US008256924B2

(12) United States Patent
Simon et al.

(10) **Patent No.: US 8,256,924 B2**

(45) **Date of Patent: Sep. 4, 2012**

(54) **LED-BASED LIGHT HAVING RAPIDLY OSCILLATING LEDS**

(75) Inventors: **David L. Simon**, Grosse Pointe Woods, MI (US); **John Ivey**, Farmington Hills, MI (US)

(73) Assignee: **Ilumisys, Inc.**, Troy, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 246 days.

(21) Appl. No.: **12/210,653**

(22) Filed: **Sep. 15, 2008**

(65) **Prior Publication Data**

US 2010/0067231 A1 Mar. 18, 2010

(51) **Int. Cl.**
F21S 4/00 (2006.01)

(52) **U.S. Cl.** **362/249.03**; 362/225; 362/272; 362/286

(58) **Field of Classification Search** .... 362/249.07, 362/269–275, 232–234, 249.11, 249.01–249.03, 362/35, 220, 221, 225, 227, 235, 236, 240, 362/249.1, 800, 217.01, 217.02, 217.08, 362/219, 249.09, 253, 254, 285–287, 498, 362/555, FOR. 103, FOR. 105; 313/498; 392/393

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

54,511 A 2/1920 Owen
58,105 A 6/1921 Poritz
79,814 A 8/1929 Hoch
80,419 A 1/1930 Kramer
84,763 A 7/1931 Stange
D119,797 S 4/1940 Winkler et al.
D125,312 S 2/1941 Logan
2,826,679 A * 3/1958 Irmischer et al. 362/269
2,909,097 A 10/1959 Alden et al.
3,318,185 A 5/1967 Kott
3,561,719 A 2/1971 Grindle
3,586,936 A 6/1971 McLeroy
3,601,621 A 8/1971 Ritchie
3,612,855 A 10/1971 Juhnke
3,643,088 A 2/1972 Osteen et al.
3,739,336 A * 6/1973 Burland 340/472
3,746,918 A 7/1973 Drucker et al.
3,818,216 A 6/1974 Larraburu
3,832,503 A 8/1974 Crane
3,858,086 A 12/1974 Anderson et al.
3,909,670 A 9/1975 Wakamatsu et al.
3,924,120 A 12/1975 Cox, III

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1584388 A 2/2005

(Continued)

OTHER PUBLICATIONS

Wolsey, Robert. Interoperable Systems: The Future of Lighting Control, Lighting Research Center, Jan. 1, 1997, vol. 2 No. 2, Rensselaer Polytechnic Institute, Troy, New York [online]. Retrieved Lighting Research Center Web Page using Internet <URL: http://www.lrc.rpi.edu/programs/Futures/LF-BAS/index.asp>.

(Continued)

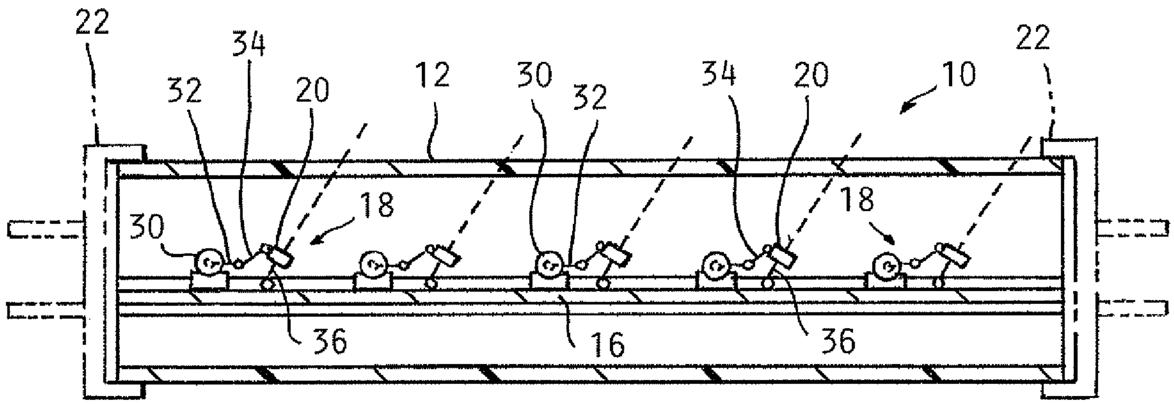
Primary Examiner — Y My Quach Lee

(74) *Attorney, Agent, or Firm* — Young Basile

(57) **ABSTRACT**

An LED-based light includes a support structure. At least one oscillator is connected to the support structure. At least one LED is coupled to each oscillator. The oscillator can oscillate the LED to produce a light blurring effect.

20 Claims, 3 Drawing Sheets



U.S. PATENT DOCUMENTS

3,958,885 A 5/1976 Stockinger et al.
3,974,637 A 8/1976 Bergey et al.
3,993,386 A 11/1976 Rowe
4,001,571 A 1/1977 Martin
4,054,814 A 10/1977 Fegley et al.
4,070,568 A 1/1978 Gala
4,082,395 A 4/1978 Donato et al.
4,096,349 A 6/1978 Donato
4,102,558 A 7/1978 Krachman
4,107,581 A 8/1978 Abernethy
4,189,663 A 2/1980 Schmutzer et al.
4,211,955 A 7/1980 Ray
4,241,295 A 12/1980 Williams, Jr.
4,271,408 A 6/1981 Teshima et al.
4,272,689 A 6/1981 Crosby et al.
4,273,999 A 6/1981 Pierpoint
4,298,869 A 11/1981 Okuno
4,329,625 A 5/1982 Nishizawa et al.
4,339,788 A 7/1982 White et al.
4,342,947 A 8/1982 Bloyd
4,344,117 A * 8/1982 Niccum 362/249.1
4,367,464 A 1/1983 Kurahashi et al.
D268,134 S 3/1983 Zurcher
4,382,272 A 5/1983 Quella et al.
4,388,567 A 6/1983 Yamazaki et al.
4,388,589 A 6/1983 Molldrem, Jr.
4,392,187 A 7/1983 Bornhorst
4,394,719 A 7/1983 Moberg
4,420,711 A 12/1983 Takahashi et al.
4,455,562 A 6/1984 Dolan et al.
4,500,796 A 2/1985 Quin
4,581,687 A 4/1986 Nakanishi
4,597,033 A 6/1986 Meggs et al.
4,600,972 A 7/1986 MacIntyre
4,607,317 A 8/1986 Lin
4,622,881 A 11/1986 Rand
4,625,152 A 11/1986 Nakai
4,635,052 A 1/1987 Aoike et al.
4,647,217 A 3/1987 Havel
4,656,398 A 4/1987 Michael et al.
4,661,890 A 4/1987 Watanabe et al.
4,668,895 A 5/1987 Schneiter
4,675,575 A 6/1987 Smith et al.
4,682,079 A 7/1987 Sanders et al.
4,686,425 A 8/1987 Havel
4,687,340 A 8/1987 Havel
4,688,154 A 8/1987 Nilssen
4,688,869 A 8/1987 Kelly
4,695,769 A 9/1987 Schweickardt
4,698,730 A 10/1987 Sakai et al.
4,701,669 A 10/1987 Head et al.
4,705,406 A 11/1987 Havel
4,707,141 A 11/1987 Havel
D293,723 S 1/1988 Buttner
4,727,289 A 2/1988 Uchida
4,740,882 A 4/1988 Miller
4,748,545 A 5/1988 Schmitt
4,753,148 A 6/1988 Johnson
4,758,173 A 7/1988 Northrop
4,771,274 A 9/1988 Havel
4,780,621 A 10/1988 Bartleucci et al.
4,794,383 A 12/1988 Havel
4,818,072 A 4/1989 Mohebban
4,824,269 A 4/1989 Havel
4,837,565 A 6/1989 White
4,843,627 A 6/1989 Stebbins
4,845,481 A 7/1989 Havel
4,845,745 A 7/1989 Havel
4,857,801 A 8/1989 Farrell
4,863,223 A 9/1989 Weissenbach et al.
4,870,325 A 9/1989 Kazar
4,874,320 A 10/1989 Freed et al.
4,887,074 A 12/1989 Simon et al.
4,894,832 A 1/1990 Colak
4,901,207 A 2/1990 Sato et al.
4,912,371 A 3/1990 Hamilton
4,922,154 A 5/1990 Cacoub
4,934,852 A 6/1990 Havel
4,941,072 A 7/1990 Yasumoto et al.
4,943,900 A 7/1990 Gartner
4,962,687 A 10/1990 Belliveau et al.
4,965,561 A 10/1990 Havel
4,973,835 A 11/1990 Kurosu et al.
4,979,081 A 12/1990 Leach et al.
4,980,806 A 12/1990 Taylor et al.
4,992,704 A 2/1991 Stinson
5,003,227 A 3/1991 Nilssen
5,008,595 A 4/1991 Kazar
5,008,788 A 4/1991 Palinkas
5,010,459 A 4/1991 Taylor et al.
5,018,054 A 5/1991 Ohashi et al.
5,027,037 A 6/1991 Wei
5,027,262 A 6/1991 Freed
5,032,960 A 7/1991 Katoh
5,034,807 A 7/1991 Von Kohorn
5,036,248 A 7/1991 McEwan et al.
5,038,255 A 8/1991 Nishihashi et al.
5,065,226 A 11/1991 Kluitmans et al.
5,072,216 A 12/1991 Grange
5,078,039 A 1/1992 Tulk et al.
5,083,063 A 1/1992 Brooks
5,088,013 A 2/1992 Revis
5,089,748 A 2/1992 Ihms
5,103,382 A 4/1992 Kondo et al.
5,122,733 A 6/1992 Havel
5,126,634 A 6/1992 Johnson
5,128,595 A 7/1992 Hara
5,130,909 A 7/1992 Gross
5,134,387 A 7/1992 Smith et al.
5,140,220 A 8/1992 Hasegawa
5,142,199 A 8/1992 Elwell
5,151,679 A 9/1992 Dimmick
5,154,641 A 10/1992 McLaughlin
5,161,879 A 11/1992 McDermott
5,161,882 A 11/1992 Garrett
5,164,715 A 11/1992 Kashiwabara et al.
5,184,114 A 2/1993 Brown
5,194,854 A 3/1993 Havel
5,198,756 A 3/1993 Jenkins et al.
5,209,560 A 5/1993 Taylor et al.
5,220,250 A 6/1993 Szuba
5,225,765 A 7/1993 Callahan et al.
5,226,723 A 7/1993 Chen
5,254,910 A 10/1993 Yang
5,256,948 A 10/1993 Boldin et al.
5,278,542 A 1/1994 Smith et al.
5,282,121 A 1/1994 Bornhorst et al.
5,283,517 A 2/1994 Havel
5,287,352 A 2/1994 Jackson et al.
5,294,865 A 3/1994 Haraden
5,298,871 A 3/1994 Shimohara
5,301,090 A 4/1994 Hed
5,303,124 A 4/1994 Wrobel
5,307,295 A 4/1994 Taylor et al.
5,321,593 A 6/1994 Moates
5,323,226 A 6/1994 Schreder
5,329,431 A 7/1994 Taylor et al.
5,344,068 A 9/1994 Haessig
5,350,977 A 9/1994 Hamamoto et al.
5,357,170 A 10/1994 Luchaco et al.
5,371,618 A 12/1994 Tai et al.
5,374,876 A 12/1994 Horibata et al.
5,375,043 A 12/1994 Tokunaga
D354,360 S 1/1995 Murata
5,381,074 A 1/1995 Rudzewicz et al.
5,388,357 A 2/1995 Malita
5,402,702 A 4/1995 Hata
5,404,282 A 4/1995 Klinke et al.
5,406,176 A 4/1995 Sugden
5,410,328 A 4/1995 Yoksza et al.
5,412,284 A 5/1995 Moore et al.
5,412,552 A 5/1995 Fernandes
5,420,482 A 5/1995 Phares
5,421,059 A 6/1995 Leffers, Jr.
5,430,356 A 7/1995 Ference et al.
5,432,408 A 7/1995 Matsuda et al.
5,436,535 A 7/1995 Yang

5,436,853	A	7/1995	Shimohara
5,450,301	A	9/1995	Waltz et al.
5,461,188	A	10/1995	Drago et al.
5,463,280	A	10/1995	Johnson
5,465,144	A	11/1995	Parker et al.
5,475,300	A	12/1995	Havel
5,481,441	A *	1/1996	Stevens 362/35
5,489,827	A	2/1996	Xia
5,491,402	A	2/1996	Small
5,493,183	A	2/1996	Kimball
5,504,395	A	4/1996	Johnson et al.
5,506,760	A	4/1996	Giebler et al.
5,513,082	A	4/1996	Asano
5,519,496	A	5/1996	Borgert et al.
5,530,322	A	6/1996	Ference et al.
5,544,809	A	8/1996	Keating et al.
5,545,950	A	8/1996	Cho
5,550,440	A	8/1996	Allison et al.
5,559,681	A	9/1996	Duarte
5,561,346	A	10/1996	Byrne
D376,030	S	11/1996	Cohen
5,575,459	A	11/1996	Anderson
5,575,554	A	11/1996	Guritz
5,581,158	A	12/1996	Quazi
5,592,051	A	1/1997	Korkala
5,600,199	A	2/1997	Martin, Sr. et al.
5,607,227	A	3/1997	Yasumoto et al.
5,608,290	A	3/1997	Hutchisson et al.
5,614,788	A	3/1997	Mullins et al.
5,621,282	A	4/1997	Haskell
5,621,603	A	4/1997	Adamec et al.
5,621,662	A	4/1997	Humphries et al.
5,622,423	A	4/1997	Lee
5,633,629	A	5/1997	Hochstein
5,634,711	A	6/1997	Kennedy et al.
5,640,061	A	6/1997	Bornhorst et al.
5,640,141	A	6/1997	Myllymaki
5,642,129	A	6/1997	Zavracky et al.
5,655,830	A	8/1997	Ruskouski
5,656,935	A	8/1997	Havel
5,661,645	A	8/1997	Hochstein
5,673,059	A	9/1997	Zavracky et al.
5,682,103	A	10/1997	Burrell
5,688,042	A	11/1997	Madadi et al.
5,697,695	A	12/1997	Lin et al.
5,701,058	A	12/1997	Roth
5,712,650	A	1/1998	Barlow
5,721,471	A	2/1998	Begemann et al.
5,725,148	A	3/1998	Hartman
5,726,535	A	3/1998	Yan
5,731,759	A	3/1998	Finucan
5,734,590	A	3/1998	Tebbe
5,751,118	A	5/1998	Mortimer
5,752,766	A	5/1998	Bailey et al.
5,765,940	A	6/1998	Levy et al.
5,769,527	A	6/1998	Taylor et al.
5,784,006	A	7/1998	Hochstein
5,785,227	A	7/1998	Akiba
5,790,329	A	8/1998	Klaus et al.
5,803,579	A	9/1998	Turnbull et al.
5,803,580	A	9/1998	Tseng
5,803,729	A	9/1998	Tsimerman
5,806,965	A	9/1998	Deese
5,808,689	A	9/1998	Small
5,810,463	A	9/1998	Kawahara et al.
5,812,105	A	9/1998	Van de Ven
5,813,751	A	9/1998	Shaffer
5,813,753	A	9/1998	Vriens et al.
5,821,695	A	10/1998	Vilanilam et al.
5,825,051	A	10/1998	Bauer et al.
5,828,178	A	10/1998	York et al.
5,836,676	A	11/1998	Ando et al.
5,848,837	A	12/1998	Gustafson
5,850,126	A	12/1998	Kanbar
5,851,063	A	12/1998	Doughty et al.
5,852,658	A	12/1998	Knight et al.
5,854,542	A	12/1998	Forbes
RE36,030	E	1/1999	Nadeau
5,859,508	A	1/1999	Ge et al.
5,865,529	A	2/1999	Yan
5,890,794	A	4/1999	Abtahi et al.
5,896,010	A	4/1999	Mikolajczak et al.
5,907,742	A	5/1999	Johnson et al.
5,912,653	A	6/1999	Fitch
5,921,660	A	7/1999	Yu
5,924,784	A	7/1999	Chliwnyj et al.
5,927,845	A	7/1999	Gustafson et al.
5,934,792	A	8/1999	Camarota
5,946,209	A	8/1999	Eckel et al.
5,949,347	A	9/1999	Wu
5,952,680	A	9/1999	Strite
5,959,547	A	9/1999	Tubel et al.
5,962,989	A	10/1999	Baker
5,962,992	A	10/1999	Huang et al.
5,963,185	A	10/1999	Havel
5,974,553	A	10/1999	Gandar
5,980,064	A	11/1999	Metroyanis
5,998,925	A	12/1999	Shimizu et al.
5,998,928	A	12/1999	Hipp
6,007,209	A	12/1999	Pelka
6,008,783	A	12/1999	Kitagawa et al.
6,011,691	A	1/2000	Schreffler
6,016,038	A	1/2000	Mueller et al.
6,018,237	A	1/2000	Havel
6,019,493	A	2/2000	Kuo et al.
6,020,825	A	2/2000	Chansky et al.
6,025,550	A	2/2000	Kato
6,028,694	A	2/2000	Schmidt
6,030,099	A	2/2000	McDermott
6,031,343	A	2/2000	Recknagel et al.
D422,737	S	4/2000	Orozco
6,056,420	A	5/2000	Wilson et al.
6,068,383	A	5/2000	Robertson et al.
6,069,597	A	5/2000	Hansen
6,072,280	A	6/2000	Allen
6,084,359	A	7/2000	Hetzel et al.
6,086,220	A	7/2000	Lash et al.
6,091,200	A	7/2000	Lenz
6,092,915	A	7/2000	Rensch
6,095,661	A	8/2000	Lebens et al.
6,097,352	A	8/2000	Zavracky et al.
6,116,748	A	9/2000	George
6,121,875	A	9/2000	Hamm et al.
6,127,783	A	10/2000	Pashley et al.
6,132,072	A	10/2000	Turnbull et al.
6,135,604	A	10/2000	Lin
6,139,174	A	10/2000	Butterworth
6,149,283	A	11/2000	Conway et al.
6,150,774	A	11/2000	Mueller et al.
6,151,529	A	11/2000	Batko
6,158,882	A	12/2000	Bischoff, Jr.
6,166,496	A	12/2000	Lys et al.
6,175,201	B1	1/2001	Sid
6,175,220	B1	1/2001	Billig et al.
6,181,126	B1	1/2001	Havel
6,183,086	B1	2/2001	Neubert
6,183,104	B1	2/2001	Ferrara
6,184,628	B1	2/2001	Ruthenberg
6,196,471	B1	3/2001	Ruthenberg
6,203,180	B1	3/2001	Fleischmann
6,211,626	B1	4/2001	Lys et al.
6,215,409	B1	4/2001	Blach
6,217,190	B1	4/2001	Altman et al.
6,219,239	B1	4/2001	Mellberg et al.
6,227,679	B1	5/2001	Zhang et al.
6,238,075	B1	5/2001	Dealey, Jr. et al.
6,241,359	B1	6/2001	Lin
6,250,774	B1	6/2001	Begemann et al.
6,252,350	B1	6/2001	Alvarez
6,252,358	B1	6/2001	Xydis et al.
6,268,600	B1	7/2001	Nakamura et al.
6,273,338	B1	8/2001	White
6,275,397	B1	8/2001	McClain
6,283,612	B1	9/2001	Hunter
6,292,901	B1	9/2001	Lys et al.
6,293,684	B1	9/2001	Riblett
6,297,724	B1	10/2001	Bryans et al.
6,305,109	B1	10/2001	Lee

6,305,821	B1	10/2001	Hsieh et al.	
6,307,331	B1	10/2001	Bonasia et al.	
6,310,590	B1	10/2001	Havel	
6,323,832	B1	11/2001	Nishizawa et al.	
6,325,651	B1	12/2001	Nishihara et al.	
6,334,699	B1	1/2002	Gladnick	
6,340,868	B1	1/2002	Lys et al.	
6,354,714	B1	3/2002	Rhodes	
6,361,186	B1	3/2002	Slayden	
6,369,525	B1	4/2002	Chang et al.	
6,371,637	B1	4/2002	Atchinson et al.	
6,379,022	B1	4/2002	Amerson et al.	
D457,667	S	5/2002	Piepgras et al.	
D457,669	S	5/2002	Piepgras et al.	
D457,974	S	5/2002	Piepgras et al.	
6,388,393	B1	5/2002	Illingworth	
6,394,623	B1	5/2002	Tsui	
D458,395	S	6/2002	Piepgras et al.	
6,400,096	B1	6/2002	Wells et al.	
6,404,131	B1	6/2002	Kawano et al.	
6,411,022	B1	6/2002	Machida	
6,422,716	B2	7/2002	Henrici et al.	
6,428,189	B1	8/2002	Hochstein	
D463,610	S	9/2002	Piepgras et al.	
6,445,139	B1	9/2002	Marshall et al.	
6,448,550	B1	9/2002	Nishimura	
6,448,716	B1	9/2002	Hutchison	
6,459,919	B1	10/2002	Lys et al.	
6,469,457	B2	10/2002	Callahan	
6,471,388	B1	10/2002	Marsh	
6,472,823	B2	10/2002	Yen	
6,473,002	B1	10/2002	Hutchison	
D468,035	S	12/2002	Blanc et al.	
6,488,392	B1	12/2002	Lu	
6,495,964	B1	12/2002	Muthu et al.	
6,527,411	B1	3/2003	Sayers	
6,528,954	B1	3/2003	Lys et al.	
6,528,958	B2	3/2003	Hulshof et al.	
6,538,375	B1	3/2003	Duggal et al.	
6,548,967	B1	4/2003	Dowling et al.	
6,573,536	B1	6/2003	Dry	
6,577,072	B2	6/2003	Saito et al.	
6,577,080	B2	6/2003	Lys et al.	
6,577,512	B2	6/2003	Tripathi et al.	
6,577,794	B1	6/2003	Currie et al.	
6,578,979	B2	6/2003	Truttmann-Battig	
6,582,103	B1	6/2003	Popovich et al.	
6,583,550	B2	6/2003	Iwasa et al.	
6,583,573	B2	6/2003	Bierman	
6,585,393	B1	7/2003	Brandes et al.	
6,586,890	B2	7/2003	Min et al.	
6,590,343	B2	7/2003	Pederson	
6,592,238	B2	7/2003	Cleaver et al.	
6,596,977	B2	7/2003	Muthu et al.	
6,598,996	B1	7/2003	Lodhie	
6,608,453	B2	8/2003	Morgan et al.	
6,608,614	B1	8/2003	Johnson	
6,609,804	B2	8/2003	Nolan et al.	
6,612,712	B2	9/2003	Nepil	
6,612,717	B2	9/2003	Yen	
6,621,222	B1	9/2003	Hong	
6,623,151	B2	9/2003	Pederson	
6,624,597	B2	9/2003	Dowling et al.	
D481,484	S	10/2003	Cuevas et al.	
6,634,770	B2	10/2003	Cao	
6,634,779	B2	10/2003	Reed	
6,636,003	B2	10/2003	Rahm et al.	
6,639,349	B1	10/2003	Bahadur	
6,641,284	B2	11/2003	Stopa et al.	
6,659,622	B2	12/2003	Katogi et al.	
6,660,935	B2	12/2003	Southard et al.	
6,666,689	B1	12/2003	Savage, Jr.	
6,667,623	B2	12/2003	Bourgault et al.	
6,674,096	B2	1/2004	Sommers	
6,676,284	B1	1/2004	Wynne Willson	
6,679,621	B2	1/2004	West et al.	
6,681,154	B2	1/2004	Nierlich et al.	
6,682,205	B2	1/2004	Lin	
6,683,419	B2	1/2004	Kriparos	
6,700,136	B2	3/2004	Guida	
6,712,486	B1	3/2004	Popovich et al.	
6,717,376	B2	4/2004	Lys et al.	
6,717,526	B2	4/2004	Martineau et al.	
6,720,745	B2	4/2004	Lys et al.	
6,726,348	B2	4/2004	Gloisten	
6,741,324	B1	5/2004	Kim	
D491,678	S	6/2004	Piepgras	
D492,042	S	6/2004	Piepgras	
6,744,223	B2	6/2004	Laflamme et al.	
6,748,299	B1	6/2004	Motoyama	
6,762,562	B2	7/2004	Leong	
6,774,584	B2	8/2004	Lys et al.	
6,777,891	B2	8/2004	Lys et al.	
6,781,329	B2	8/2004	Mueller et al.	
6,787,999	B2	9/2004	Stimac et al.	
6,788,000	B2	9/2004	Appelberg et al.	
6,788,011	B2	9/2004	Mueller et al.	
6,791,840	B2	9/2004	Chun	
6,796,680	B1	9/2004	Showers et al.	
6,801,003	B2	10/2004	Schanberger et al.	
6,806,659	B1	10/2004	Mueller et al.	
6,814,470	B2	11/2004	Rizkin et al.	
6,814,478	B2 *	11/2004	Menke	362/499
6,815,724	B2	11/2004	Dry	
6,846,094	B2	1/2005	Luk	
6,851,816	B2	2/2005	Wu et al.	
6,851,832	B2	2/2005	Tieszen	
6,853,151	B2	2/2005	Leong et al.	
6,853,563	B1	2/2005	Yang et al.	
6,857,924	B2	2/2005	Fu et al.	
6,860,628	B2	3/2005	Robertson et al.	
6,866,401	B2	3/2005	Sommers et al.	
6,869,204	B2	3/2005	Morgan et al.	
6,871,981	B2	3/2005	Alexanderson et al.	
6,874,924	B1	4/2005	Hulse et al.	
6,879,883	B1	4/2005	Motoyama	
6,882,111	B2	4/2005	Kan et al.	
6,883,929	B2	4/2005	Dowling	
6,883,934	B2	4/2005	Kawakami et al.	
6,888,322	B2	5/2005	Dowling et al.	
6,897,624	B2	5/2005	Lys et al.	
6,909,239	B2	6/2005	Gauna	
6,909,921	B1	6/2005	Bilger	
6,918,680	B2	7/2005	Seeberger	
6,921,181	B2	7/2005	Yen	
6,936,968	B2	8/2005	Cross et al.	
6,936,978	B2	8/2005	Morgan et al.	
6,940,230	B2	9/2005	Myron et al.	
6,948,829	B2	9/2005	Verdes et al.	
6,957,905	B1	10/2005	Pritchard et al.	
6,963,175	B2	11/2005	Archenhold et al.	
6,964,501	B2	11/2005	Ryan	
6,965,197	B2	11/2005	Tyan et al.	
6,965,205	B2	11/2005	Piepgras et al.	
6,967,448	B2	11/2005	Morgan et al.	
6,969,179	B2	11/2005	Sloan et al.	
6,969,186	B2	11/2005	Sonderegger et al.	
6,969,954	B2	11/2005	Lys	
6,975,079	B2	12/2005	Lys et al.	
6,979,097	B2	12/2005	Elam et al.	
6,982,518	B2	1/2006	Chou et al.	
6,995,681	B2	2/2006	Pederson	
6,997,576	B1	2/2006	Lodhie et al.	
7,004,603	B2	2/2006	Knight	
D518,218	S	3/2006	Roberge et al.	
7,008,079	B2	3/2006	Smith	
7,014,336	B1	3/2006	Ducharme et al.	
7,015,650	B2	3/2006	McGrath	
7,018,063	B2	3/2006	Michael et al.	
7,021,799	B2	4/2006	Mizuyoshi	
7,021,809	B2	4/2006	Iwasa et al.	
7,024,256	B2	4/2006	Krzyzanowski et al.	
7,031,920	B2	4/2006	Dowling et al.	
7,033,036	B2	4/2006	Pederson	
7,038,398	B1	5/2006	Lys et al.	
7,038,399	B2	5/2006	Lys et al.	
7,042,172	B2	5/2006	Dowling et al.	
7,048,423	B2	5/2006	Stepanenko et al.	

7,049,761	B2	5/2006	Timmermans et al.
7,052,171	B1	5/2006	Lefebvre et al.
7,053,557	B2	5/2006	Cross et al.
7,064,498	B2	6/2006	Dowling et al.
7,064,674	B2	6/2006	Pederson
7,067,992	B2	6/2006	Leong et al.
7,077,978	B2	7/2006	Setlur et al.
7,080,927	B2	7/2006	Feuerborn et al.
7,086,747	B2	8/2006	Nielson et al.
7,088,014	B2	8/2006	Nierlich et al.
7,088,904	B2	8/2006	Ryan, Jr.
7,102,902	B1	9/2006	Brown et al.
7,113,541	B1	9/2006	Lys et al.
7,114,830	B2	10/2006	Robertson et al.
7,114,834	B2	10/2006	Rivas et al.
7,118,262	B2	10/2006	Negley
7,119,503	B2	10/2006	Kemper
7,121,679	B2	10/2006	Fujimoto
7,122,976	B1	10/2006	Null et al.
7,128,442	B2	10/2006	Lee et al.
7,128,454	B2	10/2006	Kim et al.
D532,532	S	11/2006	Maxik
7,132,635	B2	11/2006	Dowling
7,132,785	B2	11/2006	Ducharme
7,132,804	B2	11/2006	Lys et al.
7,135,824	B2	11/2006	Lys et al.
7,139,617	B1	11/2006	Morgan et al.
7,144,135	B2	12/2006	Martin et al.
7,153,002	B2	12/2006	Kim et al.
7,161,311	B2	1/2007	Mueller et al.
7,161,313	B2	1/2007	Piepgras et al.
7,161,556	B2	1/2007	Morgan et al.
7,164,110	B2	1/2007	Pitigoi-Aron et al.
7,164,235	B2	1/2007	Ito et al.
7,165,863	B1	1/2007	Thomas et al.
7,165,866	B2	1/2007	Li
7,167,777	B2	1/2007	Budike, Jr.
7,168,843	B2	1/2007	Striebel
D536,468	S	2/2007	Crosby
7,178,941	B2	2/2007	Roberge et al.
7,180,252	B2	2/2007	Lys et al.
D538,950	S	3/2007	Maxik
D538,952	S	3/2007	Maxik et al.
D538,962	S	3/2007	Elliott
7,186,003	B2	3/2007	Dowling et al.
7,186,005	B2	3/2007	Hulse
7,187,141	B2	3/2007	Mueller et al.
7,190,126	B1	3/2007	Paton
7,192,154	B2	3/2007	Becker
7,198,387	B1	4/2007	Gloisten et al.
7,201,491	B2	4/2007	Bayat et al.
7,201,497	B2	4/2007	Weaver, Jr. et al.
7,202,613	B2	4/2007	Morgan et al.
7,204,615	B2	4/2007	Arik et al.
7,204,622	B2	4/2007	Dowling et al.
7,207,696	B1	4/2007	Lin
7,210,818	B2	5/2007	Luk et al.
7,210,957	B2	5/2007	Mrakovich
7,211,959	B1	5/2007	Chou
7,213,934	B2	5/2007	Zarian et al.
7,217,004	B2	5/2007	Park et al.
7,217,012	B2	5/2007	Southard et al.
7,217,022	B2	5/2007	Ruffin
7,218,056	B1	5/2007	Harwood
7,218,238	B2	5/2007	Right et al.
7,220,015	B2	5/2007	Dowling
7,220,018	B2	5/2007	Crabb et al.
7,221,104	B2	5/2007	Lys et al.
7,221,110	B2	5/2007	Sears et al.
7,224,000	B2	5/2007	Aanegola et al.
7,226,189	B2	6/2007	Lee et al.
7,228,052	B1	6/2007	Lin
7,228,190	B2	6/2007	Dowling et al.
7,231,060	B2	6/2007	Dowling et al.
7,233,115	B2	6/2007	Lys
7,233,831	B2	6/2007	Blackwell
7,236,366	B2	6/2007	Chen
7,237,924	B2	7/2007	Martineau et al.
7,237,925	B2	7/2007	Mayer et al.
7,239,532	B1	7/2007	Hsu et al.
7,241,038	B2	7/2007	Naniwa et al.
7,242,152	B2	7/2007	Dowling et al.
7,246,926	B2	7/2007	Harwood
7,246,931	B2	7/2007	Hsieh et al.
7,248,239	B2	7/2007	Dowling et al.
7,249,269	B1	7/2007	Motoyama
7,249,865	B2	7/2007	Robertson
D548,868	S	8/2007	Roberge et al.
7,252,408	B2	8/2007	Mazzochette et al.
7,253,566	B2	8/2007	Lys et al.
7,255,457	B2	8/2007	Ducharme et al.
7,255,460	B2	8/2007	Lee
7,256,554	B2	8/2007	Lys
7,258,458	B2	8/2007	Mochiachvili et al.
7,258,467	B2	8/2007	Saccomanno et al.
7,259,528	B2	8/2007	Pilz
7,262,439	B2	8/2007	Setlur et al.
7,264,372	B2	9/2007	Maglica
7,267,467	B2	9/2007	Wu et al.
7,270,443	B2	9/2007	Kurtz et al.
7,271,794	B1	9/2007	Cheng et al.
7,273,300	B2	9/2007	Mrakovich
7,274,045	B2	9/2007	Chandran et al.
7,274,160	B2	9/2007	Mueller et al.
D553,267	S	10/2007	Yuen
7,285,801	B2	10/2007	Eliashevich et al.
7,288,902	B1	10/2007	Melanson
7,296,912	B2	11/2007	Beauchamp
7,300,184	B2	11/2007	Ichikawa et al.
7,300,192	B2	11/2007	Mueller et al.
D556,937	S	12/2007	Ly
D557,854	S	12/2007	Lewis
7,303,300	B2	12/2007	Dowling et al.
7,306,353	B2	12/2007	Popovich et al.
7,307,391	B2	12/2007	Shan
7,308,296	B2	12/2007	Lys et al.
7,309,965	B2	12/2007	Dowling et al.
7,318,658	B2	1/2008	Wang et al.
7,319,244	B2	1/2008	Liu et al.
7,319,246	B2	1/2008	Soules et al.
7,321,191	B2	1/2008	Setlur et al.
7,326,964	B2	2/2008	Lim et al.
7,327,281	B2	2/2008	Hutchison
7,329,031	B2	2/2008	Liaw et al.
D563,589	S	3/2008	Hariri et al.
7,345,320	B2	3/2008	Dahm
7,348,604	B2	3/2008	Matheson
7,350,936	B2	4/2008	Ducharme et al.
7,350,952	B2	4/2008	Nishigaki
7,352,138	B2	4/2008	Lys et al.
7,352,339	B2	4/2008	Morgan et al.
7,353,071	B2	4/2008	Blackwell et al.
7,358,679	B2	4/2008	Lys et al.
7,358,929	B2	4/2008	Mueller et al.
7,374,327	B2	5/2008	Schexnaider
7,385,359	B2	6/2008	Dowling et al.
7,391,159	B2	6/2008	Harwood
7,396,146	B2	7/2008	Wang
7,401,935	B2	7/2008	VanderSchuit
7,401,945	B2	7/2008	Zhang
7,427,840	B2	9/2008	Morgan et al.
7,429,117	B2	9/2008	Pohlert et al.
7,434,964	B1	10/2008	Zheng et al.
7,438,441	B2	10/2008	Sun et al.
D580,089	S	11/2008	Ly et al.
D581,556	S	11/2008	To et al.
7,449,847	B2	11/2008	Schanberger et al.
D582,577	S	12/2008	Yuen
D584,428	S	1/2009	Li et al.
7,476,002	B2	1/2009	Wolf et al.
7,476,004	B2	1/2009	Chan
7,478,924	B2	1/2009	Robertson
D586,484	S	2/2009	Liu et al.
D586,928	S	2/2009	Liu et al.
7,490,957	B2	2/2009	Leong et al.
7,497,596	B2	3/2009	Ge
7,507,001	B2	3/2009	Kit
7,510,299	B2	3/2009	Timmermans et al.

7,520,635 B2 4/2009 Wolf et al.
7,521,872 B2 4/2009 Bruning
7,524,089 B2 4/2009 Park
D593,223 S 5/2009 Komar
7,534,002 B2 5/2009 Yamaguchi et al.
7,549,769 B2 6/2009 Kim et al.
7,556,396 B2 7/2009 Kuo et al.
7,559,663 B2 * 7/2009 Wong et al. 362/35
7,572,030 B2 8/2009 Booth et al.
7,575,339 B2 8/2009 Hung
7,602,559 B2 10/2009 Jang et al.
7,619,366 B2 11/2009 Diederiks
7,635,201 B2 12/2009 Deng
D612,528 S 3/2010 McGrath et al.
7,690,813 B2 4/2010 Kanamori et al.
2001/0033488 A1 10/2001 Chliwnyj et al.
2001/0045803 A1 11/2001 Cencur
2002/0038157 A1 3/2002 Dowling et al.
2002/0044066 A1 4/2002 Dowling et al.
2002/0047569 A1 4/2002 Dowling et al.
2002/0047624 A1 4/2002 Stam et al.
2002/0047628 A1 4/2002 Morgan et al.
2002/0048169 A1 4/2002 Dowling et al.
2002/0057061 A1 5/2002 Mueller et al.
2002/0060526 A1 5/2002 Timmermans et al.
2002/0070688 A1 6/2002 Dowling et al.
2002/0074559 A1 6/2002 Dowling et al.
2002/0078221 A1 6/2002 Blackwell et al.
2002/0101197 A1 8/2002 Lys et al.
2002/0113555 A1 8/2002 Lys et al.
2002/0130627 A1 9/2002 Morgan et al.
2002/0145394 A1 10/2002 Morgan et al.
2002/0145869 A1 10/2002 Dowling
2002/0152045 A1 10/2002 Dowling et al.
2002/0152298 A1 10/2002 Kikta et al.
2002/0153851 A1 10/2002 Morgan et al.
2002/0158583 A1 10/2002 Lys et al.
2002/0163316 A1 11/2002 Lys et al.
2002/0171365 A1 11/2002 Morgan et al.
2002/0171377 A1 11/2002 Mueller et al.
2002/0171378 A1 11/2002 Morgan et al.
2002/0176259 A1 11/2002 Ducharme
2002/0179816 A1 12/2002 Haines et al.
2002/0195975 A1 12/2002 Schanberger et al.
2003/0011538 A1 1/2003 Lys et al.
2003/0028260 A1 2/2003 Blackwell
2003/0031015 A1 2/2003 Ishibashi
2003/0057884 A1 3/2003 Dowling et al.
2003/0057886 A1 3/2003 Lys et al.
2003/0057887 A1 3/2003 Dowling et al.
2003/0057890 A1 3/2003 Lys et al.
2003/0076281 A1 4/2003 Morgan et al.
2003/0085710 A1 5/2003 Bourgault et al.
2003/0095404 A1 5/2003 Becks et al.
2003/0100837 A1 5/2003 Lys et al.
2003/0102810 A1 6/2003 Cross et al.
2003/0133292 A1 7/2003 Mueller et al.
2003/0137258 A1 7/2003 Piepgras et al.
2003/0185005 A1 10/2003 Sommers et al.
2003/0185014 A1 10/2003 Gloisten
2003/0189412 A1 10/2003 Cunningham
2003/0222587 A1 12/2003 Dowling, Jr. et al.
2004/0003545 A1 1/2004 Gillespie
2004/0012959 A1 1/2004 Robertson et al.
2004/0036006 A1 2/2004 Dowling
2004/0037088 A1 2/2004 English et al.
2004/0052076 A1 3/2004 Mueller et al.
2004/0062041 A1 4/2004 Cross et al.
2004/0075572 A1 4/2004 Buschmann et al.
2004/0080960 A1 4/2004 Wu
2004/0090191 A1 5/2004 Mueller et al.
2004/0090787 A1 5/2004 Dowling et al.
2004/0105261 A1 6/2004 Ducharme et al.
2004/0105264 A1 6/2004 Spero
2004/0113568 A1 6/2004 Dowling et al.
2004/0116039 A1 6/2004 Mueller et al.
2004/0124782 A1 7/2004 Yu
2004/0130909 A1 7/2004 Mueller et al.
2004/0141321 A1 7/2004 Dowling et al.
2004/0145886 A1 * 7/2004 Fatemi et al. 362/35
2004/0155609 A1 8/2004 Lys et al.
2004/0160199 A1 8/2004 Morgan et al.
2004/0178751 A1 9/2004 Mueller et al.
2004/0189218 A1 9/2004 Leong et al.
2004/0189262 A1 9/2004 McGrath
2004/0212320 A1 10/2004 Dowling et al.
2004/0212321 A1 10/2004 Lys et al.
2004/0212993 A1 10/2004 Morgan et al.
2004/0223328 A1 11/2004 Lee et al.
2004/0240890 A1 12/2004 Lys et al.
2004/0257007 A1 12/2004 Lys et al.
2005/0013133 A1 1/2005 Yeh
2005/0024877 A1 2/2005 Frederick
2005/0030744 A1 2/2005 Ducharme et al.
2005/0035728 A1 2/2005 Schanberger et al.
2005/0036300 A1 2/2005 Dowling et al.
2005/0040774 A1 2/2005 Mueller et al.
2005/0041161 A1 2/2005 Dowling et al.
2005/0041424 A1 2/2005 Ducharme
2005/0043907 A1 2/2005 Eckel et al.
2005/0044617 A1 3/2005 Mueller et al.
2005/0047132 A1 3/2005 Dowling et al.
2005/0047134 A1 3/2005 Mueller et al.
2005/0062440 A1 3/2005 Lys et al.
2005/0063194 A1 3/2005 Lys et al.
2005/0078477 A1 4/2005 Lo
2005/0099824 A1 5/2005 Dowling et al.
2005/0107694 A1 5/2005 Jansen et al.
2005/0110384 A1 5/2005 Peterson
2005/0116667 A1 6/2005 Mueller et al.
2005/0128751 A1 6/2005 Roberge et al.
2005/0141225 A1 6/2005 Striebel
2005/0151489 A1 7/2005 Lys et al.
2005/0151663 A1 7/2005 Tanguay
2005/0154494 A1 7/2005 Ahmed
2005/0174473 A1 8/2005 Morgan et al.
2005/0174780 A1 8/2005 Park
2005/0184667 A1 8/2005 Sturman et al.
2005/0201112 A1 9/2005 Machi et al.
2005/0206529 A1 9/2005 St.-Germain
2005/0213320 A1 9/2005 Kazuhiro et al.
2005/0213352 A1 9/2005 Lys
2005/0213353 A1 9/2005 Lys
2005/0218838 A1 10/2005 Lys
2005/0218870 A1 10/2005 Lys
2005/0219860 A1 10/2005 Schexnaider
2005/0219872 A1 10/2005 Lys
2005/0225979 A1 10/2005 Robertson et al.
2005/0231133 A1 10/2005 Lys
2005/0236029 A1 10/2005 Dowling
2005/0236998 A1 10/2005 Mueller et al.
2005/0248299 A1 11/2005 Chemel et al.
2005/0253533 A1 11/2005 Lys et al.
2005/0259424 A1 11/2005 Zampini, II et al.
2005/0265019 A1 12/2005 Sommers et al.
2005/0275626 A1 12/2005 Mueller et al.
2005/0276051 A1 12/2005 Caudle et al.
2005/0276053 A1 12/2005 Nortrup et al.
2005/0276064 A1 12/2005 Wu et al.
2005/0285547 A1 12/2005 Piepgras et al.
2006/0002110 A1 1/2006 Dowling et al.
2006/0012987 A9 1/2006 Ducharme et al.
2006/0012997 A1 1/2006 Catalano et al.
2006/0016960 A1 1/2006 Morgan et al.
2006/0022214 A1 2/2006 Morgan et al.
2006/0028155 A1 2/2006 Young
2006/0028837 A1 2/2006 Mrakovich
2006/0034078 A1 2/2006 Kovacik et al.
2006/0050509 A9 3/2006 Dowling et al.
2006/0050514 A1 3/2006 Opolka
2006/0076908 A1 4/2006 Morgan et al.
2006/0092640 A1 5/2006 Li
2006/0098077 A1 5/2006 Dowling
2006/0104058 A1 5/2006 Chemel et al.
2006/0109648 A1 5/2006 Trenchard et al.
2006/0109649 A1 5/2006 Ducharme et al.
2006/0109661 A1 5/2006 Coushaine et al.
2006/0126325 A1 6/2006 Lefebvre et al.

2006/0126338 A1 6/2006 Mighetto
2006/0132061 A1 6/2006 McCormick et al.
2006/0132323 A1 6/2006 Grady, Jr.
2006/0146531 A1 7/2006 Reo et al.
2006/0152172 A9 7/2006 Mueller et al.
2006/0158881 A1 7/2006 Dowling
2006/0170376 A1 8/2006 Piepgras et al.
2006/0192502 A1 8/2006 Brown et al.
2006/0193131 A1 8/2006 McGrath et al.
2006/0197661 A1 9/2006 Tracy et al.
2006/0198128 A1 9/2006 Piepgras et al.
2006/0208667 A1 9/2006 Lys et al.
2006/0221606 A1 10/2006 Dowling et al.
2006/0221619 A1 10/2006 Nishigaki
2006/0232974 A1 10/2006 Lee et al.
2006/0262516 A9 11/2006 Dowling et al.
2006/0262521 A1 11/2006 Piepgras et al.
2006/0262544 A1 11/2006 Piepgras et al.
2006/0262545 A1 11/2006 Piepgras et al.
2006/0273741 A1 12/2006 Stalker, III
2006/0274529 A1 12/2006 Cao
2006/0285325 A1 12/2006 Ducharme et al.
2007/0035255 A1 2/2007 Shuster et al.
2007/0040516 A1 2/2007 Chen
2007/0041220 A1 2/2007 Lynch
2007/0047227 A1 3/2007 Ducharme
2007/0053182 A1 3/2007 Robertson
2007/0053208 A1 3/2007 Justel et al.
2007/0064419 A1 3/2007 Gandhi
2007/0064425 A1* 3/2007 Frecska et al. 362/253
2007/0070621 A1 3/2007 Rivas et al.
2007/0070631 A1 3/2007 Huang et al.
2007/0081423 A1 4/2007 Chien
2007/0086754 A1 4/2007 Lys et al.
2007/0086912 A1 4/2007 Dowling et al.
2007/0097678 A1 5/2007 Yang
2007/0109763 A1 5/2007 Wolf et al.
2007/0115658 A1 5/2007 Mueller et al.
2007/0115665 A1 5/2007 Mueller et al.
2007/0120594 A1 5/2007 Balakrishnan et al.
2007/0127234 A1 6/2007 Jervey, III
2007/0133202 A1 6/2007 Huang et al.
2007/0139938 A1 6/2007 Petroski et al.
2007/0145915 A1 6/2007 Roberge et al.
2007/0147046 A1 6/2007 Arik et al.
2007/0152797 A1 7/2007 Chemel et al.
2007/0153514 A1 7/2007 Dowling et al.
2007/0159828 A1 7/2007 Wang
2007/0165402 A1 7/2007 Weaver, Jr. et al.
2007/0173978 A1 7/2007 Fein et al.
2007/0177382 A1 8/2007 Pritchard et al.
2007/0182387 A1 8/2007 Weirich
2007/0188114 A1 8/2007 Lys et al.
2007/0188427 A1 8/2007 Lys et al.
2007/0189026 A1 8/2007 Chemel et al.
2007/0195526 A1 8/2007 Dowling et al.
2007/0195527 A1 8/2007 Russell
2007/0195532 A1 8/2007 Reisenauer et al.
2007/0205712 A1 9/2007 Radkov et al.
2007/0206375 A1 9/2007 Piepgras et al.
2007/0211463 A1 9/2007 Chevalier et al.
2007/0228999 A1 10/2007 Kit
2007/0235751 A1 10/2007 Radkov et al.
2007/0236156 A1 10/2007 Lys et al.
2007/0237284 A1 10/2007 Lys et al.
2007/0240346 A1 10/2007 Li et al.
2007/0241657 A1 10/2007 Radkov et al.
2007/0242466 A1 10/2007 Wu et al.
2007/0247842 A1 10/2007 Zampini et al.
2007/0247847 A1 10/2007 Villard
2007/0247851 A1 10/2007 Villard
2007/0258231 A1 11/2007 Koerner et al.
2007/0258240 A1 11/2007 Ducharme et al.
2007/0263379 A1 11/2007 Dowling
2007/0274070 A1 11/2007 Wedell
2007/0281520 A1 12/2007 Insalaco et al.
2007/0285926 A1 12/2007 Maxik
2007/0285933 A1 12/2007 Southard et al.
2007/0290625 A1 12/2007 He et al.
2007/0291483 A1 12/2007 Lys
2007/0296350 A1 12/2007 Maxik et al.
2008/0003664 A1 1/2008 Tysoe et al.
2008/0007945 A1 1/2008 Kelly et al.
2008/0012502 A1 1/2008 Lys
2008/0012506 A1 1/2008 Mueller et al.
2008/0013316 A1 1/2008 Chiang
2008/0013324 A1 1/2008 Yu
2008/0018261 A1 1/2008 Kastner
2008/0037245 A1 2/2008 Chan
2008/0037284 A1 2/2008 Rudisill
2008/0055894 A1* 3/2008 Deng 362/217
2008/0062680 A1 3/2008 Timmermans et al.
2008/0068838 A1* 3/2008 Galke et al. 362/250
2008/0068839 A1* 3/2008 Matheson 362/250
2008/0089075 A1 4/2008 Hsu
2008/0092800 A1 4/2008 Smith et al.
2008/0093615 A1 4/2008 Lin et al.
2008/0093998 A1 4/2008 Dennery et al.
2008/0094819 A1* 4/2008 Vaish 362/35
2008/0094837 A1* 4/2008 Dobbins et al. 362/249
2008/0130267 A1 6/2008 Dowling et al.
2008/0151535 A1 6/2008 de Castris
2008/0158871 A1 7/2008 McAvoy et al.
2008/0158887 A1 7/2008 Zhu et al.
2008/0164826 A1 7/2008 Lys
2008/0164827 A1 7/2008 Lys
2008/0164854 A1 7/2008 Lys
2008/0175003 A1 7/2008 Tsou et al.
2008/0180036 A1 7/2008 Garrity et al.
2008/0186704 A1 8/2008 Chou et al.
2008/0192436 A1 8/2008 Peng et al.
2008/0211419 A1 9/2008 Garrity
2008/0224629 A1 9/2008 Melanson
2008/0224636 A1 9/2008 Melanson
2008/0253125 A1 10/2008 Kang et al.
2008/0258647 A1 10/2008 Scianna
2008/0285257 A1 11/2008 King
2008/0290814 A1 11/2008 Leong et al.
2008/0291675 A1 11/2008 Lin et al.
2008/0298080 A1* 12/2008 Wu et al. 362/555
2008/0315784 A1 12/2008 Tseng
2009/0002995 A1 1/2009 Lee et al.
2009/0016063 A1 1/2009 Hu
2009/0046473 A1 2/2009 Tsai et al.
2009/0052186 A1 2/2009 Xue
2009/0059557 A1* 3/2009 Tanaka 362/35
2009/0067182 A1 3/2009 Hsu et al.
2009/0086492 A1 4/2009 Meyer
2009/0091938 A1 4/2009 Jacobson et al.
2009/0140285 A1 6/2009 Lin et al.
2009/0175041 A1 7/2009 Yuen et al.
2009/0185373 A1 7/2009 Grajcar
2009/0195186 A1 8/2009 Guest et al.
2009/0196034 A1 8/2009 Gherardini et al.
2009/0213588 A1 8/2009 Manes
2009/0273926 A1 11/2009 Deng
2009/0290334 A1* 11/2009 Ivey et al. 362/219
2009/0303720 A1 12/2009 McGrath
2009/0316408 A1 12/2009 Villard
2010/0019689 A1* 1/2010 Shan 315/294
2010/0027259 A1 2/2010 Simon et al.
2010/0033964 A1 2/2010 Choi et al.

FOREIGN PATENT DOCUMENTS

CN 2766345 Y 3/2006
CN 2869556 Y 2/2007
EP 0013782 B1 3/1983
EP 0091172 A2 10/1983
EP 0124924 B1 9/1987
EP 0174699 B1 11/1988
EP 0197602 B1 11/1990
EP 0214701 B1 3/1992
EP 0262713 B1 6/1992
EP 0203668 B1 2/1993
EP 0337567 B1 11/1993
EP 0390262 B1 12/1993
EP 0359329 B1 3/1994
EP 0403011 B1 4/1994

EP	0632511	A2	1/1995
EP	0432848	B1	4/1995
EP	0403001	B1	8/1995
EP	0525876	B1	5/1996
EP	0714556	B1	1/1999
EP	0458408	B1	9/1999
EP	0578302	B1	9/1999
EP	0723701	B1	1/2000
EP	0787419	B1	5/2001
EP	1195740	A2	4/2002
EP	1016062	B1	8/2002
EP	1195740	A3	1/2003
EP	1149510	B1	2/2003
EP	1056993	B1	3/2003
EP	0766436	B1	5/2003
EP	0924281	B1	5/2003
EP	0826167	B1	6/2003
EP	1147686	B1	1/2004
EP	1142452	B1	3/2004
EP	1145602	B1	3/2004
EP	1422975	A1	5/2004
EP	0890059	B1	6/2004
EP	1348319	B1	6/2005
EP	1037862	B1	7/2005
EP	1346609	B1	8/2005
EP	1321012	B1	12/2005
EP	1610593	A2	12/2005
EP	1415517	B1	5/2006
EP	1415518	B1	5/2006
EP	1438877	B1	5/2006
EP	1166604	B1	6/2006
EP	1479270	B1	7/2006
EP	1348318	B1	8/2006
EP	1399694	B1	8/2006
EP	1461980	B1	10/2006
EP	1110120	B1	4/2007
EP	1440604	B1	4/2007
EP	1047903	B1	6/2007
EP	1500307	B1	6/2007
EP	0922305	B1	8/2007
EP	0922306	B1	8/2007
EP	1194918	B1	8/2007
EP	1048085	B1	11/2007
EP	1763650	B1	12/2007
EP	1776722	B1	1/2008
EP	1459599	B1	2/2008
EP	1887836	A2	2/2008
EP	1579733	B1	4/2008
EP	1145282	B1	7/2008
EP	1518445	B1	5/2009
EP	1337784	B1	6/2009
GB	2215024	A	9/1989
GB	2324901	A	11/1998
JP	6-54103	U	7/1994
JP	H6-54103		7/1994
JP	7-249467		9/1995
JP	08-162677		6/1996
JP	11-135274	A	5/1999
JP	2001-238272	A	8/2001
JP	2002-141555	A	5/2002
JP	3098271	U	2/2004
JP	2004-335426		11/2004
JP	2005-158363	A	6/2005
JP	2005-166617	A	6/2005
JP	2005-347214	A	12/2005
JP	2006-507641	A	3/2006
JP	3139714	U	2/2008
KR	10-2004-0008244	A	1/2004
KR	20-0430022	Y1	11/2006
KR	10-0781652	B1	12/2007
TW	M337036		7/2008
WO	9906759	A1	2/1999
WO	99/10867	A1	3/1999
WO	99/31560	A2	6/1999
WO	00/01067	A2	1/2000
WO	02/25842	A2	3/2002
WO	02/061330	A2	8/2002
WO	02/069306	A2	9/2002
WO	02/091805	A2	11/2002
WO	02/098182	A2	12/2002
WO	02/099780	A2	12/2002
WO	03/026358	A1	3/2003
WO	03/055273	A2	7/2003
WO	03/067934	A2	8/2003
WO	03/090890	A1	11/2003
WO	03/096761	A1	11/2003
WO	2004/021747	A2	3/2004
WO	2004/023850	A2	3/2004
WO	2004/032572	A2	4/2004
WO	2004/100624	A2	11/2004
WO	2005031860	A2	4/2005
WO	2005/052751	A2	6/2005
WO	2005/060309	A2	6/2005
WO	2005/084339	A2	9/2005
WO	2005/089293	A2	9/2005
WO	2005/089309	A2	9/2005
WO	2006/023149	A2	3/2006
WO	2006044328	A1	4/2006
WO	WO 2006/056120	A1 *	6/2006
WO	2006/093889	A2	9/2006
WO	2006/127666	A2	11/2006
WO	2006/127785	A2	11/2006
WO	2006/133272	A2	12/2006
WO	2006137686	A1	12/2006
WO	2007/081674	A1	7/2007
WO	2007/094810	A2	8/2007
WO	2007090292	A1	8/2007
WO	2010/030509	A2	3/2010

OTHER PUBLICATIONS

Experiment Electronic Ballast. Electronic Ballast for Fluorescent Lamps [online], Revised Fall of 2007. [Retrieved on Sep. 1, 1997]. Retrieved from Virginia Tech Web Page using Internet <URL: http://www.ece.vt.edu/ece3354/labs/ballast.pdf.>.

Truck-Lite, LEDSelect—LED, Model 35, Clearance & Marker Lighting, [online], [retrieved on Jan. 13, 2000] Retrieved from Truck-Lite Web Page using Internet <URL: http://trucklite.com/leds14.html>.

Truck-Lite, LEDSelect—LED, Super 44, Stop, Turn & Tail Lighting, [online], [retrieved on Jan. 13, 2000] Retrieved from Truck-Lite Web Page using Internet <URL: http://trucklite.com/leds2.html>.

Truck-Lite, LEDSelect—LED, Model 45, Stop, Turn & Tail Lighting [online], [retrieved on Jan. 13, 2000] Retrieved from Truck-Lite Web Page using Internet <URL: http://trucklite.com/leds4.html>.

Telecite Products & Services—Display Options, [online], [retrieved on Jan. 13, 2000] Retrieved from Telecite Web page using Internet <URL: http://www.telecite.com/en/products/options en.htm>.

Traffic Signal Products—Transportation Products Group, [online], [retrieved on Jan. 13, 2000] Retrieved from the Dialight Web Page using Internet <URL: http://www.dialight.com/trans.htm>.

LED Lights, Replacement LED lamps for any incandescent light, [online], [retrieved on Jan. 13, 2000] Retrieved from LED Lights Web Page using Internet <URL: http://www.ledlights.com/replac.htm>.

LEDtronics, LEDtronics Catalog, 1996, p. 10, LEDtronics, Torrance, California.

Piper. The Best Path to Efficiency. Building Operating Management, Trade Press Publishing Company May 2000 [online], [retrieved on Jan. 17, 2008]. Retrieved from Find Articles Web Page using Internet <URL:http://findarticles.com/p/articles/mi__qu3922/is__200005/ai__n8899499/>.

Henson, Keith. The Benefits of Building Systems Integration, Access Control & Security Systems Integration, Oct. 1, 2000, Penton Media. [online], [retrieved on Oct. 24, 2008] Retrieved from Security Solutions Web page using Internet <URL: http://securitysolutions.com/mag/security__benefits__building__systems/>.

Phason Electronic Control Systems, Light Level Controller (LLC) case study. Nov. 30, 2004. 3 pages, Phason Inc., Winnipeg, Manitoba, Canada.

Airport International. Fly High With Intelligent Airport Building and Security Solutions [online], [retrieved on Oct. 24, 2008]. Retrieved from Airport International web page using Internet <URL: http://www.airport-int.com/categories/airport-building-and-security-solutions/fly-high-with-intelligent-airport-building-and-security-solutions.html>.

Spencer, Eugene. High Sales, Low Utilization. Green Intelligent Buildings, Feb. 1, 2007. [online]. Retrieved from Green Intelligent Buildings web page using Internet <URL: http://www.greenintelligentbuildings.com/CDA/IBT_Archive/BNP_GUID_9-5-2006_A_10000000000000056772>.
Sensor Switch, nLight Lighting Control System, [online], [retrieved on Jan. 11, 2008] Retrieved from Sensor Switch web page using Internet <URL: http://www.sensorswitch.com>.
Six Strategies, [online], [retrieved on Jan. 11, 2008] Retrieved from Encelium Technologies Inc. Web Page using Internet <URL: http://www.enceliurn.com/products/strategies.html>.
Lawrence Berkeley National Labratory. Lighting Control System—Phase Cut Carrier. University of California, [online] [retrieved on Jan. 14, 2008] Retrieved from Lawrence Berkeley National Labratory web page using Internet <URL: http://www.lbl.gov/tt/techs/lbnl1871.html>.
Best Practice Guide—Commercial Office Buildings—Central HVAC System. [online], [Retrieved on Jan. 17, 2008] Retrieved from Flex Your Power Organization web page using Internet <URL: http://www.fypower.org/bpg/module.html?b=offices&m+Central HVAC Systems&s=Contr...>.
Cornell University. Light Canopy—Cornell University Solar Decathlon, [online], [retrieved on Jan. 17, 2008] Retrieved from Cornell University web page using Internet <URL: http://cusd.cornell.edu/cusd/web/index.php/page/show/section/Design/page/controls>.
D.N.A.—III, [online], [retrieved Mar. 10, 2009] Retrieved from the PLC Lighting Web Page using Internet <URL: http://www.plclighting.com/product_info.php?cPath=1&products_id=92>.
E22201-44 Esprit Collection, [online],, [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: http://www.et2online.com/proddetail.aspx?ItemID=E22201-44>.
E20116-18 Larmes Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: http://www.et2online.com/proddetail.aspx?ItemID=E20116-18>.
E20112-22 Starburst Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: http://www.et2online.com/proddetail.aspx?ItemID=E20112-22>.
E20743-09 Stealth Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: http://www.et2online.com/proddetail.aspx?ItemID=E20743-09>.
E20524-10 & E20525-10 Curva Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: http//www.et2online.com/proddetail.aspx?ItemID=E20524-10&20525-10>.

* cited by examiner

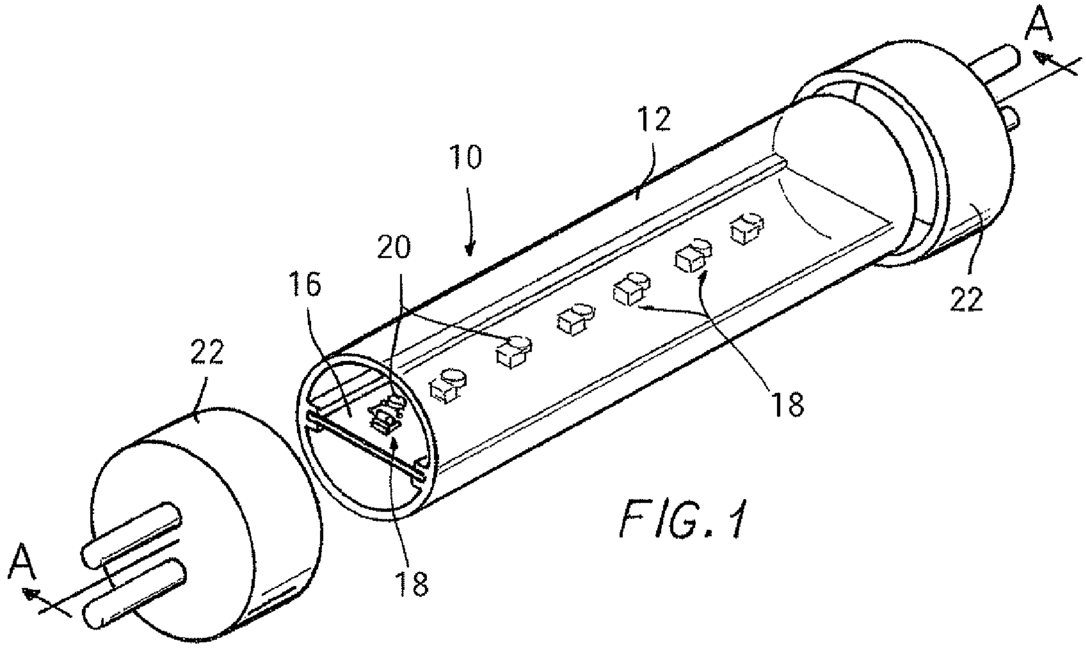


FIG. 1

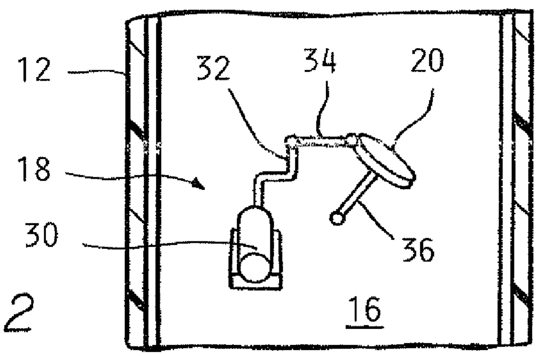


FIG. 2

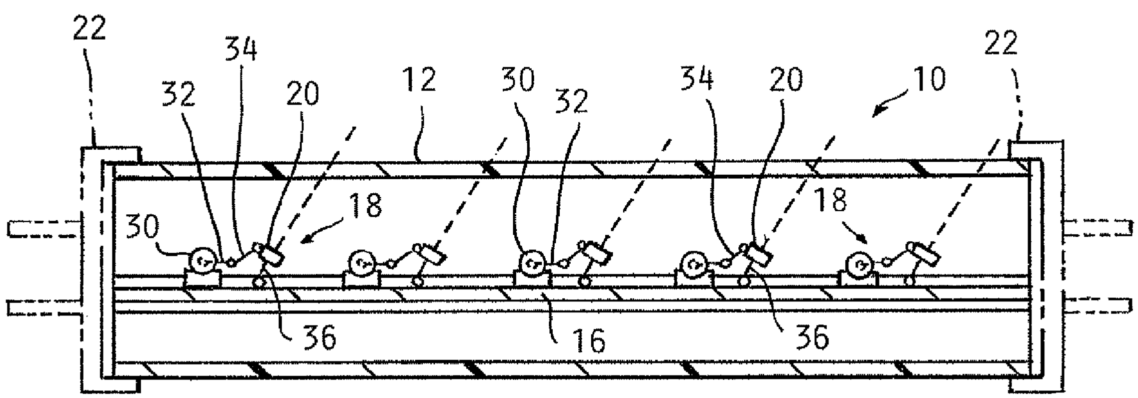


FIG 3A

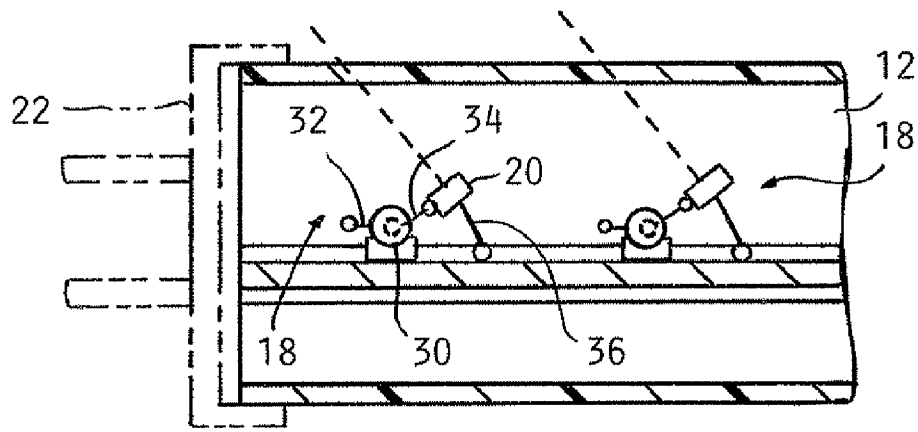


FIG. 3B

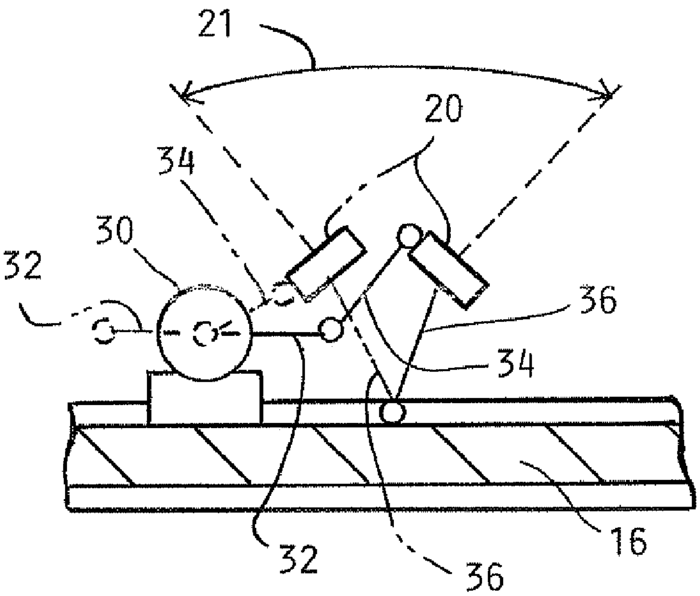


FIG. 4

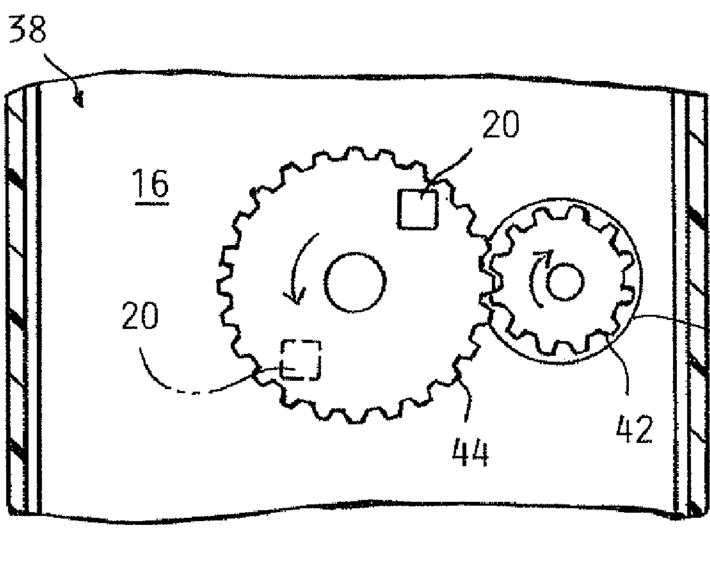


FIG. 5

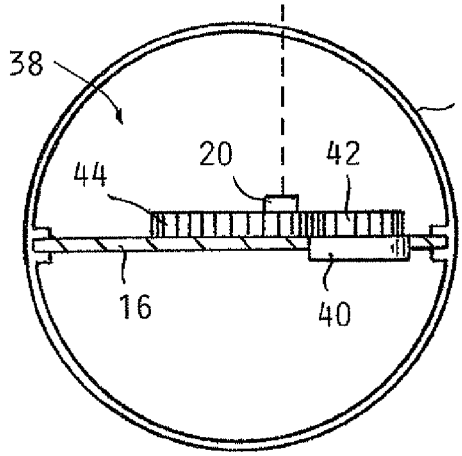


FIG 6A

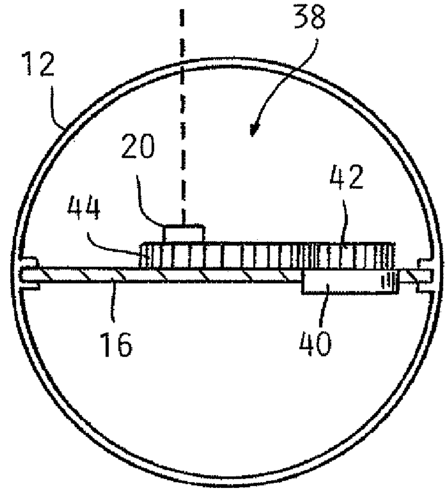


FIG. 6B

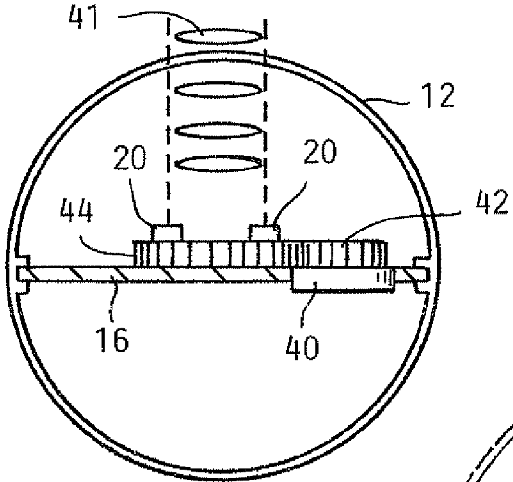


FIG. 7

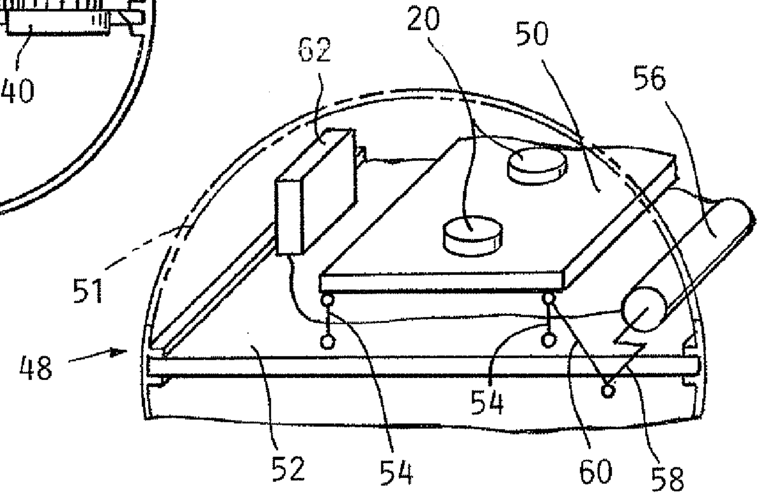


FIG. 8

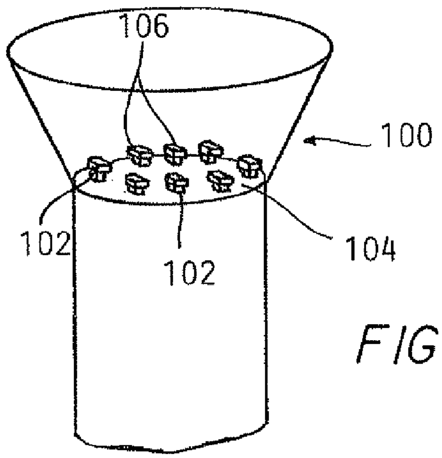


FIG. 9

LED-BASED LIGHT HAVING RAPIDLY OSCILLATING LEDS

TECHNICAL FIELD

The invention relates to a light emitting diode (LED) based light, for example, an LED-based light usable in a fluorescent light fixture in place of a conventional fluorescent tube.

BACKGROUND

Fluorescent tubes are widely used in a variety of locations, such as schools and office buildings. Although conventional fluorescent tubes have certain advantages over, for example, incandescent lights, they also pose certain disadvantages including, inter alia, disposal problems due to the presence of toxic materials within the glass tube.

Tube shaped LED lights which can be used as one-for-one replacements for fluorescent tubes have appeared in recent years. Many LED-based lights shaped to replace fluorescent tubes are constrained by the directional light output of their LEDs, in contrast to the uniform non-directional light output of fluorescent tubes.

BRIEF SUMMARY

Oscillating an LED can reduce the appearance of point sources of light by producing a light blurring effect. In one example, an LED-based light is provided including a support structure, at least one oscillator connected to the support structure, and at least one LED coupled to each oscillator.

In another example, a replacement light for a conventional fluorescent tube usable in a fluorescent fixture is provided. The replacement light includes a support structure and at least one oscillator connected to the support structure. At least one LED is coupled to each oscillator, and at least one electrical connector at a longitudinal end of the support structure is in electrical communication with the at least one LED.

In yet another example, a method of distributing light produced by LEDs in an LED-based light usable in a fluorescent fixture is provided. The method includes providing at least one microelectromechanical system. The method also includes connecting the LEDs to the at least one microelectromechanical system and energizing the at least one microelectromechanical system during operation of the LEDs to move the LEDs at a sufficient speed to produce a light blurring effect.

BRIEF DESCRIPTION OF THE DRAWINGS

The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

FIG. **1** is an exploded schematic of an example of an LED-based replacement light;

FIG. **2** is a schematic of an example of an oscillator;

FIGS. **3**A and **3**B are a cross section view with LEDs in a first position and a partial cross section view with the LEDs in a second position, respectively, of the light of FIG. **1** along line A-A;

FIG. **4** is a partial cross section view the light of FIG. **1** along light A-A showing a distribution of light produced by the LEDs during oscillation, with the LED in the second position shown in phantom;

FIG. **5** is a partial schematic of another example of an oscillator;

FIGS. **6**A and **6**B are end views of a housing of an example of an LED-based light including the oscillator of FIG. **5**;

FIG. **7** is an end view of the housing of FIGS. **6**A and **6**B showing a distribution of light produced by the LEDs during oscillation;

FIG. **8** is a partial schematic of yet another example of an oscillator; and

FIG. **9** is a partial perspective view of a flashlight.

DETAILED DESCRIPTION

FIGS. **1-9** illustrate examples of LED-based lights. In the example illustrated in FIG. **1**, a light **10** is configured as a replacement for a fluorescent tube in a fluorescent fixture. The light **10** includes a housing **12**, a circuit board **16** in the housing **12**, multiple microelectromechanical systems (MEMS) **18** spaced along the circuit board **16**, an LED **20** attached to each MEMS **18**, and two bi-pin end caps **22**.

The housing **12** as shown in FIG. **1** is a light transmitting cylindrical tube. The housing **12** can be made from polycarbonate, acrylic, glass or another light transmitting material (i.e., the housing **12** can be transparent or translucent). For example, a translucent housing **12** can be made from a composite, such as polycarbonate with particles of a light refracting material interspersed in the polycarbonate. While the illustrated housing **12** is cylindrical, the housing **12** can alternatively have a square, triangular, polygonal, or other cross sectional shape. Similarly, while the illustrated housing **12** is linear, the housing **12** can have an alternative shape, e.g., a U-shape or a circular shape. Additionally, the housing **12** need not be a single piece as shown in FIG. **1**. Instead, the housing **12** can be formed by attaching multiple individual parts, not all of which need be light transmitting. For example, the housing **12** can include a lower portion and a lens attached to the lower portion to cover the LEDs **20**. The housing **12** can be manufactured to include light diffusing or refracting properties, such as by surface roughening or applying a diffusing film to the housing **12**. The housing **12** can have a length such that the light **10** is approximately 48" long, and the housing **12** can have a 0.625", 1.0", or 1.5" diameter for engagement with common fluorescent fixtures.

The circuit board **16** as illustrated in FIG. **1** is an elongate printed circuit board. Multiple circuit board sections can be joined by bridge connectors to create the circuit board **16**. The circuit board **16** as shown in FIG. **1** is slidably engaged with the housing **12**, though the circuit board **16** can alternatively be clipped, adhered, snap- or friction-fit, screwed or otherwise connected to the housing **12**. For example, the circuit board **16** can be mounted on a heat sink that is attached to the housing **12**. Also, other types of circuit boards may be used, such as a metal core circuit board. Or, instead of a circuit board **16**, other types of electrical connections (e.g., wires) can be used to electrically connect the MEMS **18** and/or LEDs **20** to a power source.

The LEDs **20** can be surface-mount devices of a type available from Nichia, though other types of LEDs can alternatively be used. For example, although surface-mounted LEDs **20** are shown, one or more organic LEDs can be used in place of or in addition thereto. The LEDs **20** can be mounted to the MEMS **18** as described above. The LEDs **20** can emit white light. However, LEDs that emit blue light, ultra-violet light or other wavelengths of light can be used in place of white light emitting LEDs **20**.

The number of LEDs **20** can be a function of the desired power of the light **10** and the power of the LEDs **20**. For a 48" light, such as the light **10**, the number of LEDs **20** can vary from about five to four hundred such that the light **10** outputs approximately 500 to 3,000 lumens. However, a different number of LEDs **20** can alternatively be used, and the light **10** can output another amount of lumens. The LEDs **20** can be evenly spaced along the circuit board **16**, and the spacing of the LEDs **20** can be determined based on, for example, the light distribution of each LED **20** and the number of LEDs **20**.

As shown in FIG. **2**, the MEMS **18** can include a motor **30**, a cam **32**, a link **34**, and a lever **36**. The motor **30** can be in electrical communication with the end caps **22**. Alternatively, the motor **30** can be powered by another power source, e.g., a battery. The motor **30** can be a variable speed motor. The cam **32** can be coupled to the motor **30**, either directly or through a transmission. The link **34** can couple the cam **32** to the lever **36**, with opposing ends of the link **34** pivotally coupled to the cam **32** and lever **36** respectively. The lever **36** can be pivotally coupled to the circuit board **16**. An LED **20** can be attached to the distal end of the lever **36**, for example by adhering the LED **20** to the lever **36** or a snap-fit between the LED **20** and a platform at the distal end of the lever **36**. However, the lever **36** and LED **20** can alternatively be attached to a support structure other than the circuit board **16**, such as the housing **12**, a heat sink, or a beam extending through the housing **12**.

During operation, a current can be applied to the motor **30** to operate the motor **30** and rotate the cam **32**. Rotation of the cam **32** can be transmitted to the lever **36** via the link **34**. As a result, the distal end of the lever **36** can be oscillated between a first position shown in FIG. **3**A and a second position as shown in FIG. **3**B. The LEDs **20** can thus be oscillated parallel to a longitudinal axis of the housing **12**, as obtaining a uniform distribution of light from LEDs **20** along a length of the housing **12** is often more difficult than obtaining a uniform distribution of light around an arc of the housing **12**. However, the LEDs **20** can be oscillated in a different direction, e.g., perpendicular to the longitudinal axis of the housing **12**. Also, the LEDs **20** can be oscillated to another position in addition to the first and second positions, e.g., the LEDs **20** can be oscillated in an L-shaped pattern including three positions or in a circular pattern as described in another example below including an infinite number of positions.

The speed of the motor **30** can be set high enough such that the LED **20** moves at a sufficiently rapid speed to produce a light blurring effect. That is, the LED **20** can be moved at a sufficiently high speed such that a human eye perceives the LED **20** as producing a larger distribution of light than if the LED **20** were stationary. Thus, by mounting the light on the MEMS **18** as shown in FIG. **2**, the LED **20** can appear as a line of light **21** as shown in FIG. **4** extending between the LED **20** in the first position and the LED **20** shown in phantom in the second position.

Regarding the MEMS **18**, structures are generally classified as microelectromechanical systems based on their size. For example, a structure smaller than a few millimeters in size (e.g., a structure less than a millimeter in length) can be deemed a microelectromechanical system. However, as used herein, the term “microelectromechanical system” is not intended to require any specific size limitation. That is, no bright line is intended between a structure that is small enough to be considered a microelectromechanical system and a structure that is not considered a microelectromechanical system. Instead, the term “microelectromechanical system” refers to a system having a size of similar magnitude to the size of the LED **20** attached thereto or smaller.

The light **10** can include two bi-pin end caps **22** (i.e., each end cap **22** can carry two pins), one at each longitudinal end of the housing **12**, for physically and electrically connecting the light **10** to a fluorescent fixture. The end caps **22** can be electrically connected to the circuit board **16** to provide power to the MEMS **18** and LEDs **20**. Each end cap **22** can include two pins, though two of the total four pins can be “dummy pins” that do not provide an electrical connection. Alternatively, other types of electrical connectors can be used, such as an end cap carrying a single pin. Also, while the end caps **22** are shown as including cup-shaped bodies, the end caps **22** can have a different configuration (e.g., the end caps **22** can be shaped to be press fit into the housing **12**).

An oscillator other than the MEMS **18** can be used. For example, FIG. **5** shows a MEMS **38** including a motor **40** attached to an aperture defined by the circuit board **16**, a pinion gear **42** coupled to the motor **40**, a spur gear **44** meshed with the pinion gear **42**, and an LED **20** in a first position and a phantom LED **20** in a second position attached to the spur gear **44**. Operating the motor **40** can cause the pinion gear **42** to rotate, which in turn can cause the spur gear **44** to rotate. Rotation of the spur gear **44** can move the LED **20** in a circular pattern, with the first and second positions of the LED **20** shown in FIGS. **6**A and **6**B. The MEMS **38** can cause the LED **20** to appear as a circular source of light as shown by a circular line **41** in FIG. **7** instead of a point source of light.

Alternatively, structures other than microelectromechanical systems can be used as oscillators. For example, FIG. **8** shows a light **48** including a circuit board **50** pivotally mounted by a pair of levers **54** to a support **52** slidably engaged with a housing **51**. Multiple LEDs **20** can be mounted on the circuit board **50**. A motor **56** can be attached to the support **52**, and a cam **58** can be coupled to the motor **56**. The cam **58** can be coupled to the circuit board **50** by a link **60**. Operation of the motor **56** can rotate the cam **58**, and the link **60** can transmit motion from the cam **58** to the circuit board **50**. As a result, the entire circuit board **50**, as well as the LEDs **20** mounted thereon, can be oscillated. The motor **56** can be operated to rotate at a sufficient speed that the LEDs **20** move fast enough to produce a light blurring effect. Also, the levers **54**, motor **56**, cam **58**, and link **60** can be large enough that they are not considered MEMS. For example, the motor **56** can be substantially larger than one of the LEDs **20**.

Additionally, the light **48** in FIG. **8** can include a controller **62**. The controller **62** can be in electrical communication the motor **56**, and it can also be in electrical communication with a power source, such as the end caps **22**. The controller **62** can control the rotational speed of the motor **56** by governing the current supplied to the motor **56**. As a result, the controller **62** can control an oscillation frequency of the LEDs **20**, which can alter the appearance of the light produced by the LEDs **20**. The controller **62** can include a CPU and memory, and operation of the controller **62** can be controlled by a switch on the light **48**, remotely, or internally by a program stored on the memory. Additionally, the controller **62** can be in communication with the LEDs **20** to vary the output of the LEDs **20** during operation, for example.

While the above described embodiments illustrate the use of oscillators in lights shaped to replace fluorescent tubes, LEDs can also be mounted on oscillators in other types of light, such as vehicle lights, table lights, street lights, and lights designed to replace incandescent bulbs. As a further example, FIG. **9** illustrates a flashlight **100** including multiple MEMS **102** mounted on a base plate **104**. The base plate **104** can be any type of support structure, for example a plastic piece beneath a lens of the flashlight **100**. An LED **106** can be connected to each MEMS **102**. The MEMS **102** can oscillate the LEDs **106**, either by rotating the LEDs **106**, translating the LED **106**, moving the LEDs **106** using a combination of translation and rotation, moving a support structure to which all the LEDs **106** are connected, or otherwise moving the

LEDs **106**, in order to produce a light blurring effect. As a result, the flashlight **100** can produce light with a wide viewing angle.

The above-described embodiments have been described in order to allow easy understanding of the invention and do not limit the invention. On the contrary, the invention is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structure as is permitted under the law.

What is claimed is:

1. An LED-based light comprising:

a support structure;

a plurality of oscillators connected to and substantially evenly spaced along the support structure, the plurality of oscillators each including a microelectromechanical system;

a plurality of LEDs, wherein each of substantially all of the plurality of oscillators is coupled to at least one LED of the plurality of LEDs; and

a light transmitting lens enclosing the plurality of LEDs;

wherein each microelectromechanical system is a smaller or a substantially similar size than its corresponding at least one LED and is operative in response to a current to continuously move the at least one LED between at least a first position and a second position during operation of the at least one LED at a sufficient speed to produce a light blurring effect; and

wherein a light produced by the plurality of LEDs and transmitted through the lens is substantially uniformly distributed.

2. The LED-based light of claim **1**, wherein a longitudinal axis of alight emitted from the at least one LED at the first position is at an angle with the longitudinal axis of the light emitted from the at least one LED at the second position.

3. The LED-based light of claim **1**, further comprising:

a plurality of circuit boards, wherein each of least some of the plurality of oscillators is connected to at least one of the plurality of circuit boards for movement of the at least one circuit board relative to the support structure, and wherein the at least one LED is mounted on the circuit board for movement with respect to the support structure between the first position and the second position.

4. The LED-based light of claim **1**, further comprising:

a tubular housing; and

two pin-carrying end caps connected to opposing ends of the housing; with at least one of the end caps in electrical communication with the LEDs; and

wherein the support structure includes a circuit board positioned in the tubular housing.

5. The LED-based light of claim **4** wherein at least one of the pin-carrying end caps is in electrical communication with the plurality of oscillators.

6. The LED-based light of claim **1**, wherein the plurality of oscillators are evenly spaced along a length of the support structure.

7. The LED-based light of claim **1**, wherein the plurality of oscillators are evenly spaced along a circumference of the support structure.

8. The LED-based light of claim **1**, wherein at least one of the microelectromechanical systems includes a cam, a motor and a lever wherein:

the motor is coupled to the cam and operable to rotate the cam in response to the current and the lever is pivotally coupled between the cam and the support structure and operable to move the at least one LED between the first position and the second position upon rotation of the cam.

9. The LED-based light of claim **1**, wherein at least one of the substantially all of the plurality of oscillators is coupled to a single LED.

10. A replacement light for a conventional fluorescent tube usable in a fluorescent fixture comprising:

a support structure;

a plurality of oscillators connected to the support structure, the plurality of oscillators each including a microelectromechanical system;

a plurality of LEDs, wherein each of substantially all of the plurality of oscillators is coupled to at least one LED of the plurality of LEDs;

wherein each microelectromechanical system is a smaller or a substantially similar size than its corresponding at least one LED and is operative in response to a current to continuously move the at least one LED between at least a first position and a second position during operation of the at least one LED at a sufficient speed to produce a light blurring effect between the first and second positions;

a light transmitting lens enclosing the at least one LED, wherein alight produced by the plurality of LEDs and transmitted through the lens is substantially uniformly distributed about the lens; and

at least one electrical connector at a longitudinal end of the support structure in electrical communication with the at least one LED.

11. The LED-based light of claim **10**, wherein a longitudinal axis of a light emitted from the at least one LED at the first position is at an angle with the longitudinal axis of the light emitted from the at least one LED at the second position, a line of light forming between the axes; and wherein lines of light produced by the plurality of LEDs are aligned such that the light produced by the plurality of LEDs substantially uniformly distributed along a longitudinal length of the light.

12. The LED-based light of claim **11**, wherein the lens is configured to radially distribute the lines of light produced by the plurality of LEDs.

13. The LED-based light of claim **10**, further comprising:

a plurality of circuit boards, wherein each of at least some of the plurality of oscillators includes at least one of the plurality of circuit boards for movement of the at least one circuit board relative to the support structure, and wherein the at least one LED is mounted on the circuit board for movement with respect to the support structure between the first position and the second position.

14. The LED-based light of claim **10**, wherein the at least one electrical connector is further in electrical communication with the plurality of oscillators.

15. The LED-based fight of claim **10**, wherein the support structure includes a circuit board; and wherein the at least one electrical connector includes a pair of pin-carrying end caps.

16. A method of distributing light produced by a plurality of LEDs in an LED-based light usable in a fluorescent fixture, the method comprising:

providing a plurality of microelectromechanical systems;

connecting each of substantially all of the plurality of microelectromechanical systems to at least one of the plurality of LEDs;

mounting the plurality of microelectromechanical systems along a support structure; and

providing electrical connections to permit powering of the plurality of microelectromechanical systems during operation to continuos oscillate the plurality of LEDs at a sufficient speed to produce a light blurring effect during operation;

wherein the plurality of LEDs are positioned about the support structure in a sufficient number such that a substantially uniform and non-directional light is produced by the plurality of oscillating LEDs.

17. The method of claim **16**, further comprising

enabling the angle of orientation of the plurality of LEDs to change during their operation.

18. The method of claim **16**, wherein providing electrical connections comprises:

providing electrical connections to permit power of the plurality of microelectromechanical systems and the plurality of LEDs by a common power source.

19. The method of claim **16**, further comprising:

providing a controller configured to vary an oscillation frequency of the at least one microelectromechanical system.

20. The method of claim **16**, further comprising:

providing a microelectromechanical motor configured to drive the microelectromechanical system.

* * * * *