



US006042059A

# United States Patent [19]

[11] Patent Number: **6,042,059**

**Bilanin et al.**

[45] Date of Patent: **Mar. 28, 2000**

[54] **SYSTEM AND METHOD OF VORTEX WAKE CONTROL USING VORTEX LEVERAGING**

[75] Inventors: **Alan J. Bilanin**, Princeton; **Todd R. Quackenbush**, Pennington, both of N.J.

[73] Assignee: **Continuum Dynamics, Inc.**, Princeton, N.J.

[21] Appl. No.: **09/027,104**

[22] Filed: **Feb. 20, 1998**

### Related U.S. Application Data

[60] Provisional application No. 60/038,286, Feb. 20, 1997.

[51] Int. Cl.<sup>7</sup> ..... **B64C 23/06**

[52] U.S. Cl. .... **244/199; 244/201; 244/204; 244/213; 244/91**

[58] Field of Search ..... 244/198, 201, 244/204, 205, 199, 200, 91, 45 R, 45 A, 213

### [56] References Cited

#### U.S. PATENT DOCUMENTS

2,120,760	6/1938	Lumiere	.....	244/91
2,740,596	4/1956	Lee	.....	244/199
3,845,918	11/1974	White, Jr.	.....	244/41
3,881,669	5/1975	Lessen	.....	244/40
4,017,041	4/1977	Nelson	.....	244/40
4,046,336	9/1977	Tangler	.....	244/198
4,190,219	2/1980	Hackett	.....	244/199
4,477,042	10/1984	Griswold, II	.....	244/199
4,697,769	10/1987	Blackwelder et al.	.....	244/199
5,209,438	5/1993	Wynanski	.....	244/199
5,226,618	7/1993	Greenhalgh	.....	244/213
5,492,289	2/1996	Nosenchuck et al.	.....	244/204

#### FOREIGN PATENT DOCUMENTS

4-78793	3/1992	Japan	.....	244/199
1436097	5/1976	United Kingdom	.....	244/199
2 051 706	1/1981	United Kingdom	.....	

#### OTHER PUBLICATIONS

A.J. Bilanin et al., Aircraft Wake Dissipation by Sinusoidal Instability and Vortex Breakdown, American Institute of Aeronautics & Astronautics, 1973, pp. 1-11.

Delwin R. Croom et al., Low-Speed Wind-Tunnel Investigation of Span Load Alteration, Forward-Located Spoilers, and Splines as Trailing-Vortex-Hazard.

Alleviation Devices on a Transport Aircraft Model, National Aeronautics & Space Administration, 1975, pp. 2-46.

S.C. Crow, Stability Theory for a Pair of Trailing Vortices, American Institute of Aeronautics & Astronautics, vol. 8, No. 12, 1970, pp. 2172-2179.

V.R. Nikolie et al., Attenuation of Airplane Wake Vortices by Excitation of Far-Field Instability, American Institute of Aeronautics & Astronautics, Inc., vol. 93. No. 3511, 1993, pp. 876-884.

John N. Olsen et al., Aircraft Wake Turbulence and its Detection, Symposium on Aircraft Wake Turbulence, 1971, pp. 577-582.

Vernon J. Rossow, Prospects for Destructive Self-Induced Interactions in a Vortex Pair, American Institute of Aeronautics, and Astronautics Inc., vol. 24, No. 7, 1987, pp. 433-440.

Vernon J. Rossow, On the Wake Hazard Alleviation Associated With Roll Oscillations of Wake-Generating Aircraft, American Institute of Aeronautics & Astronautics, Inc., vol. 85, No. 1774, 1985.

*Primary Examiner*—Galen L. Barefoot  
*Attorney, Agent, or Firm*—Woodbridge & Associates

### [57] ABSTRACT

This invention relates to a system and method for reducing the primary vortex wake structure generated by a lifting body mounted on an object moving through a fluid. This is achieved by first, altering the generated initial vortex wake to make it vulnerable to rapid breakup; and, second, producing disturbances to this wake with secondary vortices from auxiliary lifting surfaces, called vortex leveraging tabs, to instigate this breakup. This invention relates to various fields of uses to include vortices generated by any type of lifting body moving through a fluid to include aircraft and watercraft, such as surface vessels and submarines.

**47 Claims, 9 Drawing Sheets**

