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(54) **ELECTRICALLY ACTUATED VARIABLE PRESSURE CONTROL SYSTEM**(71) Applicants: **Jeffrey John Grimm**, Holton, KS (US); **Graeme W. Henderson**, Jacksonville, FL (US)(72) Inventors: **Jeffrey John Grimm**, Holton, KS (US); **Graeme W. Henderson**, Jacksonville, FL (US)(73) Assignee: **Capstan Ag Systems, Inc.**, Topeka, KS (US)

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(51) **Int. Cl.**

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| <i>B05B 9/04</i> | (2006.01) |
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(58) **Field of Classification Search**

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| USPC | <i>239/11, 146, 67, 68, 159, 161, 162, 163, 239/170, 436, 443, 444, 548, 550, 551, 239/562, 556, 566, 557, 569, 578, 112, 239/113, 61, 62, 155–157, 172, 104, 106</i> |

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | |
|-------------|------------------------|
| 3,782,534 A | 1/1974 Holleman |
| 3,853,272 A | 12/1974 Deckser et al. |
| 4,328,025 A | 5/1982 Whitcomb |

(Continued)

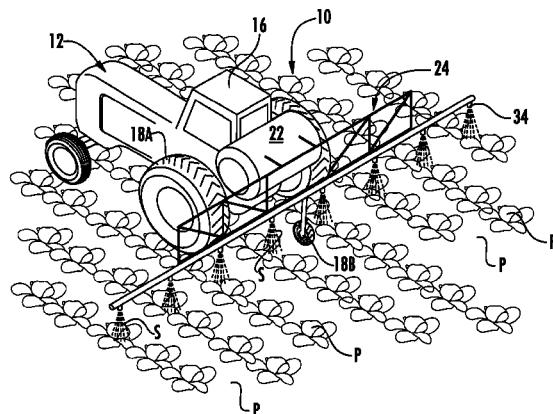
OTHER PUBLICATIONS

Product Data Sheet for AIM Command® Spray System (Case IH), 2 pages, www.caseih.com/products, Aug. 30, 2004.

(Continued)

Primary Examiner — Arthur O Hall*Assistant Examiner* — Steven M Cernoch(74) *Attorney, Agent, or Firm* — Armstrong Teasdale LLP(57) **ABSTRACT**

An electrically-actuated variable pressure control system for use with flow-controlled liquid application systems. Direct acting solenoid valves are pulsed at varying frequencies and duty cycles to change the resistance to flow encountered by the flow-controlled liquid application system. This pulsing solenoid valve technique preserves a high degree of accuracy and uniformity through a wide range of pressure control. This wide range of pressure control indirectly allows the flow-controlled liquid application system to operate over a wider range of flow control, yielding indirect benefits to performance and productivity. When the solenoid valves are attached to pressure-atomization spray nozzles, control over spray pattern and droplet size is further achieved.

22 Claims, 8 Drawing Sheets

| | | | | | |
|----------------------|------------------|-----------|-------------|--------|--------------|
| (51) Int. Cl. | B05B 9/06 | (2006.01) | 5,861,556 A | 1/1999 | Nukui et al. |
| | B05B 1/08 | (2006.01) | 5,881,919 A | 3/1999 | Womac et al. |

| | | | | |
|------------------------------|-----------------------|-----------------|---------|------------------|
| (56) References Cited | U.S. PATENT DOCUMENTS | 5,908,161 A | 6/1999 | Womac et al. |
| | | 5,967,066 A | 10/1999 | Giles et al. |
| | | 6,003,383 A | 12/1999 | Zielinska et al. |
| | | 6,053,053 A | 4/2000 | Huotari |
| | | 6,126,088 A | 10/2000 | Wilger et al. |
| | | 6,170,338 B1 | 1/2001 | Kleven et al. |
| | | 6,260,941 B1 | 7/2001 | Su et al. |
| | | 6,270,020 B1 | 8/2001 | Thomason et al. |
| | | 6,565,015 B2 | 5/2003 | Leer et al. |
| | | 6,596,996 B1 | 7/2003 | Stone et al. |
| | | 6,689,338 B2 | 2/2004 | Kotov |
| | | 7,040,552 B2 | 5/2006 | McCrea et al. |
| | | 7,300,004 B2 | 11/2007 | Sinden et al. |
| | | 2005/0000277 A1 | 1/2005 | Giles |
| | | 2008/0001004 A1 | 1/2008 | Ringer |

| | | |
|-------------|---------|------------------|
| 4,530,463 A | 7/1985 | Hiniker et al. |
| 4,553,702 A | 11/1985 | Coffee et al. |
| 4,630,773 A | 12/1986 | Ortlip et al. |
| 4,637,547 A | 1/1987 | Huniker et al. |
| 4,823,268 A | 4/1989 | Giles et al. |
| 4,905,897 A | 3/1990 | Rogers et al. |
| 5,134,961 A | 8/1992 | Giles et al. |
| 5,334,987 A | 8/1994 | Teach |
| 5,348,226 A | 9/1994 | Heiniger et al. |
| 5,389,781 A | 2/1995 | Beck et al. |
| 5,433,380 A | 7/1995 | Hahn |
| 5,442,552 A | 8/1995 | Slaughter et al. |
| 5,520,333 A | 5/1996 | Tofte |
| 5,544,813 A | 8/1996 | Giles et al. |
| 5,624,409 A | 4/1997 | Seale |
| 5,653,389 A | 8/1997 | Henderson et al. |
| 5,704,546 A | 1/1998 | Henderson et al. |
| 5,763,873 A | 6/1998 | Beck et al. |
| 5,809,440 A | 9/1998 | Beck et al. |
| 5,833,144 A | 11/1998 | Kinter |
| 5,841,035 A | 11/1998 | Andoh et al. |

OTHER PUBLICATIONS

Piezo Film Sensors Technical Manual, Measurement Specialties, Inc., Appendices A and B, pp. 59-82, Apr. 1999, Norristown, PA.
 "Sensing Spray Nozzle Vibration as a Means for Monitoring Operation", by D.K. Giles, pp. 1-7, ILASS Americas, 17th Annual Conference on Liquid Atomization and Spray Systems, Arlington, VA.
 U.S. Appl. No. 11/135,054, filed May 23, 2005 entitled "Networked Diagnostic and Control System for Dispensing Apparatus".(Issued U.S. Pat. No. 7,502,665).