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Crawford

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(54) **CARD-BASED DIVERSITY ANTENNA STRUCTURE FOR WIRELESS COMMUNICATIONS**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

3,488,445	A		1/1970	Chang	179/15
4,538,153	A		8/1985	Taga	343/700
5,138,328	A		8/1992	Zibrik et al.	343/702
5,146,232	A		9/1992	Nishikawa et al.	343/713
5,282,222	A		1/1994	Fattouche et al.	375/1
5,369,670	A		11/1994	Zagloul et al.	375/84
5,402,136	A		3/1995	Goto et al.	343/729
5,410,748	A		4/1995	Hayashi et al.	455/277.1
5,420,599	A		5/1995	Erkocevic	343/828
5,463,406	A		10/1995	Vannatta	343/725
5,486,836	A		1/1996	Kuffner et al.	343/700
5,487,069	A		1/1996	O'Sullivan et al.	370/94.3
5,552,798	A		9/1996	Dietrich et al.	343/893
5,555,268	A		9/1996	Fattouche et al.	375/206
5,650,788	A		7/1997	Jha	343/700
5,657,028	A		8/1997	Sanad	343/700
5,680,144	A		10/1997	Sanad	343/700
5,832,031	A	*	11/1998	Hammons	375/262
5,832,044	A		11/1998	Sousa et al.	375/347
5,867,131	A	*	2/1999	Camp et al.	343/797
5,936,580	A	*	8/1999	Van Puijenbrock	343/700 MS
5,943,020	A		8/1999	Liebendoerfer et al.	343/702
5,990,838	A		11/1999	Burns et al.	343/702
5,991,864	A	*	11/1999	Kinney et al.	712/1
5,995,062	A		11/1999	Denney et al.	343/853
6,008,774	A		12/1999	Wu	343/828
6,031,503	A		2/2000	Preiss, II et al.	343/770
6,043,790	A		3/2000	Derneryd et al.	343/853
6,054,955	A		4/2000	Schlegeli et al.	
6,091,364	A		7/2000	Murakami et al.	343/700
6,104,349	A		8/2000	Cohen	
6,115,762	A	*	9/2000	Bell et al.	710/62
6,160,514	A		12/2000	Judd	343/700
6,198,460	B1		3/2001	Brankovic	343/879
6,222,503	B1		4/2001	Gietema et al.	343/890
6,181,284	B1	*	1/2002	Madsen et al.	343/702

OTHER PUBLICATIONS

U.S. patent application Ser. No. 09/693,465, Crawford, filed Oct. 19, 2000.

U.S. patent application Ser. No. 09/799,411, Crawford, filed Mar. 5, 2001.

* cited by examiner

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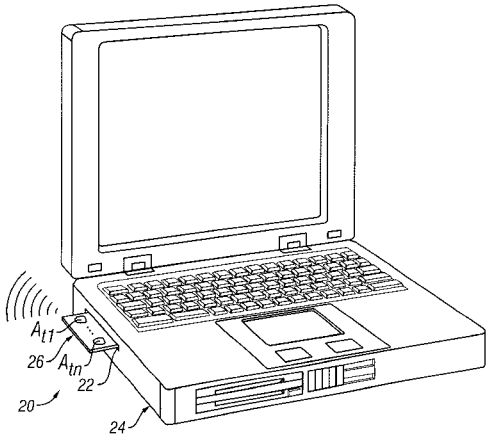
(57) **ABSTRACT**

A card-based diversity antenna structure includes a card and at least two antenna elements. The card has active circuitry attached thereto and connectors located at a first end thereof configured for engagement with an interface slot. The at least two antenna elements are attached to the card at a second end thereof and are coupled to the active circuitry. At least two antenna elements are sufficiently spaced apart so as to achieve spatial diversity. The polarizations of two of the at least two antenna elements may be orthogonal to each other so as to achieve polarization diversity. The antenna structure delivers good receive and transmit diversity performance and is well suited to the form factor limits imposed by the dimensions of small cards, such as PCMCIA cards. The configuration is very convenient for application in the 5 to 6 GHz frequency band.

56 Claims, 11 Drawing Sheets