



US008596550B2

(12) **United States Patent**
Steinberg et al.

(10) **Patent No.:** **US 8,596,550 B2**
(45) **Date of Patent:** **Dec. 3, 2013**

(54) **SYSTEM, METHOD AND APPARATUS FOR IDENTIFYING MANUAL INPUTS TO AND ADAPTIVE PROGRAMMING OF A THERMOSTAT**

(75) Inventors: **John Douglas Steinberg**, Millbrae, CA (US); **Scott Douglas Hublou**, Redwood City, CA (US); **Leo Cheung**, Sunnyvale, CA (US)

(73) Assignee: **EcoFactor, Inc.**, Millbrae, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 866 days.

(21) Appl. No.: **12/778,052**

(22) Filed: **May 11, 2010**

(65) **Prior Publication Data**
US 2010/0308119 A1 Dec. 9, 2010

Related U.S. Application Data
(60) Provisional application No. 61/215,999, filed on May 12, 2009.

(51) **Int. Cl.**
G05D 23/00 (2006.01)

(52) **U.S. Cl.**
USPC **236/1 C**; 236/51; 236/94; 62/161; 700/278

(58) **Field of Classification Search**
USPC 236/1 C, 46 R, 51, 94; 62/161, 163; 700/276, 278
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

4,136,732 A 1/1979 Demaray et al.
4,341,345 A 7/1982 Hammer et al.

4,403,644 A 9/1983 Hebert
4,475,685 A 10/1984 Grimado et al.
4,655,279 A 4/1987 Harmon
4,674,027 A 6/1987 Beckey
4,897,798 A * 1/1990 Cler 700/276
5,244,146 A 9/1993 Jefferson et al.
5,270,952 A 12/1993 Adams et al.
5,314,004 A 5/1994 Strand et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0415747 3/1991
KR 10-1994-0011902 6/1994
KR 10-2000-0059532 10/2000

OTHER PUBLICATIONS

Honeywell, W7600/W7620 Controller Reference Manual, HWO021207, Oct. 1992.

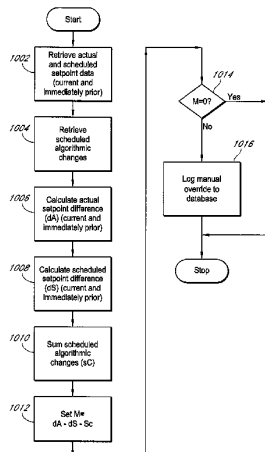
(Continued)

Primary Examiner — Marc Norman
(74) *Attorney, Agent, or Firm* — Knobbe, Martens, Olson & Bear, LLP

(57) **ABSTRACT**

Systems and methods are disclosed for incorporating manual changes to the setpoint for a thermostatic controller into long-term programming of the thermostatic controller. For example, one or more of the exemplary systems compares the actual setpoint at a given time for the thermostatic controller to an expected setpoint for the thermostatic controller in light of the scheduled programming. A determination is then made as to whether the actual setpoint and the expected setpoint are the same or different. Furthermore, a manual change to the actual setpoint for the thermostatic controller is compared to previously recorded setpoint data for the thermostatic controller. At least one rule is then applied for the interpretation of the manual change in light of the previously recorded setpoint data.

23 Claims, 11 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

5,462,225 A	10/1995	Massara et al.	7,894,943 B2	2/2011	Sloup et al.
5,544,036 A	8/1996	Brown et al.	7,908,116 B2	3/2011	Steinberg et al.
5,555,927 A	9/1996	Shah	7,908,117 B2	3/2011	Steinberg et al.
5,572,438 A	11/1996	Ehlers et al.	8,010,237 B2	8/2011	Cheung et al.
5,682,949 A	11/1997	Ratcliffe et al.	8,019,567 B2	9/2011	Steinberg et al.
5,717,609 A	2/1998	Packa et al.	8,090,477 B1	1/2012	Steinberg
5,818,347 A	10/1998	Dolan et al.	8,131,497 B2	3/2012	Steinberg et al.
5,977,964 A	11/1999	Williams et al.	8,131,506 B2	3/2012	Steinberg et al.
6,115,713 A	9/2000	Pascucci et al.	8,180,492 B2	5/2012	Steinberg
6,145,751 A	11/2000	Ahmed	8,340,826 B2	12/2012	Steinberg
6,178,362 B1	1/2001	Woolard et al.	8,457,797 B2	6/2013	Imes et al.
6,260,765 B1	7/2001	Natale et al.	2003/0040934 A1	2/2003	Skidmore et al.
6,351,693 B1	2/2002	Monie	2004/0176880 A1	9/2004	Obradovich et al.
6,400,956 B1	6/2002	Richton	2005/0222889 A1	10/2005	Lai et al.
6,400,996 B1	6/2002	Hoffberg et al.	2005/0288822 A1	12/2005	Rayburn
6,437,692 B1	8/2002	Petite et al.	2006/0045105 A1	3/2006	Dobosz et al.
6,454,177 B1 *	9/2002	Sasao et al. 236/46 R	2006/0214014 A1	9/2006	Bash et al.
6,478,233 B1	11/2002	Shah	2007/0043477 A1	2/2007	Ehlers et al.
6,480,803 B1	11/2002	Pierret et al.	2007/0045431 A1	3/2007	Chapman et al.
6,483,906 B1	11/2002	Lggulden et al.	2007/0146126 A1	6/2007	Wang
6,536,675 B1	3/2003	Pesko et al.	2008/0083234 A1	4/2008	Krebs et al.
6,542,076 B1	4/2003	Joao	2008/0198549 A1	8/2008	Rasmussen et al.
6,549,130 B1	4/2003	Joao	2008/0281472 A1	11/2008	Podgorny et al.
6,574,537 B2	6/2003	Kipersztok et al.	2009/0052859 A1	2/2009	Greenberger et al.
6,580,950 B1	6/2003	Johnson	2009/0099699 A1	4/2009	Steinberg et al.
6,594,825 B1	7/2003	GoldschmidtIki et al.	2009/0125151 A1	5/2009	Steinberg et al.
6,595,430 B1	7/2003	Shah	2009/0240381 A1	9/2009	Lane
6,598,056 B1	7/2003	Hull et al.	2009/0281667 A1	11/2009	Masui et al.
6,619,555 B2	9/2003	Rosen	2010/0019052 A1	1/2010	Yip
6,622,097 B2	9/2003	Hunter	2010/0070086 A1	3/2010	Harrod et al.
6,622,115 B1	9/2003	Brown et al.	2010/0070089 A1	3/2010	Harrod et al.
6,622,925 B2	9/2003	Carnier et al.	2010/0070093 A1	3/2010	Harrod et al.
6,622,926 B1	9/2003	Sartain et al.	2010/0156608 A1	6/2010	Bae et al.
6,628,997 B1	9/2003	Fox et al.	2010/0162285 A1	6/2010	Cohen et al.
6,633,823 B2	10/2003	Bartone et al.	2010/0211224 A1	8/2010	Keeling et al.
6,643,567 B2	11/2003	Kolk et al.	2010/0235004 A1	9/2010	Thind
6,671,586 B2	12/2003	Davis et al.	2010/0282857 A1	11/2010	Steinberg
6,695,218 B2	2/2004	Fleckenstein	2010/0289643 A1	11/2010	Trundle et al.
6,726,113 B2	4/2004	Guo	2010/0308119 A1	12/2010	Steinberg et al.
6,731,992 B1	5/2004	Ziegler	2010/0318227 A1	12/2010	Steinberg et al.
6,734,806 B1	5/2004	Cratsley	2011/0031323 A1	2/2011	Nold et al.
6,772,052 B1	8/2004	Amundsen	2011/0046792 A1	2/2011	Imes et al.
6,785,592 B1	8/2004	Smith	2011/0046798 A1	2/2011	Imes et al.
6,785,630 B2	8/2004	Kolk	2011/0046799 A1	2/2011	Imes et al.
6,789,739 B2	9/2004	Rosen	2011/0046800 A1	2/2011	Imes et al.
6,853,959 B2	2/2005	Ikedo et al.	2011/0046801 A1	2/2011	Imes et al.
6,868,293 B1	3/2005	Schurr	2011/0051823 A1	3/2011	Imes et al.
6,868,319 B2	3/2005	Kipersztok et al.	2011/0054699 A1	3/2011	Imes et al.
6,882,712 B1	4/2005	Iggulden et al.	2011/0054710 A1	3/2011	Imes et al.
6,889,908 B2	5/2005	Crippen et al.	2011/0173542 A1	7/2011	Imes et al.
6,891,838 B1	5/2005	Petite et al.	2011/0202185 A1	8/2011	Imes et al.
6,912,429 B1	6/2005	Bilger	2011/0214060 A1	9/2011	Imes et al.
6,991,029 B2	1/2006	Orfield et al.	2011/0224838 A1	9/2011	Imes et al.
7,009,493 B2	3/2006	Howard et al.	2011/0246898 A1	10/2011	Imes et al.
7,031,880 B1	4/2006	Seem et al.	2011/0290893 A1	12/2011	Steinberg
7,039,532 B2	5/2006	Hunter	2011/0307101 A1	12/2011	Imes et al.
7,061,393 B2	6/2006	Buckingham et al.	2011/0307103 A1	12/2011	Cheung et al.
7,089,088 B2	8/2006	Terry et al.	2012/0023225 A1	1/2012	Imes et al.
7,130,719 B2	10/2006	Ehlers et al.	2012/0046859 A1	2/2012	Imes et al.
7,130,832 B2	10/2006	Bannai et al.	2012/0064923 A1	3/2012	Imes et al.
H2176 H	12/2006	Meyer et al.	2012/0065935 A1	3/2012	Steinberg et al.
7,167,079 B2	1/2007	Smyth et al.	2012/0072033 A1	3/2012	Imes et al.
7,187,986 B2	3/2007	Johnson et al.	2012/0086562 A1	4/2012	Steinberg
7,205,892 B2	4/2007	Luebke et al.	2012/0093141 A1	4/2012	Imes et al.
7,215,746 B2	5/2007	Iggulden et al.	2012/0101637 A1	4/2012	Imes et al.
7,216,015 B2	5/2007	Poth	2012/0135759 A1	5/2012	Imes et al.
7,231,424 B2	6/2007	Bodin et al.	2012/0158350 A1	6/2012	Steinberg et al.
7,232,075 B1	6/2007	Rosen	2012/0215725 A1	8/2012	Imes et al.
7,242,988 B1	7/2007	Hoffberg et al.	2012/0221151 A1	8/2012	Steinberg
7,260,823 B2	8/2007	Schlack et al.	2012/0221294 A1	8/2012	Steinberg et al.
7,356,384 B2	4/2008	Gull et al.	2012/0221718 A1	8/2012	Imes et al.
7,483,964 B1	1/2009	Jackson et al.	2012/0252430 A1	10/2012	Imes et al.
7,644,869 B2	1/2010	Hoglund et al.	2012/0324119 A1	12/2012	Imes et al.
7,784,704 B2	8/2010	Harter	2013/0053054 A1	2/2013	Lovitt et al.
7,848,900 B2	12/2010	Steinberg et al.	2013/0054758 A1	2/2013	Imes et al.
			2013/0054863 A1	2/2013	Imes et al.
			2013/0060387 A1	3/2013	Imes et al.
			2013/0144453 A1	6/2013	Subbloie
			2013/0167035 A1	6/2013	Imes et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

OTHER PUBLICATIONS

Wetter, et al., A comparison of deterministic and probabilistic optimization algorithms for nonsmooth simulation-based optimization, *Building and Environment* 39, 2004, pp. 989-999.

U.S. Appl. No. 13/523,697, filed Jun. 14, 2012, Hublou, et al.

U.S. Appl. No. 13/725,447, filed Dec. 21, 2012, Steinberg, John Douglas.

Bourhan, et al., "Dynamic model of an HVAC system for control analysis", Elsevier 2004.

Emerson Climate Technologies, "Network Thermostat for E2 Building Controller Installation and Operation Manual", 2007.

Johnson Controls, "T600HCx-3 Single-Stage Thermostats", 2006.

Written Opinion and Search Report for PCT/US2011/032537, dated Dec. 12, 2011.

Converge SuperStat Flyer, prior to Jun. 28, 2007.

Control4 Wireless Thermostat Brochure, 2006.

Cooper Power Systems Web Page, 2000-2009.

Enernoc Web Page, 2004-2009.

Enerwise Website, 1999-2009.

Honeywell Programmable Thermostat Owner's Guide, www.honeywell.com/yourhome, 2004.

Pier, Southern California Edison, Demand Responsive Control of Air Conditioning via Programmable Communicating, Feb. 14, 2006.

Proliphix Thermostat Brochure, prior to Jun. 2007.

Arens, et al., "How Ambient Intelligence Will Improve Habitability and Energy Efficiency in Buildings", 2005, research paper, Center for the Built Environment, Controls and Information Technology.

Johnson Controls, Touch4 building automation system brochure, 2007.

Kilicotte, et al., "Dynamic Controls for Energy Efficiency and Demand Response: Framework Concepts and a New Construction Study Case in New York", Proceedings of the 2006 ACEEE Summer Study of Energy Efficiency in Buildings, Pacific Grove, CA, Aug. 13-18, 2006.

Lin, et al., "Multi-Sensor Single-Actuator Control of HVAC Systems", 2002 Communicating Thermostats Draft Report.

Wang, et al., "Opportunities to Save Energy and Improve Comfort by Using Wireless Sensor Networks in Buildings," (2003), Center for Environmental Design Research.

Wetter, et al., "A comparison of deterministic and probabilistic optimization algorithms for nonsmooth simulation-based optimization", *Building and Environment* 39, 2004, pp. 989-999.

Brush, et al., Preheat—Controlling Home Heating with Occupancy Prediction, 2013.

Gupta, et al., A Persuasive GPS-Controlled Thermostat System, MIT, 2008.

Gupta, Adding GPS-Control to Traditional Thermostats: An Exploration of Potential Energy Savings and Design Challenges, MIT, 2009.

Krumm, et al., Learning Time-Based Presence Probabilities, Jun. 2011.

Scott, et al., Home Heating Using GPS-Based Arrival Prediction, 2010.

* cited by examiner

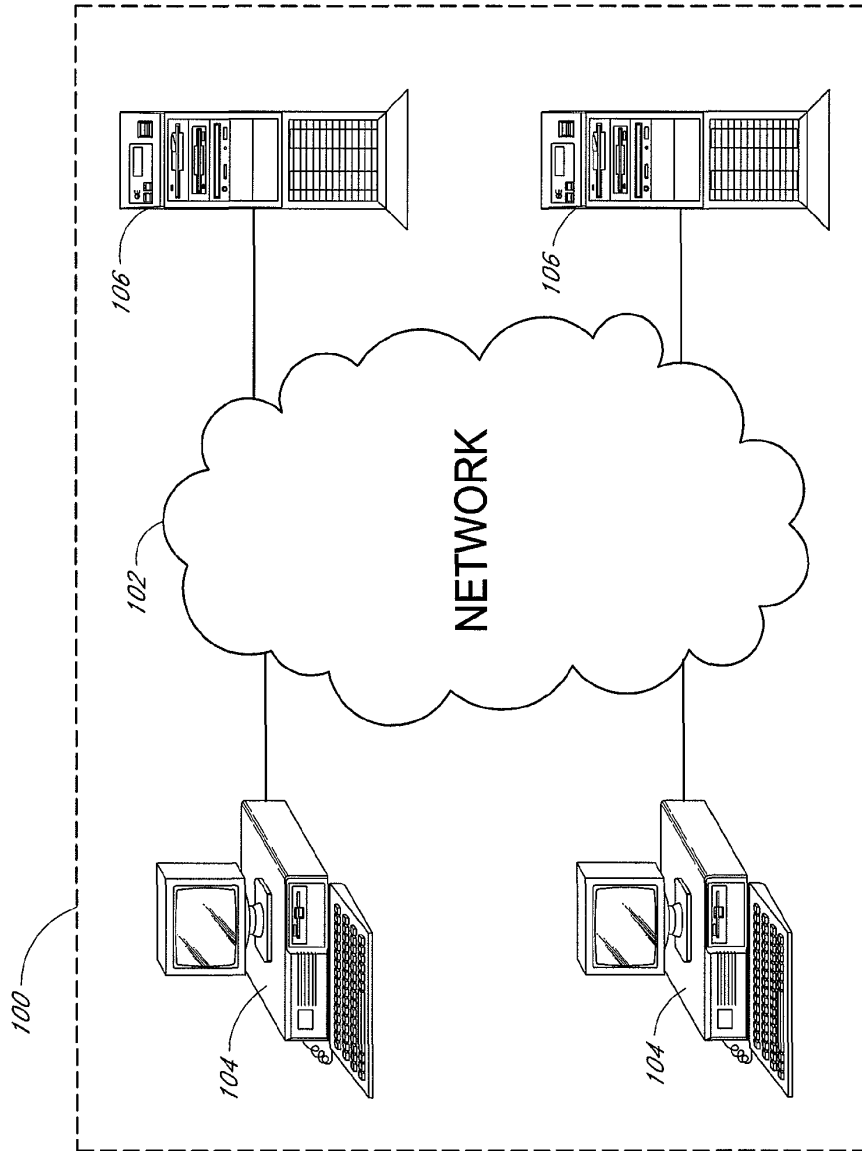
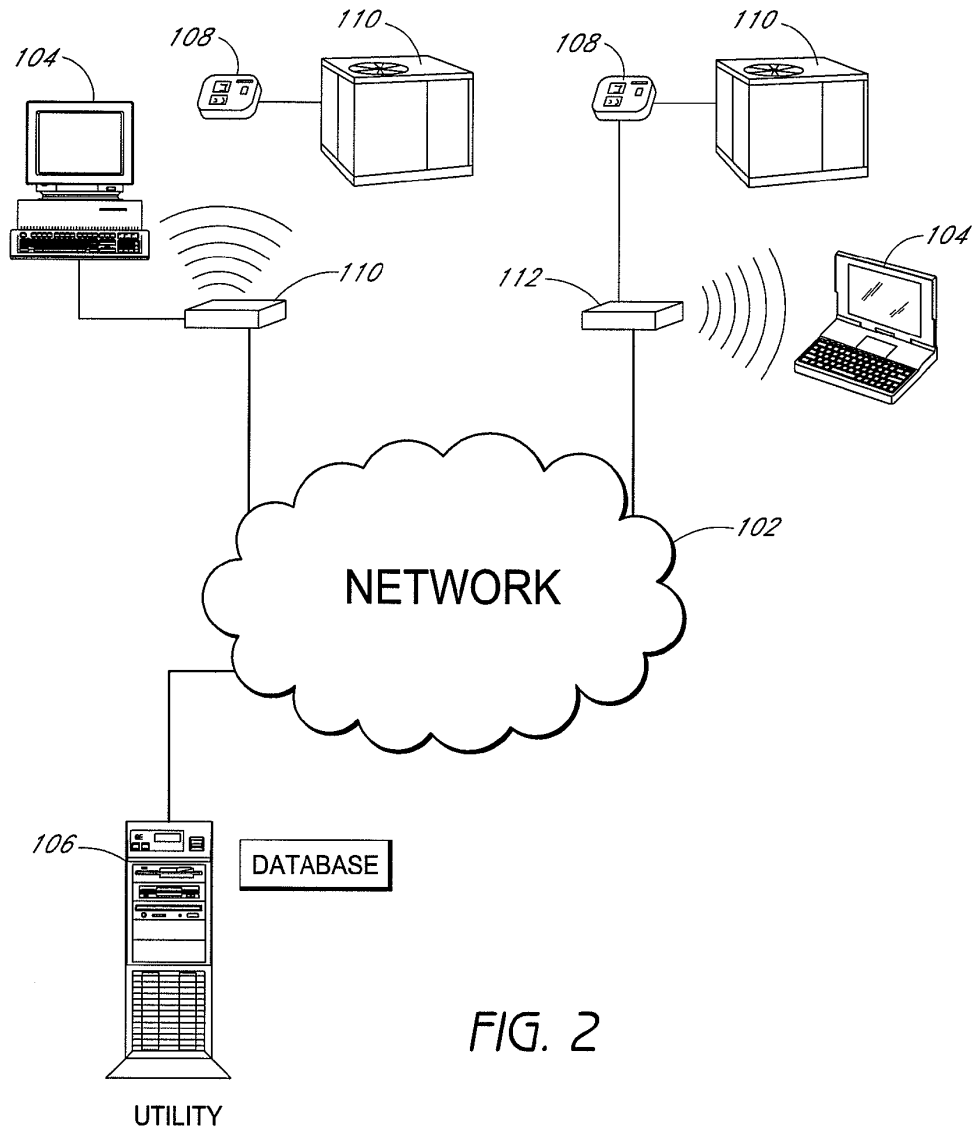


FIG. 1



Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.