Hatching not indicated for sectional portions of an object. Fig(s) _____
 - Cross section not drawn same as view with parts in cross section with regularly spaced parallel oblique strokes. Fig(s) _____
- ARRANGEMENT OF VIEWS.** 37 CFR 1.84(i)
 - Words do not appear on a horizontal, left-to-right fashion when page is either upright or turned so that the top becomes the right side, except for graphs. Fig(s) _____
- SCALE.** 37 CFR 1.84(k)
 - Scale not large enough to show mechanism with crowding when drawing is reduced in size to two-thirds in reproduction. Fig(s) _____
 - Indication such as "actual size" or scale 1/2" not permitted. Fig(s) _____
- CHARACTER OF LINES, NUMBERS, & LETTERS.** 37 CFR 1.84(l)
 - Lines, numbers & letters not uniformly thick and well defined, clean, durable, and black (except for color drawings). Fig(s) _____
- SHADING.** 37 CFR 1.84(m)
 - Solid black shading areas not permitted. Fig(s) _____
 - Shade lines, pale, rough and blurred. Fig(s) _____
- NUMBERS, LETTERS, & REFERENCE CHARACTERS.** 37 CFR 1.84(p)
 - Numbers and reference characters not plain and legible. 37 CFR 1.84(p)(l) Fig(s) _____
 - Numbers and reference characters not oriented in same direction as the view. 37 CFR 1.84(p)(l) Fig(s) _____
 - English alphabet not used. 37 CFR 1.84(p)(2) Fig(s) _____
 - Numbers, letters, and reference characters do not measure at least .32 cm. (1/8 inch) in height. 37 CFR(p)(3) Fig(s) _____
- LEAD LINES.** 37 CFR 1.84(q)
 - Lead lines cross each other. Fig(s) _____
 - Lead lines missing. Fig(s) _____
- NUMBERING OF SHEETS OF DRAWINGS.** 37 CFR 1.84(t)
 - Sheets not numbered consecutively, and in Arabic numerals, beginning with number 1. Sheet(s) _____
- NUMBER OF VIEWS.** 37 CFR 1.84(u)
 - Views not numbered consecutively, and in Arabic numerals, beginning with number 1. Fig(s) _____
 - View numbers not preceded by the abbreviation Fig. Fig(s) _____
- CORRECTIONS.** 37 CFR 1.84(w)
 - Corrections not made from prior PTO-948. Fig(s) _____
- DESIGN DRAWING.** 37 CFR 1.152
 - Surface shading shown not appropriate. Fig(s) _____
 - Solid black shading not used for color contrast. Fig(s) _____

COMMENTS:

ATTACHMENT TO PAPER NO. 15 REVIEWER CBK DATE 3/10/97
PTO Copy

DAM

#104M

PATENT

Attorney Docket No.: 03680.0143

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



In re Application of:)	
William D. HAYS et al.	)	Group Art Unit: 2611
Serial No.: 08/480,718	)	Examiner: L. Nguyen
Filed: June 7, 1995	)	NOTICE OF ALLOWANCE DATED:
	)	February 4, 1997
For: MULTICARRIER TECHNIQUES	)	Batch No.: J12
IN BANDLIMITED CHANNELS)	

BOX ISSUE FEE
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

SUBMISSION OF FORMAL DRAWINGS

In response to a Notice of Drawing Requirements dated March 25, 1997, Applicants submit corrected formal drawings responsive to the objections of the Draftsperson. Subject to the approval of the Examiner, please replace the previously submitted formal drawings (Figs. 5A, 6A, and 7A) with the corrected formal drawings filed herewith. If the corrected formal drawings for any reason are not in full compliance with the pertinent statutes and regulations, please so advise the undersigned.

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT
& DUNNER, L.L.P.
1300 I STREET, N.W.
WASHINGTON, DC 20005
202-408-4000

Attorney Docket No.: 03680.0143
Serial No.: 08/480,718

If any fees are due in connection with the submission
of these formal drawings, please charge those fees to
Deposit Account No. 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By: 

Howard A. Kwon
Reg. No. 36,350

Dated: April 3, 1997

Enclosures: Figures - 5A, 6A, 7A

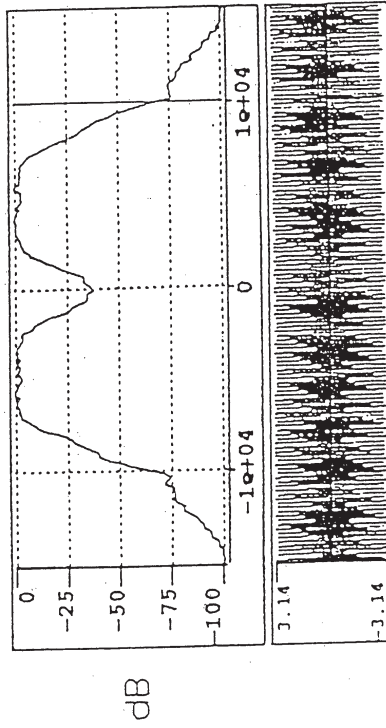
LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT
& DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

- 2 -

APPROVED	O.C. FIG.
BY	CLASS
DRAFTSMAN	SUBCLAS

FIGURE 5A

2400 max deviation, 6k bps bit rate, 4590 Hz carrier

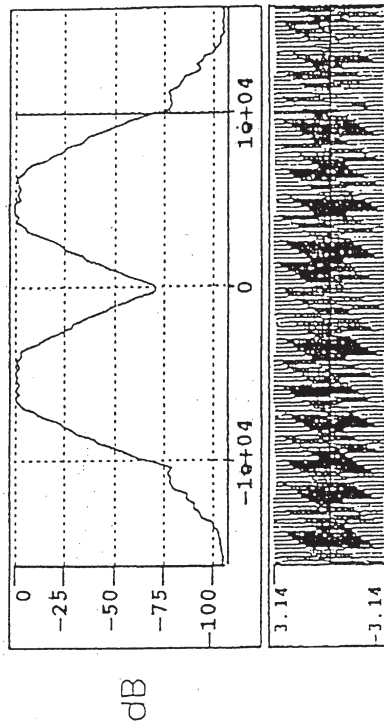


Freq. = 10004.9
 Db = -70.0818
 Phase = 1.96349

APPROVED	O.G. FNS.
BY	CLASS. SUBP.LESS
DATE	

FIGURE 6A

1800 max deviation, 6.4k bps bit rate, 5150 Hz carrier

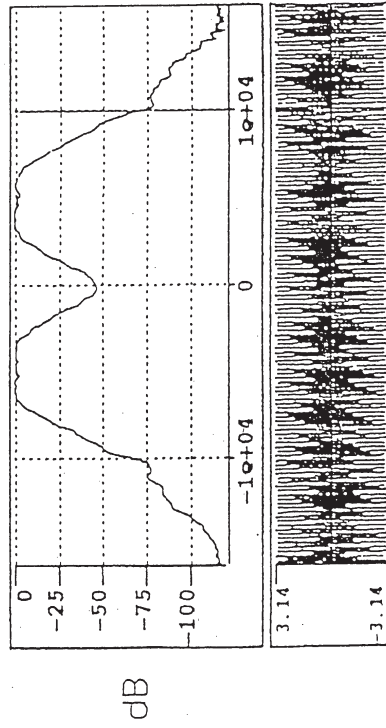


Freq. = 10000
Db = -70.9704
Phase = 1.57080

APPROVED	O.G. PIC.
BY	CLASS
DATE	REVISION

FIGURE 7A

2100 max deviation, 6.4k bps bit rate, 4750 Hz carrier



Freq. = 10000
 Db = -70.2824
 Phase = 1.01049e-05

PART B—ISSUE FEE TRANSMITTAL

142-1290

MAILING INSTRUCTIONS: This form should be used when transmitting the ISSUE FEE. Blocks 2 through 6 should be completed where appropriate. All further correspondence including the issue Fee Receipt, the Patent, advance fee receipts, and notification of maintenance fees will be mailed to addresses entered in Block 1 unless you direct otherwise, by: (a) specifying a new correspondence address in Block 3 below; or (b) providing the PTO with a separate "FEE ADDRESS" for maintenance fee notifications with the payment of issue Fee or thereafter. See reverse for Certificate of Mailing, below.

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1. CORRESPONDENCE ADDRESS
 25M2/0204
 FINNEGAN HENDERSON FARABOW GARRETT & DUNNER
 1300 I STREET NW
 WASHINGTON DC 20005-3315

2. INVENTOR(S) ADDRESS CHANGE (Complete only if there is a change)

INVENTOR'S NAME _____
 Street Address _____
 City, State and Zip Code _____

CO-INVENTOR'S NAME _____
 Street Address _____
 City, State and Zip Code _____

Check if additional changes are enclosed

RECEIVED
 Patent Division
 May 01 1997
 05

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP/ART UNIT	DATE MAILED
08/480,718	06/07/95	005	NGUYEN, L	2611 02/04/97
First Named Applicant	HAYS, WILLIAM D.			

TITLE OF INVENTION: MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2	03680.0143	455-103.000	J12 UTILITY	NO	\$1290.00	05/05/97

3. Correspondence address change (Complete only if there is a change)

4. For printing on the patent front page, list the names of not more than 3 registered patent attorneys or agents OR, alternatively, the name of a firm having as a member a registered attorney or agent. If no name is listed, no name will be printed.

1 FINNEGAN, HENDERSON,
 2 FARABOW, GARRETT
 3 AND DUNNER

5. ASSIGNMENT DATA TO BE PRINTED ON THE PATENT (print or type)

(1) NAME OF ASSIGNEE: MOBILE TELECOMMUNICATION TECHNOLOGIES
 (2) ADDRESS: (CITY & STATE OR COUNTRY) P.O. Box 2469 - Jackson, MS 39225-2469

6a. The following fees are enclosed:
 Issue Fee Advance Order - # of Copies _____
 6b. The following fees should be charged to:
 DEPOSIT ACCOUNT NUMBER _____
 (ENCLOSE A COPY OF THIS FORM)
 Issue Fee Advance Order - # of Copies _____
 Any Deficiencies in Enclosed Fees _____

A This application is NOT assigned.
 Assignment previously submitted to the Patent and Trademark Office.
 Assignment is being submitted under separate cover. Assignment should be directed to Box ASSIGNMENTS.
PLEASE NOTE: Unless an assignee is identified in Block 5, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

The COMMISSIONER OF PATENTS AND TRADEMARKS is requested to apply the Issue Fee to the application identified above.
 (Authorized Signature) Howard A. Kwon (Date) 5/1/97
 Howard A. Kwon, Reg. No. 36,350

NOTE: The Issue Fee will not be accepted from anyone other than the applicant, a registered attorney or agent, or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

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Note: If this certificate of mailing is used, it can be used to transmit the Issue Fee. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing.

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: **Box ISSUE FEE**
 Assistant Commissioner for Patents
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810 BL 05/14/97 08480718
 1 142 1,290.00 CK

on: _____ (Date)
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Transaction History Date 1997-08-19
Date information retrieved from USPTO Patent
Application Information Retrieval (PAIR)
system records at www.uspto.gov

The
United
States
of
America



PTO UTILITY GRANT
Paper Number 17

The Commissioner of Patents and Trademarks

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America for the term set forth below, subject to the payment of maintenance fees as provided by law.

If this application was filed prior to June 8, 1995, the term of this patent is the longer of seventeen years from the date of grant of this patent or twenty years from the earliest effective U.S. filing date of the application, subject to any statutory extension.

If this application was filed on or after June 8, 1995, the term of this patent is twenty years from the U.S. filing date, subject to a statutory extension. If the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121 or 365(c), the term of the patent is twenty years from the date on which the earliest application was filed, subject to any statutory extension.

Bruce Ledman
Commissioner of Patents and Trademarks

Pandra Morton
Attest

Form PTO-1584 (Rev. 2/97)

(RIGHT INSIDE)

FPI-LOW

Table of Contents

1. US5659891A Multicarrier techniques in bandlimited channels
-

Family 1/1

1 record(s) per family

Record 1/1 US5659891A Multicarrier techniques in bandlimited channels

Publication Number: US5659891A 19970819

Title: Multicarrier techniques in bandlimited channels

Title - DWPI: Paging carrier operating method for mobile paging service has frequency difference between centre frequency of outermost of carriers and band edge of mask defining channel which is more than half frequency difference between centre frequencies of each adjacent carrier

Priority Number: US1995480718A

Priority Date: 1995-06-07

Application Number: US1995480718A

Application Date: 1995-06-07

Publication Date: 1997-08-19

IPC Class Table:

IPC	Section	Class	Subclass	Class Group	Subgroup
H04L002726	H	H04	H04L	H04L0027	H04L002726

IPC Class Table - DWPI:

IPC - DWPI	Section - DWPI	Class - DWPI	Subclass - DWPI	Class Group - DWPI	Subgroup - DWPI
H04B000102	H	H04	H04B	H04B0001	H04B000102

Assignee/Applicant: Mobile Telecommunication Technologies,Jackson,MS,US

JP F Terms:

JP FI Codes:

Assignee - Original: Mobile Telecommunication Technologies

Any CPC Table:

Type	Invention	Additional	Version	Office
Current	H04L 27/2601	-	20130101	EP

ECLA: H04L002726M

Abstract:

A method of multicarrier modulation using co-located transmitters to achieve higher transmission capacity for mobile paging and two-way digital communication in a manner consistent with FCC emission mask limits. Co-location of the transmitters obviates the need for stringent, symmetrical subchannel interference protection and provides for a wider range of operating parameters, including peak frequency deviation, bit rate, and carrier frequencies, to obtain optimal transmission performance.

Language of Publication: EN

INPADOC Legal Status Table:

Gazette Date	Code	INPADOC Legal Status Impact
2009-07-30	SULP	+
Description: SURCHARGE FOR LATE PAYMENT		
2009-07-30	FPAY	+
Description: FEE PAYMENT		
2009-02-23	REMI	-
Description: MAINTENANCE FEE REMINDER MAILED		
2007-03-14	AS	-
Description: ASSIGNMENT NEWCASTLE PARTNERS, L.P., TEXAS SECURITY AGREEMENT; ASSIGNORS:BELL INDUSTRIES, INC.; BELL INDUSTRIES, INC.; REEL/FRAME:019009/0529 2007-03-12		
2007-01-31	AS	-
Description: ASSIGNMENT WELLS FARGO FOOTHILL, INC., AS AGENT, CALIFORNIA PATENT SECURITY AGREEMENT; ASSIGNORS:BELL INDUSTRIES, INC., A CALIFORNIA CORPORATION; BELL INDUSTRIES, INC., A MINNESOTA CORPORATION; REEL/FRAME:018826/0503 2007-01-31		
2007-01-24	AS	-
Description: ASSIGNMENT SKYTEL CORP., VIRGINIA MERGER; ASSIGNOR:SKYTEL COMMUNICATIONS, INC.; REEL/FRAME:018797/0318 2004-12-31		
2005-02-22	FPAY	+
Description: FEE PAYMENT		

2004-08-23	AS	-
Description: ASSIGNMENT SKYTEL COMMUNICATIONS, INC., VIRGINIA CHANGE OF NAME; ASSIGNOR:MOBILE TELECOMMUNICATIONS TECHNOLOGIES CORP.; REEL/FRAME:015074/0648 1998-05-21		
2001-03-13	REMI	-
Description: MAINTENANCE FEE REMINDER MAILED		
2001-02-16	FPAY	+
Description: FEE PAYMENT		
1995-09-21	AS	-
Description: ASSIGNMENT MOBILE TELECOMMUNICATIONS TECHNOLOGIES, MISSISSIPP ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNORS:HAYS, WILLIAM D.; CAMERON, DENNIS; ROEHR, WALTER; REEL/FRAME:007721/0991; SIGNING DATES FROM 19950911 TO 19950920		

Post-Issuance (US):

Reassignment (US) Table:

Assignee	Assignor	Date Signed	Reel/Frame	Date
NEWCASTLE PARTNERS L.P.,DALLAS,TX,US	BELL INDUSTRIES, INC.	2007-03-12	019009/0529	2007-03-14
	BELL INDUSTRIES, INC.	2007-03-12		
Conveyance: SECURITY AGREEMENT				
Corresponent: RANDY M. FRIEDBERG, ESQ. OLSHAN GRUNDMAN FROME ROSENSZWEIG ET AL PARK AVENUE TOWER 65 EAST 55TH STREET NEW YORK, NY 10022				
WELLS FARGO FOOTHILL INC. AS AGENT,SANTA MONICA,CA,US	BELL INDUSTRIES, INC., A CALIFORNIA CORPORATION	2007-01-31	018826/0503	2007-01-31
	BELL INDUSTRIES, INC., A MINNESOTA CORPORATION	2007-01-31		
Conveyance: PATENT SECURITY AGREEMENT				
Corresponent: PAUL HASTINGS JANOFFSKY & WALKER LLP 515 SOUTH FLOWER STREET, 25TH FLOOR LOS ANGELES, CA 90071				
SKYTEL CORP.,ASHBURN,VA,US	SKYTEL COMMUNICATIONS, INC.	2004-12-31	018797/0318	2007-01-24

Conveyance: MERGER (SEE DOCUMENT FOR DETAILS).				
Corresponent: EDEN STRIGHT 1515 COURTHOUSE ROAD, SUITE 500 ARLINGTON, VA 22201-2909				
SKYTEL COMMUNICATIONS INC.,ASHBURN,VA,US	MOBILE TELECOMMUNICATIONS TECHNOLOGIES CORP.	1998-05-21	015074/0648	2004-08-23
Conveyance: CHANGE OF NAME (SEE DOCUMENT FOR DETAILS).				
Corresponent: MICHAEL A. WRENN 9854/003 1133 19TH STREET NW WASHINGTON, D.C. 20036				
MOBILE TELECOMMUNICATIONS TECHNOLOGIES,JACKSON, MS,US	HAYS, WILLIAM D.	1995-09-20	007721/0991	1995-09-21
	CAMERON, DENNIS	1995-09-18		
	ROEHR, WALTER	1995-09-11		
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				
Corresponent: HOWARD A. KWON FINNEGAN, HENDERSON ET AL. 1300 I STREET WASHINGTON, D.C. 20005-3315				

Maintenance Status (US):

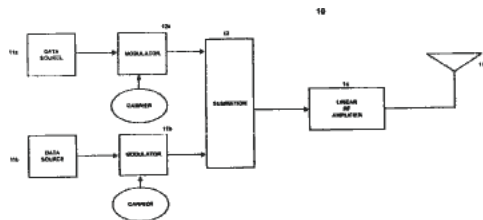
Litigation (US): 2013-04-02 2013 Mobile Telecommunications Technologies, LLC Apple, Inc. E.D. Texas 2:13cv00258

Opposition (EP):

License (EP):

EPO Procedural Status:

Front Page Drawing:



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USPTO Maintenance Report

Patent Bibliographic Data				06/13/2013 11:53 AM	
Patent Number:	5659891	Application Number:	08480718		
Issue Date:	08/19/1997	Filing Date:	06/07/1995		
Title:	MULTICARRIER TECHNIQUES IN BANDLIMITED CHANNELS				
Status:	4th, 8th and 12th year fees paid		Entity:	LARGE	
Window Opens:	N/A	Surcharge Date:	N/A	Expiration:	N/A
Fee Amt Due:	Window not open	Surchg Amt Due:	Window not open	Total Amt Due:	Window not open
Fee Code:					
Surcharge Fee Code:					
Most recent events (up to 7):	07/30/2009 07/30/2009 02/23/2009 02/22/2005 03/13/2001 02/20/2001 02/16/2001	11.5 yr surcharge- late pmt w/in 6 mo, Large Entity. Payment of Maintenance Fee, 12th Year, Large Entity. Maintenance Fee Reminder Mailed. Payment of Maintenance Fee, 8th Year, Large Entity. Maintenance Fee Reminder Mailed. Payor Number Assigned. Payment of Maintenance Fee, 4th Year, Large Entity. --- End of Maintenance History ---			
Address for fee purposes:	COMPUTER PACKAGES, INC. 414 HUNGERFORD DRIVE ROCKVILLE MD 20850				