(51) **Int. Cl.**
B01D 53/32 (2006.01)
B01D 53/14 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,841,543 A * 7/1958 Haller 205/432
3,165,460 A 1/1965 Zang et al.
3,344,050 A * 9/1967 Mayland et al. 205/555
3,515,513 A 6/1970 Parsl
3,519,488 A 7/1970 Giner
5,064,733 A 11/1991 Krist et al.
5,079,103 A 1/1992 Schramm
5,134,043 A 7/1992 Nakazawa
5,141,620 A 8/1992 Molter
5,198,311 A 3/1993 Nakazawa et al.
5,208,113 A 5/1993 Kinoshita
5,215,728 A 6/1993 McManus
5,232,793 A 8/1993 Miyauchi et al.
5,246,551 A 9/1993 Pletcher et al.
5,284,556 A 2/1994 Rich
5,320,816 A 6/1994 Tsai et al.
5,344,529 A 9/1994 Stauffer
5,401,372 A 3/1995 Liu et al.
5,429,886 A 7/1995 Struthers
5,433,934 A 7/1995 Chang et al.
5,456,807 A 10/1995 Wachsman
5,512,144 A 4/1996 Stauffer
5,593,552 A 1/1997 Joshi et al.
5,616,430 A 4/1997 Aoyama
5,622,681 A 4/1997 Grierson et al.
5,648,054 A 7/1997 DeBerry
5,736,023 A 4/1998 Gallagher et al.
5,770,785 A 6/1998 Tamura et al.
5,807,526 A 9/1998 Miljevic
5,832,712 A 11/1998 Ronning et al.
5,840,174 A 11/1998 Lehmann et al.
6,004,445 A 12/1999 Genders et al.
6,051,677 A 4/2000 Maeda et al.
6,093,380 A 7/2000 Lagana et al.
6,187,465 B1 2/2001 Galloway
6,331,232 B1 12/2001 Lundgren et al.
6,517,794 B2 2/2003 Gieshoff et al.
6,537,514 B1 3/2003 Prasad et al.
6,566,003 B2 5/2003 Acker
6,645,655 B1 11/2003 McNamee et al.
6,808,838 B1 10/2004 Wilson
6,818,107 B2 11/2004 Awano et al.
6,984,372 B2 1/2006 Randhava et al.
7,132,183 B2 11/2006 Galloway
7,220,502 B2 5/2007 Galloway
7,378,068 B2 5/2008 Mao et al.
7,387,719 B2 6/2008 Carson et al.
7,387,849 B2 6/2008 Keefer et al.
7,396,440 B2 7/2008 Amendola
7,479,215 B2 1/2009 Carson et al.
7,517,445 B2 4/2009 Carson et al.
7,520,916 B2 4/2009 McElroy et al.
7,521,031 B2 4/2009 Okubo et al.
7,527,770 B2 5/2009 Monzyk et al.
7,531,080 B2 5/2009 Carson et al.
7,531,708 B2 5/2009 Carson et al.
7,611,620 B2 11/2009 Carson et al.
7,691,251 B2 4/2010 Carson et al.
7,753,973 B2 7/2010 Galloway
7,795,175 B2 9/2010 Olah et al.
7,807,040 B2 10/2010 Legg et al.
7,828,883 B2 11/2010 Aines et al.
7,871,508 B2 1/2011 Carson et al.
7,883,610 B2 2/2011 Monzyk et al.
2002/0121093 A1 9/2002 Wallace et al.
2002/0142196 A1 10/2002 Finkelshatin et al.
2003/0022035 A1 1/2003 Galloway
2003/0027023 A1 2/2003 Dutil et al.
2003/0129469 A1 7/2003 Sun et al.
2003/0138677 A1 7/2003 Preidel
2003/0143449 A1 7/2003 Hunik
2003/0152818 A1 8/2003 Preidel
2004/0213732 A1 10/2004 Lightner
2004/0265680 A1 12/2004 Ren et al.
2005/0016871 A1 1/2005 Compton et al.
2005/0112423 A1 5/2005 Omoto et al.
2006/0024539 A1 2/2006 Dumesic et al.
2006/0102468 A1 5/2006 Monzyk et al.
2006/0115691 A1 6/2006 Hilmen et al.
2006/0127718 A1 6/2006 Kurashima et al.
2006/0140852 A1 6/2006 Russell et al.
2006/0234098 A1 10/2006 Gur
2007/0045125 A1 3/2007 Hartvigsen et al.
2007/0105013 A1 5/2007 Rajh et al.
2007/0187247 A1 8/2007 Lackner et al.
2007/0212584 A1 9/2007 Chuang
2007/0217981 A1 9/2007 Van Essendelft
2007/0256361 A1 11/2007 Kindig
2008/0022593 A1 1/2008 Gur et al.
2008/0060346 A1 3/2008 Asen et al.
2008/0072496 A1 3/2008 Yogev et al.
2008/0081227 A1 4/2008 Mossman et al.
2008/0134666 A1 6/2008 Kulkarni et al.
2008/0166602 A1 7/2008 Bronold et al.
2008/0202341 A1 8/2008 Poole et al.
2008/0223727 A1 9/2008 Oloman et al.
2008/0241638 A1 10/2008 McElroy et al.
2008/0245660 A1 10/2008 Little et al.
2008/0245672 A1 10/2008 Little et al.
2008/0248350 A1 10/2008 Little et al.
2008/0292944 A1 11/2008 Beckmann et al.
2009/0068502 A1 3/2009 Corrigan et al.
2009/0071844 A1 3/2009 Gomez
2009/0136797 A1 5/2009 Ong et al.
2009/0158701 A1 6/2009 Hoffmann et al.
2009/0159500 A1 6/2009 Greaney et al.
2009/0159501 A1 6/2009 Greaney et al.
2009/0162914 A1 6/2009 Offerman et al.
2009/0169452 A1 7/2009 Constantz et al.
2009/0169931 A1 7/2009 Qi
2009/0188164 A1 7/2009 Huang et al.
2009/0188782 A1 7/2009 Genuario et al.
2009/0214902 A1 8/2009 Pelman et al.
2009/0220388 A1 9/2009 Monzyk et al.
2009/0294366 A1 12/2009 Wright et al.
2009/0317882 A1 12/2009 Cheng et al.
2010/0028241 A1 2/2010 Saxena
2010/0126180 A1 5/2010 Forsyth et al.
2010/0140103 A1* 6/2010 Gilliam et al. 205/637
2010/0150802 A1 6/2010 Gilliam et al.
2010/0154431 A1 6/2010 Genovese et al.
2010/0154639 A1 6/2010 Perry et al.
2010/0180889 A1 7/2010 Monzyk et al.
2010/0193370 A1 8/2010 Olah et al.
2010/0200419 A1 8/2010 Gilliam et al.
2010/0205856 A1 8/2010 Kubic et al.
2010/0219373 A1 9/2010 Seeker et al.
2010/0224503 A1 9/2010 Kirk et al.
2010/0233796 A1 9/2010 Kurihara et al.
2010/0300286 A1 12/2010 Gu et al.
2010/0300894 A1 12/2010 Lin et al.
2010/0319534 A1 12/2010 Currier et al.
2011/0014526 A1 1/2011 Gur
2011/0020208 A1 1/2011 Aines et al.
2011/0186441 A1* 8/2011 LaFrancois et al. 205/555
2011/0277670 A1 11/2011 Self et al.

FOREIGN PATENT DOCUMENTS

EP 0 772 205 12/1999
EP 0 831 205 5/2004
EP 1 699 545 10/2008
EP 2 023 066 2/2009
GB 1293963 10/1972
WO WO 91/10617 7/1991
WO WO 92/22680 12/1992
WO WO 93/16216 8/1993
WO WO 9316216 A1 * 8/1993
WO WO 94/04258 3/1994