US 20170049296A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2017/0049296 A1
Leone et al. (43) Pub. Date: Feb. 23, 2017

(54) CONTROLLING THE OPERATION OF A DISHWASHING APPLIANCE

(71) Applicant: **General Electric Company**, Schenectady, NY (US)

(72) Inventors: **Davide Jonathan Leone**, Louisville, KY (US); **Andrew Leroy Reder**, Louisville, KY (US)

(21) Appl. No.: **14/828,584**

(22) Filed: **Aug. 18, 2015**

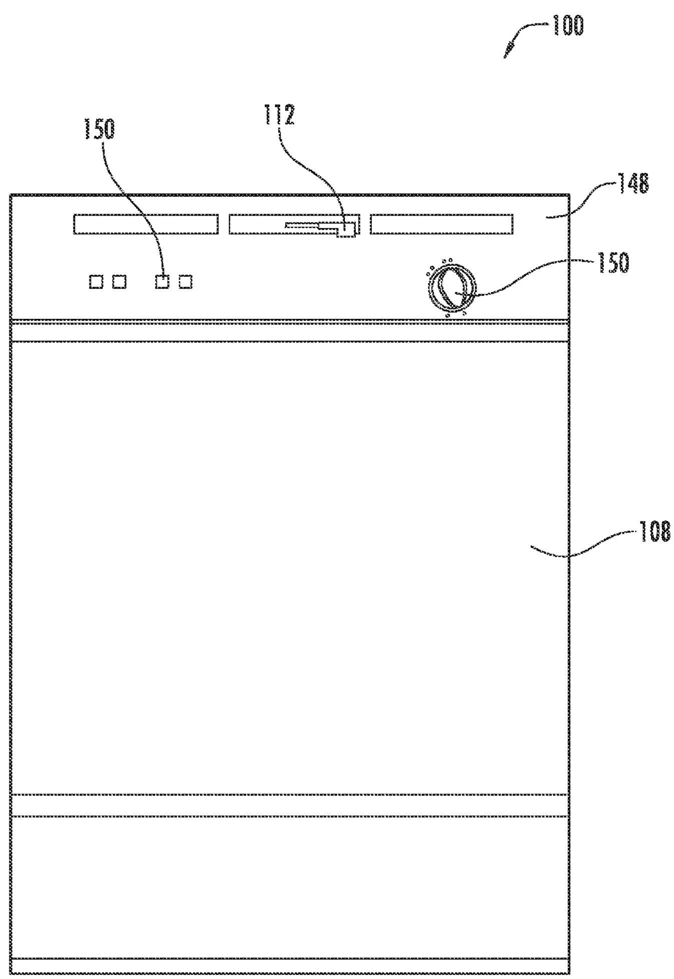
**Publication Classification**

(51) **Int. Cl.**
***A47L 15/46*** (2006.01)
***A47L 15/48*** (2006.01)
***A47L 15/42*** (2006.01)

(52) **U.S. Cl.**
CPC ............ ***A47L 15/46*** (2013.01); ***A47L 15/4285*** (2013.01); ***A47L 15/48*** (2013.01); *A47L 2401/30* (2013.01); *A47L 2501/30* (2013.01); *A47L 2501/06* (2013.01); *A47L 2501/11* (2013.01)

(57) **ABSTRACT**

Systems and methods for controlling one or more operations of a dishwashing appliance are provided. In particular, a supply voltage applied to a heating element of the dishwashing appliance can be determined. The supply voltage can be compared with an acceptable operating range of supply voltages to determine whether the supply voltage is within the acceptable operating range and, if the supply voltage is not within the acceptable operating range, one or more operations of the dishwashing appliance can be controlled based at least in part on the determined supply voltage. For instance, an amount of time during which the heating element is active during one or more operational cycles can be adjusted to compensate for the determined supply voltage.



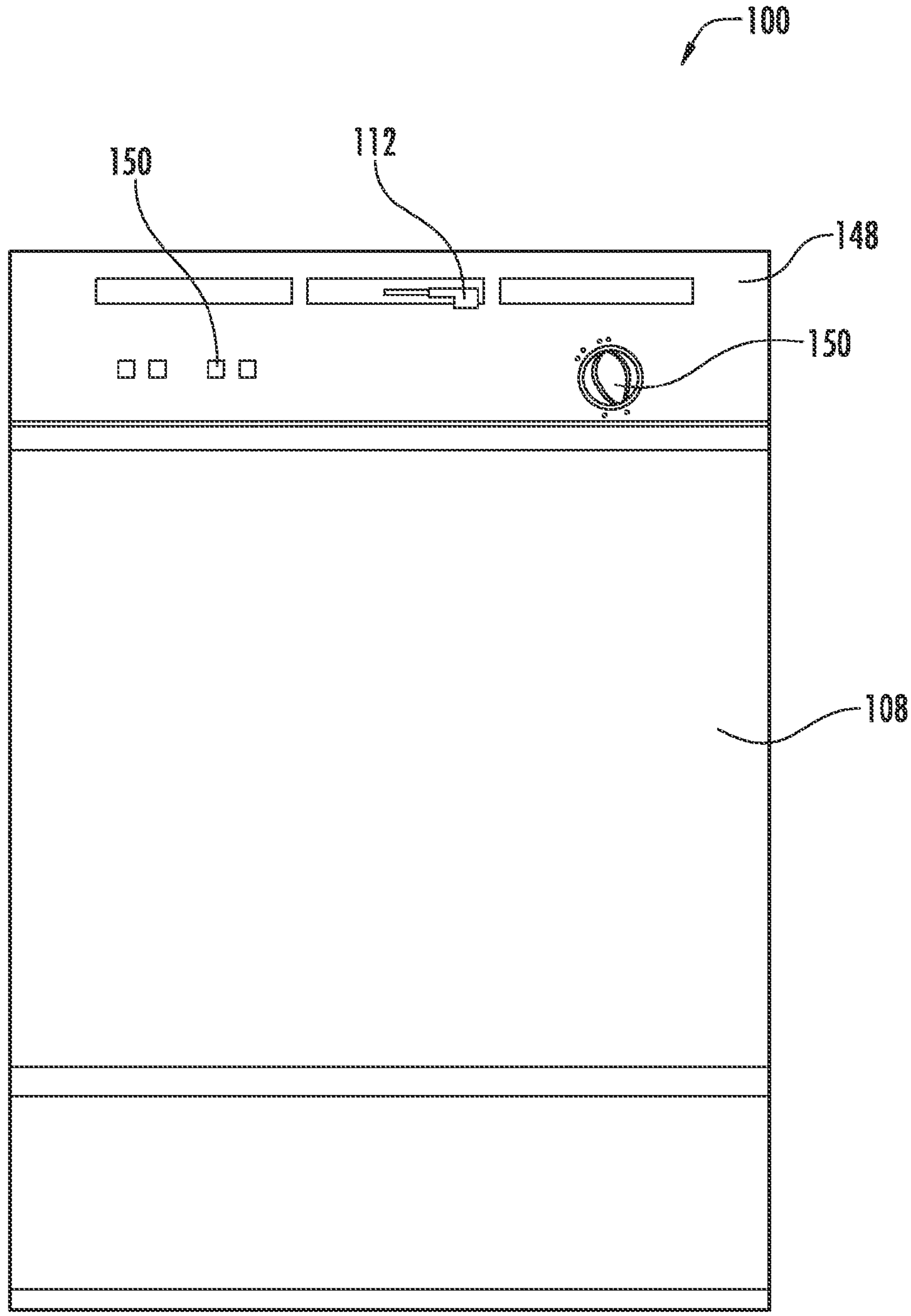



FIG. 1

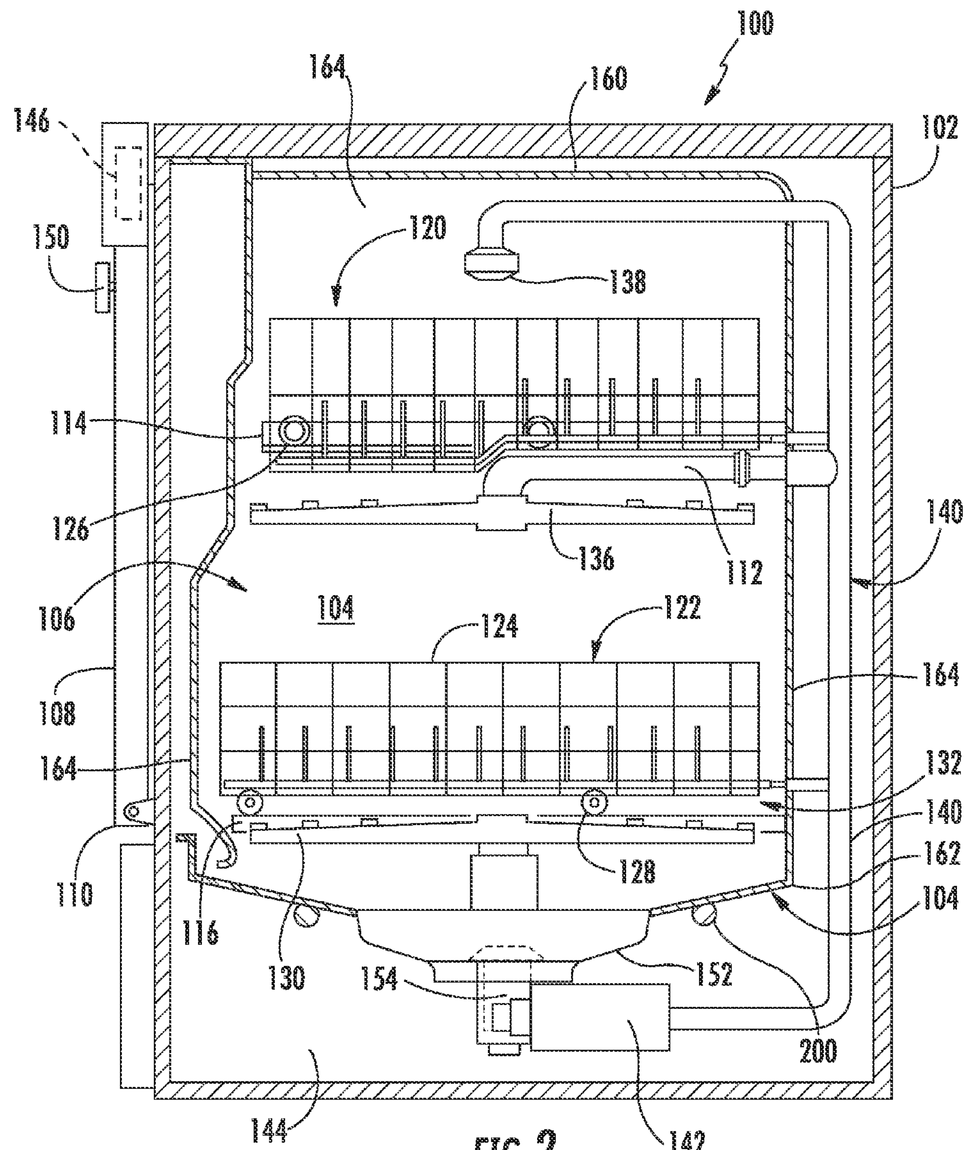

100
164
160
146
102
150
120
138
114
126
136
112
140
106
104
124
122
108
164
164
132
140
110
116
128
162
104
130
154
152
200
144
142

FIG. 2

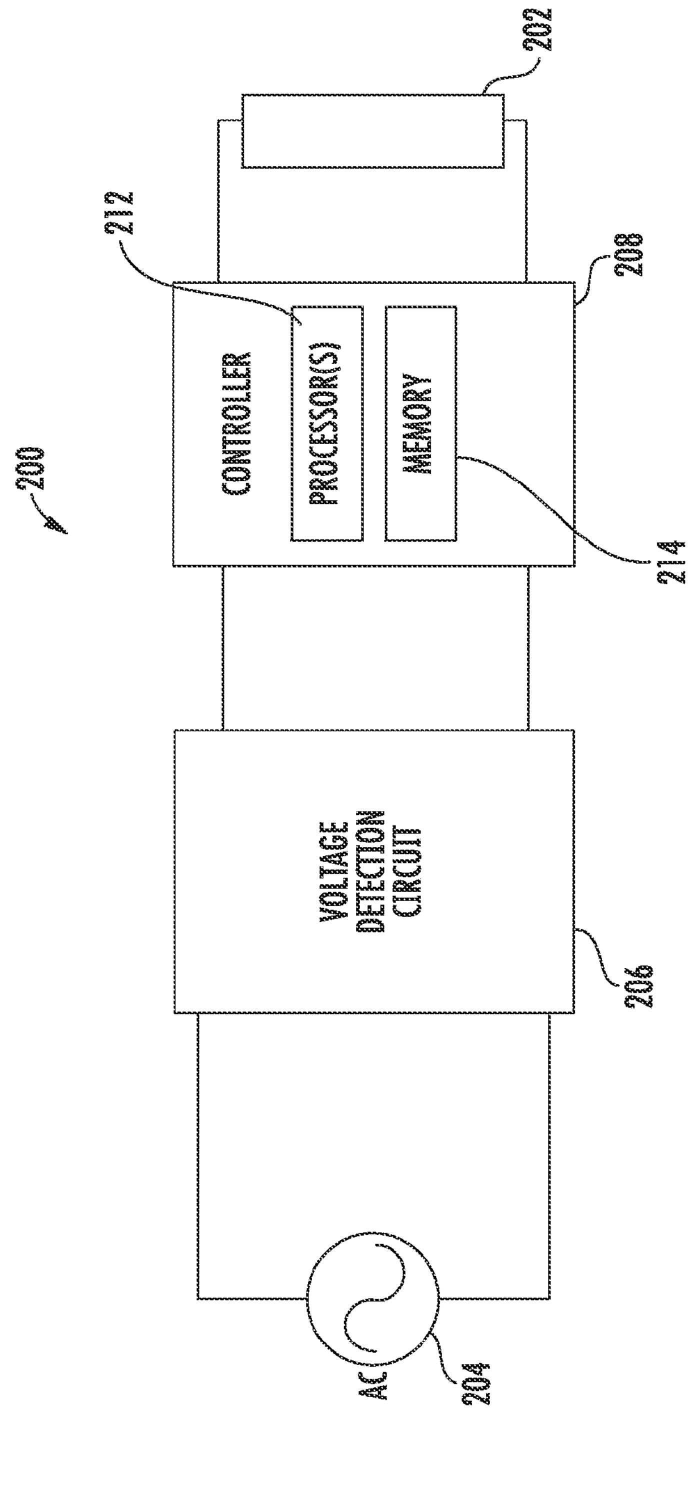

200
202
212
208
CONTROLLER
PROCESSOR(S)
MEMORY
214
VOLTAGE
DETECTION
CIRCUIT
206
AC
204

FIG. 3

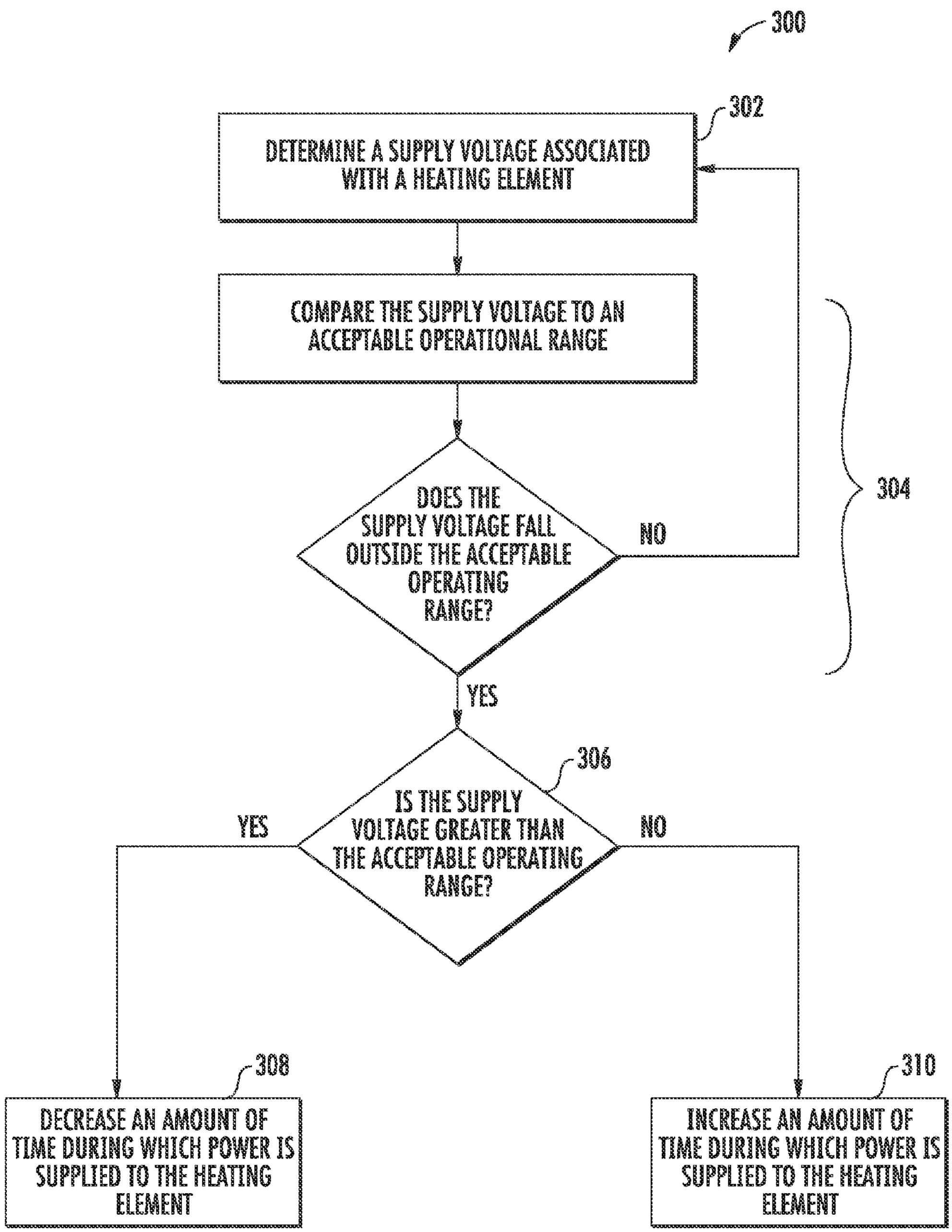

300
302
DETERMINE A SUPPLY VOLTAGE ASSOCIATED WITH A HEATING ELEMENT
COMPARE THE SUPPLY VOLTAGE TO AN ACCEPTABLE OPERATIONAL RANGE
304
DOES THE SUPPLY VOLTAGE FALL OUTSIDE THE ACCEPTABLE OPERATING RANGE?
NO
YES
306
IS THE SUPPLY VOLTAGE GREATER THAN THE ACCEPTABLE OPERATING RANGE?
YES
NO
308
DECREASE AN AMOUNT OF TIME DURING WHICH POWER IS SUPPLIED TO THE HEATING ELEMENT
310
INCREASE AN AMOUNT OF TIME DURING WHICH POWER IS SUPPLIED TO THE HEATING ELEMENT

FIG. 4

# CONTROLLING THE OPERATION OF A DISHWASHING APPLIANCE

## FIELD OF THE INVENTION

**[0001]** The present disclosure relates generally to controlling the operation of a dishwasher appliance and more particularly to controlling the operation of a dishwasher appliance based on one or more monitored voltage signals.

## BACKGROUND OF THE INVENTION

**[0002]** Modern dishwashing appliances (e.g. dishwashers) typically include a tub defining a wash chamber where, for instance, detergent, water, and heat can be applied in order to clean food and/or other materials from dishes and other articles being washed. Various cycles may be included as part of the overall cleaning process. For example, a typical, user-selected cleaning option may include a wash cycle and rinse cycle (referred to collectively as a wet cycle), as well as a drying cycle. A pre-wash cycle may also be included as part of the wet cycle, and may be automatic or an option for particularly soiled dishes.

**[0003]** It is common to provide dishwashers with rod-type, resistive heating elements in order to supply heat within the wash chamber during one or more of the dishwasher cycles (e.g. during the drying cycle). Generally, these heating elements include an electric resistance-type wire that is encased in a magnesium oxide-filled, metallic sheath.

**[0004]** A supply voltage may be applied to the heating element to facilitate the operation of the heating element. The magnitude of supply voltage can vary significantly between dishwashing appliance installations. The magnitude of supply voltage provided to the heating element can affect performance of the dishwashing appliance. As an example, an 800 watt heating element may lose about 65 watts of output power per 5 volt reduction in supply voltage. In addition, supply voltages having a large magnitude can cause damage to the dishwashing appliance and/or any contents within the dishwashing appliance (e.g. dishes, glasses, utensils, etc.) when applied to a heating element.

**[0005]** Thus, there is a need for a dishwashing appliance that can provide a consistent, safe performance by compensating for variations in supply voltage.

## BRIEF DESCRIPTION OF THE INVENTION

**[0006]** Aspects and advantages of the invention will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the invention.

**[0007]** One example aspect of the present disclosure is directed to a dishwashing appliance including a tub defining a wash chamber. The dishwashing appliance further includes a rack assembly disposed within the wash chamber for the tub. The rack assembly is configured for supporting articles for washing within the wash chamber of the tub. The dishwashing appliance further includes a resistive heating element located in the wash chamber. The dishwashing appliance further includes one or more control devices configured to control operation of the dishwashing appliance based at least in part on the determined supply voltage by detecting a supply voltage associated with the heating element, determining whether the supply voltage is within an acceptable operating supply voltage range, and adjusting at least one operational cycle of the dishwashing appliance when it is determined that the supply voltage is outside of the acceptable operating supply voltage range.

**[0008]** Another example aspect of the present disclosure is directed to a method of controlling a dishwashing appliance. The method includes determining a supply voltage based at least in part on one or more monitored signals. The supply voltage is associated with a heating element located in a dishwashing appliance. The method further includes determining whether the supply voltage is within an acceptable operating range of supply voltages. The method further includes controlling one or more operations of the dishwashing appliance based at least in part on whether the supply voltage is within the acceptable operating range. When it is determined that the supply voltage is not within the acceptable operating range, controlling the one or more operations of the dishwashing appliance comprises adjusting a time during which the heating element is active during one or more operational cycles based at least in part on the supply voltage.

**[0009]** Variations and modifications can be made to these example embodiments of the present disclosure.

**[0010]** These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0011]** A full and enabling disclosure of the present invention, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:

**[0012]** FIG. **1** depicts a front view of an example dishwashing appliance according to example embodiments of the present disclosure;

**[0013]** FIG. **2** depicts a cross-sectional view of the example dishwashing appliance according to example embodiments of the present disclosure;

**[0014]** FIG. **3** depicts a block diagram of an example system for controlling one or more operations of a dishwashing appliance according to example embodiments of the present disclosure; and

**[0015]** FIG. **4** depicts a flow diagram of an example method of controlling one or more operations of a dishwashing appliance.

## DETAILED DESCRIPTION OF THE INVENTION

**[0016]** Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

**[0017]** Example aspects of the present disclosure are directed to controlling the operation of a dishwashing appliance. In particular, a dishwashing appliance can include a voltage detection circuit configured to monitor one or more signals associated with the dishwashing appliance and to determine a supply voltage based at least in part on the one or more monitored signals. The supply voltage can be a voltage applied to a heating element of the dishwashing appliance. The determined supply voltage can be compared to an acceptable operating supply voltage range to determine whether the supply voltage falls outside of the acceptable operating range.

**[0018]** If the determined supply voltage does fall outside of the acceptable operating range, the operation of the dishwashing appliance and/or heating element can be controlled to compensate for the supply voltage. For instance, if the determined supply voltage is less than the acceptable operating range, the operation of the dishwashing appliance can be controlled by increasing an amount of time during which power is supplied to the heating element (e.g. increasing a time during which the heating element is active) during one or more operational cycles based at least in part on the determined supply voltage. In example embodiments, this can include increasing the duration of one or more operational cycles of the dishwashing appliance and/or increasing the number of operational cycles of the dishwashing appliance. If the determined supply voltage is greater than the acceptable operating range, the operation of the dishwashing appliance can be controlled by decreasing an amount of time during which power is supplied to the heating element during one or more operational cycles based at least in part on the determined supply voltage. In example embodiments, this can include decreasing the duration of one or more operational cycles of the dishwashing appliance and/or decreasing the number of operational cycles of the dishwashing appliance.

**[0019]** In example embodiments, if the determined supply voltage is greater than the acceptable operating range by a significant margin, the operation of the heating element and/or the entire dishwashing appliance can be ceased. For instance, if the determined supply voltage is greater than a threshold value, operation of the heating element and/or the dishwashing appliance can be ceased. The threshold value can correspond to a voltage wherein, when applied to the heating element, may cause the heating element to provide an amount of heat energy that causes damage to the dishwashing appliance and/or the contents of the dishwashing appliance.

**[0020]** Turing now to the figures, FIGS. **1** and **2** depict one embodiment of a domestic dishwashing appliance **100** that may be configured in accordance with aspects of the present disclosure. As shown in FIGS. **1** and **2**, the dishwashing appliance **100** may include a cabinet **102** having a tub **104** therein defining a wash chamber **106**. The tub **104** may generally include a front opening (not shown) and a door **108** hinged at its bottom **110** for movement between a normally closed vertical position (shown in FIGS. **1** and **2**), wherein the wash chamber **106** is sealed shut for washing operation, and a horizontal open position for loading and unloading of articles from the dishwasher. As shown in FIG. **1**, a latch **112** may be used to lock and unlock the door **108** for access to the chamber **106**.

**[0021]** As is understood, the tub **104** may generally have a rectangular cross-section defined by various wall panels and/or walls. For example, as shown in FIG. **2**, the tub **104** may include a top wall **160** and a bottom wall **162** spaced apart from one another along a vertical direction V of the dishwashing appliance **100**. Additionally, the tub **104** may include a plurality of sidewalls **164** (e.g., four sidewalls) extending between the top and bottom walls **160**, **162**. It should be appreciated that the tub **104** may generally be formed from any suitable material. However, in several embodiments, the tub **104** may be formed from a ferritic material, such as stainless steel.

**[0022]** As particularly shown in FIG. **2**, upper and lower guide rails **114**, **116** may be mounted on opposing side walls **164** of the tub **104** and may be configured to accommodate roller-equipped rack assemblies **120** and **122** configured for supporting articles for washing within the wash chamber of the tub. Each of the rack assemblies **120**, **122** may be fabricated into lattice structures including a plurality of elongated members **124** (for clarity of illustration, not all elongated members making up assemblies **120** and **122** are shown in FIG. **2**). Additionally, each rack **120**, **122** may be adapted for movement between an extended loading position (not shown) in which the rack is substantially positioned outside the wash chamber **106**, and a retracted position (shown in FIGS. **1** and **2**) in which the rack is located inside the wash chamber **106**. This may be facilitated by rollers **126** and **128**, for example, mounted onto racks **120** and **122**, respectively. As is generally understood, a silverware basket (not shown) may be removably attached to rack assembly **122** for placement of silverware, utensils, and the like, that are otherwise too small to be accommodated by the racks **120**, **122**.

**[0023]** Additionally, the dishwashing appliance **100** may also include a lower spray-arm assembly **130** that is configured to be rotatably mounted within a lower region **132** of the wash chamber **106** directly above the bottom wall **162** of the tub **104** so as to rotate in relatively close proximity to the rack assembly **122**. As shown in FIG. **2**, a mid-level spray-arm assembly **136** may be located in an upper region of the wash chamber **106**, such as by being located in close proximity to the upper rack **120**. Moreover, an upper spray assembly **138** may be located above the upper rack **120**.

**[0024]** As is generally understood, the lower and mid-level spray-arm assemblies **130**, **136** and the upper spray assembly **138** may generally form part of a fluid circulation assembly **140** for circulating water and dishwasher fluid within the tub **104**. As shown in FIG. **2**, the fluid circulation assembly **140** may also include a pump **142** located in a machinery compartment **144** located below the bottom wall **162** of the tub **104**, as is generally recognized in the art. Additionally, each spray-arm assembly **130**, **136** may include an arrangement of discharge ports or orifices for directing washing liquid onto dishes or other articles located in rack assemblies **120** and **122**, which may provide a rotational force by virtue of washing fluid flowing through the discharge ports. The resultant rotation of the lower spray-arm assembly **130** provides coverage of dishes and other dishwasher contents with a washing spray.

**[0025]** The dishwashing appliance **100** may be further equipped with a controller **146** configured to regulate operation of the dishwasher **100**. The controller **146** can include any number of control devices and can generally include one or more memory devices and one or more processors, such as one or more general or special purpose microprocessors operable to execute programming instructions or microcontrol code associated with a cleaning cycle. The processors and/or memory devices can be configured to perform a variety of computer-implemented functions and/or instructions (e.g. performing the methods, steps, calculations and the like and storing relevant data as disclosed herein). The instructions when executed by the processor(s) can cause the processor(s) to perform operations, including providing control commands to various aspects of dishwashing appliance **100**.

**[0026]** As used herein, the term "processor" refers not only to integrated circuits referred to in the art as being included in a computer, but also refers to a controller, a microcontroller, a microcomputer, a programmable logic controller (PLC), an application specific integrated circuit, and other programmable circuits. The processor is also configured to compute advanced control algorithms and communicate to a variety of Ethernet or serial-based protocols (Modbus, OPC, CAN, etc.). Additionally, the memory device(s) may generally comprise memory element(s) including, but not limited to, computer readable medium (e.g. random access memory (RAM)), computer readable non-volatile medium (e.g. read-only memory, or a flash memory), a floppy disk, a compact disc-read only memory (CD-ROM), a magneto-optical disk (MOD), a digital versatile disc (DVD) and/or other suitable memory elements. Such memory device(s) may generally be configured to store suitable computer-readable instructions that, when implemented by the processor(s), configure controller **104** to perform the various functions as described herein. The memory may be a separate component from the processor or may be included onboard within the processor.

**[0027]** The controller **146** may be positioned in a variety of locations throughout dishwashing appliance **100**. In the illustrated embodiment, the controller **146** is located within a control panel area **148** of the door **108**, as shown in FIG. **1**. In such an embodiment, input/output ("I/O") signals may be routed between the control system and various operational components of dishwashing appliance **100** along wiring harnesses that may be routed through the bottom **110** of the door **108**.

**[0028]** Typically, the controller **146** includes a user interface panel/controls **150** through which a user may select various operational features and modes and monitor progress of the dishwasher **100**. In one embodiment, the user interface **150** may represent a general purpose I/O ("GPIO") device or functional block. Additionally, the user interface **150** may include input components, such as one or more of a variety of electrical, mechanical or electro-mechanical input devices including rotary dials, push buttons, and touch pads. The user interface **150** may also include a display component, such as a digital or analog display device designed to provide operational feedback to a user. As is generally understood, the user interface **150** may be in communication with the controller **146** via one or more signal lines or shared communication busses.

**[0029]** Additionally, as shown in FIG. **2**, a portion of the bottom wall **162** of the tub **104** may be configured as a tub sump portion **152** that accommodates a filter assembly **154** configured to remove particulates from the fluid being recirculated through the wash chamber **106** during operation of the dishwashing appliance **100**. For example, fluid collected within the tub sump portion **152** of the bottom wall **162** may be passed through the filter assembly **154** and then diverted back to the pump **142** for return to the wash chamber **106** by way of the fluid recirculation assembly **140**.

**[0030]** Moreover, as shown in FIG. **2**, the dishwashing appliance **100** may also include a heating element **200** provided in operative association with the tub **104** for providing heat energy during a wash, rinse, and/or drying cycle to, for example, heat the fluid introduced into wash chamber **106** and/or to assist with drying articles.

**[0031]** It should be appreciated that the present subject matter is not limited to any particular configuration, model, or style of dishwashing appliance. The example embodiment depicted in FIGS. **1** and **2** is simply provided for illustrative purposes only. For example, different locations may be provided for the user interface **150** and/or controller **146**, different configurations may be provided for the racks **120**, **122**, and other differences may be applied as well.

**[0032]** The dishwashing appliance **100** can further include a voltage detection circuit. In example embodiments, the voltage detection circuit can be included in controller **146** or other controller, or the voltage detection circuit can be a separate and distinct component(s) from controller **146** communicatively coupled to controller **146**. The voltage detection circuit can be configured to monitor one or more signals associated with the dishwashing appliance **100**. For instance, such signals may include one or more of an input voltage, input current and/or a known resistance of a resistive load (e.g. heating element) associated with the dishwashing appliance **100**. The one or more monitored signals can be used to determine a supply voltage applied to the heating element.

**[0033]** FIG. **3** depicts an example system **200** for controlling the operation of a heating element **202** according to example embodiments of the present disclosure. As shown, system **200** can include an alternating current (AC) power source **204**. Power source **204** can be, for instance, a 120 VAC power source or other suitable power source. System **200** may further include a voltage detection circuit **206** configured to monitor one or more signals from power source **204**. In example embodiments, voltage detection circuit **206** may be configured to monitor a voltage signal associated with power source **204** and/or a current signal associated power source **204**. In embodiments wherein current is monitored, a voltage can be determined given the known resistance of a resistive load (e.g. heating element **202**). Voltage detection circuit **206** can be communicatively coupled to a controller **208**. Controller **208** can include one or more processors **212** and memory **214**. Controller **208** can correspond to controller **146** of FIG. **2**, or controller **208** can be a separate and distinct component from controller **146**.

**[0034]** Voltage detection circuit **206** can provide one or more signals indicative of a supply voltage to controller **208**. Controller **208** can then send one or more control signals to heating element **202**. The one or more signals can be determined based at least in part on the determined supply voltage. In particular, as indicated above, controller **208** can be configured to compare the supply voltage to an acceptable operating supply voltage range to determine whether the supply voltage falls within the acceptable operating range. If the supply voltage falls outside of the acceptable operating range, the controller can adjust an operational state of the dishwashing appliance to compensate for the supply voltage.

**[0035]** In particular, if the supply voltage falls below the acceptable operating range, controller **208** can be configured to increase an amount of time during which heating element **202** is active (e.g. provides heat energy within the wash chamber). For instance, the duration of one or more operational cycles (e.g. wash cycle, dry cycle, etc.) can be increased to compensate for the lower supply voltage. As another example, the number of operational cycles can be increased to compensate for the lower supply voltage. For instance, a dry cycle and/or wash cycle can be repeated one or more times to compensate for the lower supply voltage. In this manner, the increased duration of time during which heating element **202** is active can compensate for the decreased voltage applied to heating element **202**. In particular, the increased amount of time can be determined such that heating element **202** provides the same (or substantially the same) amount of energy (e.g. watt-hours) during the one or more operational cycles as would heating element **202** during normal operation when a baseline (e.g. nominal) supply voltage is provided.

**[0036]** In embodiments wherein the determined supply voltage is greater than the acceptable operational cycle, controller **208** can be configured to decrease an amount of time during which heating element **202** is active. For instance, the duration of one or more operational cycles can be decreased to compensate for the higher supply voltage. As another example, the number of operational cycles can be decreased to compensate for the higher supply voltage. As above, the decreased amount of time can be determined such that heating element **202** provides the same (or substantially the same) amount of energy (e.g. watt-hours) during the one or more operational cycles as would heating element **202** during normal operation when a baseline (e.g. nominal) supply voltage is provided.

**[0037]** In example embodiments, when the supply voltage is greater than the acceptable operational range, the supply voltage can be further compared to a threshold value indicative of a need to cease operation of heating element **202** and/or the entire dishwashing appliance (e.g. dishwashing appliance **100**). The threshold value can correspond to a voltage point that, when applied to heating element **202**, facilitates a temperature of heating element **202** that may cause damage to the dishwashing appliance and/or the contents of the dishwashing appliance (e.g. dishes, glasses, utensils, etc.). If the supply voltage reaches this point, the controller can be configured to immediately cease operation of the heating element and/or dishwashing appliance. In this manner, the controller may be further configured to prevent operation of the dishwashing appliance for some time period subsequent to ceasing the operation.

**[0038]** In alternative embodiments, if the supply voltage falls within the acceptable operating range, the supply voltage can be further compared to a nominal voltage value. The nominal voltage value can correspond to a supply voltage point within the acceptable operating range, such that, when the nominal voltage is applied to heating element **202** during normal operating conditions, the dishwashing appliance performs at an optimal or near optimal level. In example embodiments, the performance of the dishwashing appliance can be determined by the cleanliness and/or dryness of the contents of the dishwashing appliance after a cleaning cycle comprising one or more wash, rinse, and/or dry cycles. The nominal voltage can be about 120 VAC, although other suitable nominal voltages can be used. Controller **208** can be further configured to control the operation of heating element **202** and/or dishwashing appliance based at least in part on the comparison. For instance, if the supply voltage is greater than the nominal voltage value, controller **208** can be configured to decrease an amount of time during which heating element **202** is active during one or more operational cycles, and/or to decrease a number of operational cycles of the dishwashing appliance. If the supply voltage is less than the nominal voltage value, controller **208** can be configured to increase an amount of time during which heating element **202** is active during one or more operational cycles, and/or to increase a number of operational cycles of the dishwashing appliance.

**[0039]** FIG. **4** depicts a flow diagram of an example method (**300**) of controlling the operation of a dishwashing appliance according to example embodiments of the present disclosure. The method (**300**) can be implemented by one or more control devices, such as controller **146**, controller **208**, or other suitable controller(s). In addition, FIG. **4** depicts steps performed in a particular order for purposes of illustration and discussion, those of ordinary skill in the art, using the disclosures provided herein, will understand that various steps of any of the methods discussed herein can be adapted, modified, rearranged, omitted, or expanded in various ways without deviating from the scope of the present disclosure.

**[0040]** At (**302**), method (**300**) can include determining a supply voltage associated with a heating element. In particular, a magnitude of the supply voltage may be determined. In example embodiments, the supply voltage may be determined by monitoring one or more signals associated with a power source. For instance, the one or more signals may include one or more applied voltage signals and/or one or more current signals.

**[0041]** In example embodiments, the determined supply voltage or other suitable signal may be stored in one or more databases associated with the dishwashing appliance. Such databases may be stored locally at the dishwashing appliance and/or at a remote server device. In particular, the database may store a log of historical supply voltages or other signals for one or more periods of time (e.g. weeks, months, years, etc.). In this manner, such stored signals may be accessed by service personnel or other users of the dishwashing appliance.

**[0042]** At (**304**), method (**300**) can include comparing the supply voltage to an acceptable operating supply voltage range. In particular, the supply voltage can be compared with the acceptable operating range to determine whether the supply voltage falls within the acceptable operating range or outside of the acceptable operating range. The acceptable operating range can be a range of supply voltages, wherein, when applied to a heating element associated with a dishwashing appliance, cause the heating element to provide an amount of heat energy within a wash chamber of the dishwashing appliance during one or more operational cycles that facilitates safe operation of the dishwashing appliance and/or an acceptable cleaning performance relating to the contents of the dishwashing appliance (e.g. dishes, utensils, pots, pans, glasses, etc.). In example embodiments, the acceptable operating range may be between about 115 VAC and about 125 VAC. As used herein, the term "about, when used in relation to a numerical value, is intended to refer to within 40% of the numerical value. It will be appreciated that various other suitable acceptable operating ranges can be used, such as a smaller range of voltages or a larger range of voltages.

[0043] If the supply voltage falls within the acceptable operating range, method (**300**) may return to (**302**). If the supply voltage falls outside of the acceptable operating range, then method (**300**) can include determining whether the supply voltage is greater than the acceptable operating range (e.g. greater than the largest voltage within the acceptable operating range) (**306**). If the supply voltage is greater than the acceptable operating range, method (**300**) can include decreasing an amount of time during which power is supplied to the heating element (e.g. the amount of time during which the heating element is active) during one or more operational cycles (**308**). As indicated above, this may include decreasing the duration of one or more operational cycles (e.g. wash cycle, rinse cycle, dry cycle, etc.) and/or decreasing a number of operational cycles associated with the dishwashing appliance.

[0044] If the supply voltage is not greater than the acceptable operating range (e.g. if the supply voltage is less than the smallest voltage in the acceptable operating range), method (**300**) can include increasing an amount of time during which power is supplied to the heating element (e.g. the amount of time during which the heating element is active) during one or more operational cycles (**310**). As indicated above, this may include increasing the duration of one or more operational cycles (e.g. wash cycle, rinse cycle, dry cycle, etc.) and/or increasing a number of operational cycles associated with the dishwashing appliance.

[0045] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

What is claimed is:

**1**. A dishwashing appliance comprising:

a tub defining a wash chamber;

a rack assembly disposed within the wash chamber of the tub, the rack assembly configured for supporting articles for washing within the wash chamber of the tub;

a resistive heating element located in the wash chamber; and

one or more control devices configured to control operation of the dishwashing appliance based at least in part on the determined supply voltage by executing computer-readable instructions stored in one or more memory devices that when executed by the one or more control devices cause the one or more control devices to perform operations, the operations comprising:

detecting a supply voltage associated with the heating element;

determining whether the supply voltage is within an acceptable operating supply voltage range; and

adjusting at least one operational cycle of the dishwashing appliance when it is determined that the supply voltage is outside of the acceptable operating supply voltage range.

**2**. The dishwashing appliance of claim **1**, wherein, when it is determined that the supply voltage is not within the acceptable operational supply voltage range, the operations further comprise determining whether the supply voltage is greater than or less than the acceptable operating supply voltage range.

**3**. The dishwashing appliance of claim **2**, wherein, when it is determined that the supply voltage is greater than the acceptable operating supply voltage range, adjusting at least one operational cycle of the dishwashing appliance comprises decreasing an amount of time during which the heating element provides heat energy within the wash chamber.

**4**. The dishwashing appliance of claim **3**, wherein decreasing an amount of time during which the heating element provides heat energy within the wash chamber comprises at least one of decreasing a duration of one or more operational cycles of the dishwashing appliance, or decreasing a number of operational cycles of the dishwashing appliance.

**5**. The dishwashing appliance of claim **2**, wherein, when it is determined that the supply voltage is less than the acceptable operating supply voltage range, adjusting at least one operational cycle of the dishwashing appliance comprises increasing an amount of time during which the heating element provides heat energy within the wash chamber.

**6**. The dishwashing appliance of claim **5**, wherein increasing an amount of time during which the heating element provides heat energy within the wash chamber comprises at least one of increasing a duration of one or more operational cycles of the dishwashing appliance, or increasing a number of operational cycles of the dishwashing appliance.

**7**. The dishwashing appliance of claim **2**, wherein, when it is determined that the supply voltage is greater than the acceptable operational supply voltage range, the one or more control devices are configured to determine whether the supply voltage is greater than a threshold value.

**8**. The dishwashing appliance of claim **7**, wherein, when it is determined that the supply voltage is greater than the threshold value, adjusting at least one operational cycle of the dishwashing appliance comprises ceasing operation of at least one of the heating element or the dishwashing appliance.

**9**. The dishwashing appliance of claim **1**, wherein one or more control devices are further configured to store the determined supply voltage in the one or more memory devices.

**10**. The dishwashing appliance of claim **1**, wherein, when it is determined that the supply voltage is within the acceptable operating supply voltage range, the one or more control devices are further configured to compare the supply voltage to a nominal voltage value.

**11**. The dishwashing appliance of claim **10**, wherein, when it is determined that the supply voltage does not equal the nominal voltage value, the one or more control devices are further configured to adjust at least one operational cycle of the dishwashing appliance.

**12**. A method of controlling a dishwashing appliance, the method comprising:

determining a supply voltage based at least in part on one or more monitored signals, the supply voltage associated with a heating element located in a dishwashing appliance;

determining whether the supply voltage is within an acceptable operating range of supply voltages; and

controlling one or more operations of the dishwashing appliance based at least in part on whether the supply voltage is within the acceptable operating range;

wherein, when it is determined that the supply voltage is not within the acceptable operating range, controlling the one or more operations of the dishwashing appliance comprises adjusting a time during which the heating element is active during one or more operational cycles based at least in part on the supply voltage.

**13**. The method of claim **12**, further comprising, when it is determined that the supply voltage is not within the acceptable operating range, determining whether the supply voltage is greater than the acceptable operating range.

**14**. The method of claim **13**, wherein, when it is determined that the supply voltage is not greater than the acceptable operating range, adjusting a time during which the heating element is active during one or more operational cycles based at least in part on the supply voltage comprises increasing a time during which the heating element is active during the one or more operational cycles based at least in part on the supply voltage.

**15**. The method of claim **14**, wherein increasing a time during which the heating element is active during the one or more operational cycles based at least in part on the supply voltage comprises at least one of increasing a duration of the one or more operational cycles, or increasing a number of operational cycles of the dishwashing appliance based at least in part on the supply voltage.

**16**. The method of claim **13**, wherein, when it is determined that the supply voltage is greater than the acceptable operating range, adjusting a time during which the heating element is active during one or more operational cycles based at least in part on the supply voltage comprises decreasing a time during which the heating element is active during the one or more operational cycles based at least in part on the supply voltage.

**17**. The method of claim **14**, wherein decreasing a time during which the heating element is active during the one or more operational cycles based at least in part on the supply voltage comprises at least one of decreasing a duration of the one or more operational cycles, or decreasing a number of operational cycles of the dishwashing appliance based at least in part on the supply voltage.

**18**. The method of claim **13**, further comprising, when it is determined that the supply voltage is greater than the acceptable operating range, determining whether the supply voltage is greater than a threshold voltage, and when it is determined that the supply voltage is greater than the threshold voltage, ceasing operations of at least one of the heating element or the dishwashing appliance.

**19**. The method of claim **12**, further comprising, when it is determined that the supply voltage is within the acceptable operating range, determining if the supply voltage is equal to a nominal voltage value within the acceptable operating range.

**20**. The method of claim **19**, wherein, when it is determined that the supply voltage is not equal to the nominal voltage value, controlling the one or more operations of the dishwashing appliance comprises adjusting a time during which the heating element is active based at least in part on the supply voltage and the nominal voltage.

* * * * *