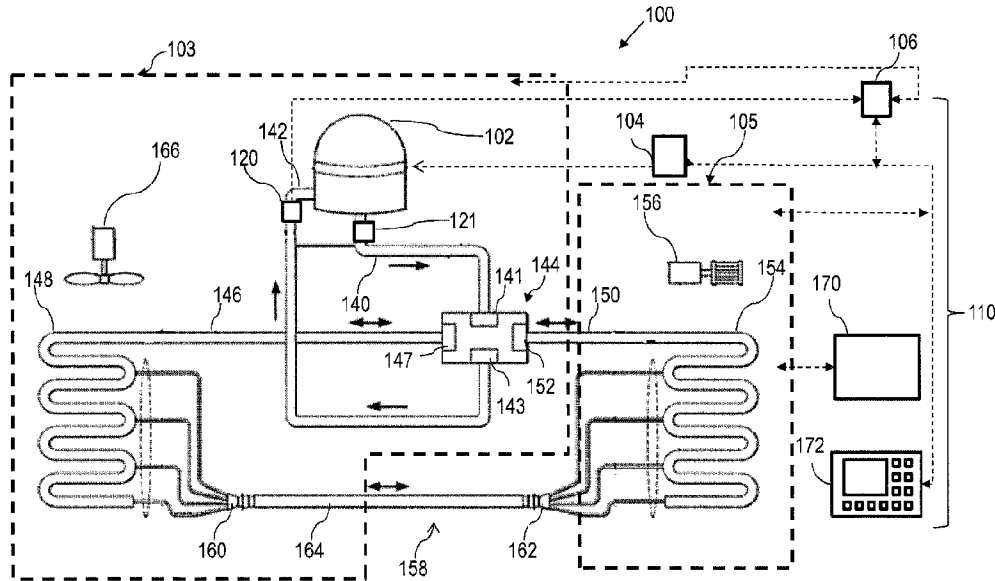




(22) Date de dépôt/Filing Date: 2014/10/27
(41) Mise à la disp. pub./Open to Public Insp.: 2015/04/28
(45) Date de délivrance/Issue Date: 2021/08/10
(30) Priorité/Priority: 2013/10/28 (US14/064,865)

(51) Cl.Int./Int.Cl. *F24F 11/30* (2018.01),
F24D 5/12 (2006.01), *F24F 11/86* (2018.01),
F25B 49/02 (2006.01)
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(54) Titre : SYSTEME DE CALIBRATION D'UN GROUPE COMPRESSEUR DANS UN SYSTEME DE CHAUFFAGE, DE VENTILATION ET DE CLIMATISATION
(54) Title: SYSTEM FOR CALIBRATION OF A COMPRESSOR UNIT IN A HEATING, VENTILATION, AND AIR CONDITIONING SYSTEM



(57) **Abrégé/Abstract:**

The present invention provides for a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system. A measuring device measures an operating parameter of the HVAC system at a position where the measuring device is mounted on a refrigerant line of the HVAC system. The measuring device switches states when the value of the measured operating parameter reaches a switching value. A controller estimates a value of the first operating parameter at the position where the first measuring device is mounted on the refrigerant line, and the controller determines whether the estimated first operating parameter is within a threshold percentage of the switching value.

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**SYSTEM FOR CALIBRATION OF A COMPRESSOR UNIT IN A HEATING,
VENTILATION, AND AIR CONDITIONING SYSTEM****ABSTRACT**

The present invention provides for a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system. A measuring device measures an operating parameter of the HVAC system at a position where the measuring device is mounted on a refrigerant line of the HVAC system. The measuring device switches states when the value of the measured operating parameter reaches a switching value. A controller estimates a value of the first operating parameter at the position where the first measuring device is mounted on the refrigerant line, and the controller determines whether the estimated first operating parameter is within a threshold percentage of the switching value.

SYSTEM FOR CALIBRATION OF A COMPRESSOR UNIT IN A HEATING, VENTILATION, AND AIR CONDITIONING SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to calibration systems used in heating, ventilation, and air conditioning (HVAC) systems and, more particularly, to a system for calibrating operation of a compressor unit in an HVAC system.

[0002] The discharge pressure and suction pressure of a compressor in a heating, ventilation, and air conditioning (HVAC) system can be used as a diagnostic tool to troubleshoot problems with the system or to confirm that the system is operating normally.

[0003] A model of the discharge pressure and suction pressure may be created from test data in a laboratory or manufacturing facility.

[0004] Once the HVAC system is installed, however, use of discharge pressure and suction pressure as a diagnostic tool is time consuming and expensive. Trained technicians may manually determine and utilize discharge and suction pressure in diagnostics. A pressure transducer may also be utilized as a tool for determining these pressures. Because of time and costs involved, suction and discharge pressure cannot often be used in the diagnostic process. What is needed are systems and methods for utilizing suction and discharge pressure as diagnostic tools in the calibration of HVAC systems.

SUMMARY

[0005] The present invention provides for a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system. A controller estimates the value of an operating parameter of the HVAC system at a position on a refrigerant line of the HVAC system where a measuring device is mounted to measure the operating parameter. The controller determines whether the estimated operating parameter is within a threshold percentage of the value of the operating parameter at which the measuring device switches states.

According to an aspect of the present invention, there is provided a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:

a control assembly configured to operationally connect to a compressor assembly of the HVAC system, wherein the compressor assembly comprises the compressor unit, wherein the compressor unit operates at an outside ambient temperature, and wherein the control assembly comprises:

a first measuring device mounted on a first line of the compressor unit, the first measuring device configured to switch states from a first state to a second state, wherein the first line comprises a channel for the flow of refrigerant with the HVAC system, wherein the first measuring device measures at least a first operating parameter of the HVAC system at a position on the first line where the first measuring device is mounted, and wherein the first measuring device switches from the first state to the second state when the value of the measured first operating parameter reaches a first switching value; and

a controller configured to estimate a first estimated value of the first operating parameter at the position where the first measuring device is mounted on the first line, and wherein the controller is configured to determine whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system:

providing a control assembly configured to operationally connect to a compressor assembly of the HVAC system, wherein the compressor assembly comprises the compressor unit configured to operate at an outside ambient temperature;

wherein the control assembly comprises a first measuring device mounted to a first line of the compressor unit, and wherein the first measuring device is configured to switch states from a first state to a second state at a first switching value, wherein the first line comprises a channel for the flow of refrigerant with the HVAC system, wherein the first measuring device measures at least a first operating parameter at a position on the first line where the first measuring device is mounted;

switching, by the first measuring device, to the second state when the value of the measured first operating parameter reaches the first switching value;

estimating, by a controller, a first estimated value of the first operating parameter at the position where the first measuring device is mounted on the first line; and

determining, by the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:

an indoor unit operatively connected to an outdoor unit;

wherein the outdoor unit comprises the compressor unit, the compressor unit comprising a suction line and a discharge line;

a control assembly configured to operationally connect to the compressor unit, wherein the compressor unit operates at an outside ambient temperature;

a measuring device mounted on the discharge line of the compressor unit, wherein the measuring device is configured to measure at least a first operating parameter of the HVAC system and switch states from a first state to a second state when the value of the measured first operating parameter reaches a first switching value; and

a controller of the control assembly is configured to estimate a first estimated value of the first operating parameter of the HVAC and determine whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system:

providing a control assembly configured to operationally connect to the compressor unit of the HVAC system, wherein the compressor unit is configured to operate at an outside ambient temperature;

mounting a measuring device on a discharge line of the compressor unit, wherein the measuring device is configured to measure at least a first operating parameter of the HVAC system and switch states from a first state to a second state when the value of the measured first operating parameter reaches a first switching value;

switching from the first state to the second state when the value of the measured first operating parameter reaches the first switching value;

estimating, using a controller, a first estimated value of the first operating parameter; and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) unit, the system comprising:

a pressure switch positioned on a discharge line of the compressor unit and configured to measure refrigerant pressure in the discharge line and switch operation of the HVAC unit from a first operating state to a second operating state when a value of the measured refrigerant pressure reaches a first switching value; and

a controller configured to estimate a first estimated value of the refrigerant pressure and determine whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the method comprising:

mounting a measuring device on a discharge line of the compressor unit, wherein the measuring device is configured to measure at least a first operating parameter of the HVAC system and switch states from a first state to a second state when a value of the measured first operating parameter reaches a first switching value;

determining whether the measuring device has switched states from the first state to the second state;

responsive to a determination that the measuring device has not switched states from the first state to the second state, changing demand on the compressor unit from a first load to a second load; and

switching from the first state to the second state when the value of the measured first operating parameter reaches the first switching value;

estimating a first estimated value of the first operating parameter;

determining whether the first estimated value is within a first threshold

percentage of the first switching value; and

responsive to a determination that the first estimated value is within the first threshold percentage of the first switching value, generating a first communication; and sending the first communication to an external device using a wireless connection.

According to another aspect of the present invention, there is provided a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) unit, the system comprising:

a temperature switch positioned on a discharge line of the compressor unit and configured to measure refrigerant temperature in the discharge line and switch operation of the HVAC unit from a first operating state to a second operating state when a value of the measured refrigerant temperature reaches a first switching value; and

a controller configured to estimate a first estimated value of the refrigerant temperature and determine whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:

an indoor unit operatively connected to an outdoor unit;

wherein the outdoor unit comprises the compressor unit, the compressor unit comprising a suction line and a discharge line;

a control assembly configured to operationally connect to the compressor unit, wherein the compressor unit operates at an outside ambient temperature;

a pressure switch configured to measure refrigerant pressure in the discharge line and switch states from a first state to a second state when a value of the measured refrigerant pressure reaches a first switching value; and

a controller configured to estimate a first estimated value of the measured refrigerant pressure and determine whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:

an indoor unit operatively connected to an outdoor unit;

wherein the outdoor unit comprises the compressor unit, the compressor unit comprising a suction line and a discharge line;

a control assembly configured to operationally connect to the compressor unit, wherein the compressor unit operates at an outside ambient temperature;

a temperature switch configured to measure refrigerant temperature in the discharge line and switch states from a first state to a second state when a value of the measured refrigerant temperature reaches a first switching value; and

a controller configured to estimate a first estimated value of the measured refrigerant temperature and determine whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system:

measuring, using a measuring device mounted on a discharge line of the compressor unit, at least a first operating parameter of the HVAC system, wherein the measuring device operates in at least one of a first state and a second state;

determining, using a controller, whether a value of the measured first operating parameter reaches a first switching value;

responsive to a positive determination, switching from the first state to the second state;

estimating, using the controller, a first estimated value of the first operating parameter; and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the method comprising:

measuring, using a pressure switch mounted on a discharge line of the compressor unit, refrigerant pressure in the discharge line;

determining, using a controller, whether the measured refrigerant pressure reaches a first switching value;

responsive to a positive determination, switching from a first state to a second state;

estimating, using the controller, a first estimated value of the measured refrigerant pressure; and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the method comprising:

measuring, using a temperature switch mounted on a discharge line of the compressor unit, refrigerant temperature in the discharge line;

determining, using a controller, whether the measured refrigerant temperature reaches a first switching value;

responsive to a positive determination, switching from a first state to a second state;

estimating, using the controller, a first estimated value of the measured refrigerant temperature; and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

According to another aspect of the present invention, there is provided a system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) unit, the system comprising:

a pressure switch positioned on a discharge line of the compressor unit and configured to measure refrigerant pressure in the discharge line and switch operation of the HVAC unit from a first operating state to a second operating state when a value of the measured refrigerant pressure reaches a first switching value; and

a controller configured to:

estimate a first estimated value of the refrigerant pressure;

determine whether the first estimated value is within a first threshold percentage of the first switching value;

generate a first communication based on the determination of whether the first estimated value is within the first threshold percentage of the first switching value; and

send the first communication to a third party.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following Detailed Description taken in conjunction with the accompanying drawings, in which:

Figure 1 illustrates an HVAC system;

Figure 2 illustrates a compressor assembly and a control assembly;

Figure 3 shows a flow chart of steps in a method for calibrating operation of a compressor unit in an HVAC system; and

Figure 4 shows a graph of discharge pressure of a compressor unit versus outside temperature.

DETAILED DESCRIPTION

[0007] In the following discussion, numerous specific details are set forth to provide a thorough understanding of the present invention. However, those skilled in the art will appreciate that the present invention may be practiced without such specific details. In other instances, well-known elements have been illustrated in schematic or block diagram form in order not to obscure the present invention in unnecessary detail. Additionally, for the most part, details concerning well-known features and elements have been omitted inasmuch as such details are not considered necessary to obtain a complete understanding of the present invention, and are considered to be within the understanding of persons of ordinary skill in the relevant art.

[0008] Referring to Figure 1, a first compressor unit 102 may be configured to operate in a heat pump, such as a heat pump system 100. The first compressor unit 102 may be configured to compress low pressure refrigerant in vapor form to a higher pressure vapor. It will be understood by persons of ordinary skill that the first compressor

unit 102 may operate within the heat pump system 100 in conjunction with other known components.

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[0009] The heat pump system 100 may comprise an outdoor unit 103 operatively connected to an indoor unit 105. The outdoor unit 103 may comprise the first compressor unit 102 having a suction line 142 and a discharge line 140. The suction line 142 and the discharge line 140 may operatively connect the first compressor unit 102 with a reversing valve 144 at an output port 143 and an input port 141, respectively. The reversing valve 144 may be configured to change the direction of flow of refrigerant within the heat pump system 100.

[0010] A first transfer line 146 may operatively connect a first reversing port 147 with an outside heat exchanger unit 148 configured to condense high pressure vapor refrigerant to a liquid. An outdoor fan 166 may be configured to blow outside air over the heat exchange section of the outside heat exchanger unit 148.

[0011] A distributor 158 may be operatively connected to the outlet of the outside heat exchanger unit 148 at a first end 160 and operatively connected to the inlet of an outside heater exchanger unit 148 at a second end 162. Liquid tubing 164 may span the first end 160 and the second end 162 for transporting substantially liquid refrigerant from the outside heat exchanger unit 148 to an inside heat exchanger unit 154. The distributor 158 may function as a metering device to regulate the amount of liquid refrigerant flowing into the inside heater exchanger unit 154.

[0012] The inside heat exchanger unit 154 may be configured to evaporate liquid refrigerant to a vapor. An indoor blower 156 may be configured to pull air over coils of the inside heat exchanger unit 154 and to circulate air into the enclosed space. A second transfer line 150 may operatively connect a second reversing port 152 with the inside heat exchanger unit 154 to transfer refrigerant in low pressure vapor form back into the compressor unit 102 through the suction line 142.

[0013] It will be understood by persons of ordinary skill that operation of the heat pump system 100 may be changed from heating to cooling by reversing flow within the system so that the inside heat exchanger unit 154 operates as a condenser and the outside heat exchanger unit operates as an evaporator.

[0014] Referring to Figure 2, a control assembly 110 may be operationally coupled to the first compressor unit 102. The control assembly 110 may comprise an electrical power

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converter, such as a first inverter 104 and an electronic first controller 106. The first inverter 104 may be operationally connected to the first compressor unit 102 and configured to adjust the input voltage delivered to the first compressor unit 102.

[0015] The first inverter 104 may be operationally connected to a first controller 106 configured to receive and send operation signals for operation of the HVAC system 100. The first controller 106 may be an outside unit controller.

[0016] The first inverter 104 may be operationally coupled to the first compressor unit 102 and configured to modify the input voltage delivered to the first compressor unit 102. The first inverter 104 may be operationally coupled to a first controller 106 configured to receive and send control signals for operation of the HVAC system 100.

[0017] A compressor speed of the first compressor unit 102 may be controlled by the first inverter 104 receiving control signals from the first controller 106. It will be understood that the compressor speed may be controlled without the use of an inverter as part of the control assembly 110. In those embodiments, the first controller 106 may be configured to utilize other known variable-speed solutions, including but not limited to pulse width modulation of the compression process, or modulating the capacity by bypassing some of the refrigerant around the compression process (referred to as “unloading”).

[0018] The control assembly 110 may further comprise other control devices, such as an inside control unit 170 and a thermostat 172. The inside control unit 170 may operate in conjunction with the first controller 106 to control operation of the indoor blower 156 and compressor unit 102. The thermostat 172 may adjust the target temperature and have other commonly-used functions to control the environmental conditions of the enclosed space.

[0019] Referring to Figure 1, the HVAC system 100 may further comprise a measuring device configured to measure an operating parameter of the HVAC system 100. In some embodiments, the measuring device comprises a pressure switch 121 mounted on the discharge line 140 configured to monitor the discharge pressure of the first compressor unit 102. The first controller 106 may be operationally connected to the pressure switch 121 to control the monitoring process and store data.

[0020] The pressure switch 121 may comprise an actuation pressure and a reset pressure. The actuation pressure is the discharge pressure at which the switch opens or

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closes from a normal position, and the reset pressure is the discharge pressure at which the switch returns to a normal position. It will be understood by persons of ordinary skill in the art that the pressure switch 121 may be configured to monitor other pressure values or operating parameters in the HVAC system that may be useful in the systems and methods disclosed in this description, including but not limited to the suction pressure.

[0021] Referring to Figures 3 and 4, the first controller 106 may be configured to perform one or more methods for calibrating operation of the HVAC system 100. The HVAC system 100 may be configured to operate in a calibration mode. Calibration of the HVAC system 100 may comprise a comparison between a normal operation model 130 of the HVAC system 100 and a measured operating parameter of the HVAC system 100. The model 130 may characterize normal operation as a function of one or more operating conditions. The model 130 shown in Figure 4 was prepared in laboratory tests using an HVAC system having a variable capacity compressor unit of 5 tons. It will be understood by persons of ordinary skill in the art that a model of normal operation may be prepared for different types of HVAC systems having one or more compressor units of different capacities.

[0022] In some embodiments, as shown in Figure 4, the model 130 may comprise a characterization of the discharge pressure of the HVAC system 100 as a function of the outside ambient temperature in which the compressor unit 102 operates. The model 130 may be compared to a measured value of discharge pressure. The comparison may be used for diagnostic purposes or to determine or infer other useful information about the operation of the HVAC system 100.

[0023] Referring to Figure 4, a normal operation model 130 of discharge pressure as a function of the outside ambient pressure may comprise a data set 132. The data set 132 may comprise one or more pressure curves 134a – d which represent the discharge pressures of the HVAC system at a set of outside ambient temperatures expected under normal operating conditions for a specific compressor speed where Speed 4 is the maximum speed of the compressor, Speed 1 is the minimum Speed of the compressor and Speeds 2 and 3 are between Speeds 1 and 4. For example, in some embodiments, Speed 1 corresponding to curve 134d may equal about 22 Hertz (Hz); Speed 2 corresponding to curve 134c may equal

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about 34 Hz; Speed 3 corresponding to curve 134b may equal about 46Hz; and Speed 4 corresponding to curve 134a may equal about 58 Hz. It will be understood that range of speed used to characterize the normal operation model 130 may vary according to the configuration and capacity of the compressor used.. The data set 132 may be stored in a memory of the first controller 106.

[0024] It will be further understood that other measuring devices may be used in place of the pressure switch 121 to obtain measured operating parameters of the HVAC system 100 that would be useful in the calibration processes disclosed in this description. For example, a bimetal temperature switch may be operationally coupled to the HVAC system and configured to measure a condensing temperature of the outdoor coil. A data set for normal operation of the HVAC system 100 may be developed as function of at least the condensing temperature in order to allow for a comparison to be made between normal expected operation and the measured operating parameter.

[0025] Referring to Figure 3, a method for controlling operation of an HVAC system may comprise a first step 202 of verifying normal operation of the system 100. This operation may include verifying that the compressor unit 102 is currently on. In other embodiments, the HVAC system may be in setback or away mode, when demand on the compressor unit 102 is low.

[0026] In a second step 204, the controller assembly may verify that the outdoor temperature is in a calibration range. A calibration range may comprise a range of temperatures for a given range of operating speeds of the compressor unit 102 at which the pressure switch 121 changes states. For example, as shown in Figure 4, the pressure switch 121 may be configured to reset at a discharge pressure of about 280 pounds per square inch gauge (psig) in a first temperature range T1 for a first speed range S1 of the compressor unit 102. The pressure switch 121 may be configured to open at a discharge pressure of about 340 psig in a second temperature range T2 for the speed range S1 of the compressor unit 102.

[0027] In a third step 206, the first controller 106 may initiate a calibration mode, based on the verification that the outdoor temperature is in the calibration range. If the temperature is not in the calibration range, then the HVAC system 100 may continue in normal operation (step 202).

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[0028] In a fourth step 208, the first controller 106 may set the compressor unit 102 to operate at a first operating speed. For example, the compressor unit 102 may be operated at the Speed 4, which may correlate to a maximum demand on the compressor unit 102. It will be understood by persons of ordinary skill in the art that the maximum demand will be compressor-specific and will vary based on the configuration and size of the compressor.

[0029] In a fifth step 210, the compressor unit 102 may be operated for a first time period t_1 . The time period t_1 may comprise a pre-determined amount of time configured to increase the discharge pressure of the compressor unit 102 by a pre-selected amount. For example, the time period t_1 may comprise about 5 minutes, which may elevate the discharge pressure by about 127%, when the compressor unit 102 is operating at the Speed 2 and at an outside temperature of about 90°F.

[0030] The time period t_1 may be configured to change the discharge pressure so that the discharge pressure crosses the threshold at which pressure switch 121 changes state. For example, operating the compressor unit 102 at the Speed 2 for 5 minutes may result in the pressure switch 121 actuating.

[0031] In step 212, the actuate event of the pressure switch 121 may be recorded in a memory of the first controller 106. If the pressure switch 121 does not change states, the first controller 106 may generate a signal (step 214) to the compressor unit 102 to change demand to operate the compressor unit at a second operating speed. The change in demand may comprise a pre-selected percentage of change from the initial demand load, where the pre-selected percentage is configured to change the discharge pressure of the compressor unit 102. In some embodiments, the discharge pressure is elevated to change the state of the pressure switch 121.

[0032] In step 210, the compressor unit 102 may be operated for a second time period t_2 . The time period t_2 may comprise a pre-determined amount of time configured to change the discharge pressure of the compressor unit 102 by a pre-selected amount. It will be understood that the time periods t_1 and t_2 may be based on the expected operational characteristics of the HVAC system 100, including but not limited to the compressor unit capacity.

[0033] In step 216, the current operating state of the HVAC system at the actuate event (recorded in step 212) may be recorded in a memory of the first controller 106. The operating state may comprise known values of the HVAC system 100 and other data readily accessible through measurement by sensors or calculable based on known or measured data within the control assembly 110, including data regarding operation of the compressor unit 102 taken from the inverter 104.

[0034] In step 218, the discharge pressure of the compressor unit 102 may be determined based on the operating state. For example, the discharge pressure may be calculated according to the systems and methods described in U.S. Patent No. 9,982,930 entitled "SYSTEM FOR CONTROLLING OPERATION OF AN HVAC SYSTEM". In other embodiments, a data set containing a characterization of discharge pressure, for example in a table format, may be stored in memory and the predicted discharge pressure may be determined by correlating one or more parameters of the operating state of the compressor unit 102 with the stored estimated value of the predicted discharge pressure. Alternatively, the estimated discharge pressure may be received by the first controller 106 from a separate device, including but not limited to a pressure transducer operationally connected to the HVAC system.

[0035] In step 220, the first controller 106 may compare the calculated discharge pressure of step 218 to the value of the pressure at which the pressure switch 121 is configured to change states (referred to as the "switch setting"). The first controller 106 may determine whether the calculated discharge pressure is within a threshold percentage of the switch setting. In some embodiments, the threshold percentage may be in a range of -10% to +10% of the switch setting. The threshold percentage may be pre-selected and programmed into the controller 106 based on the acceptable operational tolerances of the HVAC system 100.

[0036] In step 222, the first controller 106 may be configured to generate and send a communication based on whether the calculated discharge pressure is within the pre-selected percentage of the switch setting. For example, if the calculated discharge pressure is outside the threshold percentage of the switch setting, the first controller 106 may send a

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communication indicating that the HVAC system 100 is not operating within acceptable parameters.

[0037] The communication may comprise a textual or visual summary of data regarding operation of the HVAC system 100, including a characterization of discharge pressure of the compressor unit 102, such as a chart, graph, or table. The communication may be sent to a display, stored in memory, or communicated directly to a third party. Referring to Figure 2, the communication may be stored in a memory log 112 operationally connected to the first controller 106. The predicted pressure may be sent to a display 114. For example, a diagnostician may be connected to a port operationally connected to the controller 106 and may request a reading of the predicted discharge pressure, or may access the memory log 112 that contains a history of the predicted pressure for a given time period. In other embodiments, the communication generated by the first controller 106 in step 222 may be sent via a wireless device, for example as an email or text message.

[0038] In other embodiments, the measuring device, such as the pressure switch 121, may be positioned at other positions within the HVAC system 100 for calibrating the pressure at that position, including but not limited to positioning a pressure switch 120 positioned on the suction line 142 for measuring suction pressure, as shown in Figure 1.

[0039] Having thus described the present invention by reference to certain of its preferred embodiments, it is noted that the embodiments disclosed are illustrative rather than limiting in nature and that a wide range of variations, modifications, changes, and substitutions are contemplated in the foregoing disclosure and, in some instances, some features of the present invention may be employed without a corresponding use of the other features. Many such variations and modifications may be considered desirable by those skilled in the art based upon a review of the foregoing description of preferred embodiments. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:

a control assembly configured to operationally connect to a compressor assembly of the HVAC system, wherein the compressor assembly comprises the compressor unit, wherein the compressor unit operates at an outside ambient temperature, and wherein the control assembly comprises:

a first measuring device mounted on a first line of the compressor unit, the first measuring device configured to switch states from a first state to a second state, wherein the first line comprises a channel for the flow of refrigerant with the HVAC system, wherein the first measuring device measures at least a first operating parameter of the HVAC system at a position on the first line where the first measuring device is mounted, and wherein the first measuring device switches from the first state to the second state when the value of the measured first operating parameter reaches a first switching value; and

a controller configured to estimate a first estimated value of the first operating parameter at the position where the first measuring device is mounted on the first line, and wherein the controller is configured to determine whether the first estimated value is within a first threshold percentage of the first switching value.

2. The system of claim 1, wherein the controller is configured to generate a first communication based on the determination of whether the first estimated value is within the first threshold percentage of the first switching value.

3. The system of claim 2, wherein the controller is configured to send the first communication by a wireless connection with an external device.

4. The system of claim 2, wherein the controller is configured to determine whether the first measuring device has switched states from the first state to the second state.

5. The system of claim 4, wherein the controller is configured to change demand on the compressor unit from a first load to a second load if the first measuring device has not switched states from the first state to the second state.
6. The system of claim 5, wherein changing the demand on the compressor unit comprises changing a speed of the compressor unit.
7. The system of claim 5 or 6, wherein the controller is configured to initiate a first mode of operation for calibrating operation of the compressor unit, wherein the initiation of the first mode of operation is based on the outside ambient temperature, and wherein the controller is configured to operate the compressor unit under the second load for a first time period to change the measured first operating parameter of the HVAC system to cause the first measuring device to switch states.
8. The system of claim 7, wherein the controller is configured to determine whether the outside ambient temperature is within a first calibration range, and wherein the measuring device is configured to change states when the compressor unit is operated within the first calibration range.
9. The system of claim 8, wherein the first measuring device comprises a pressure switch and the first operating parameter comprises the pressure of the refrigerant in the first line at the position where the first measuring device is mounted, and wherein the pressure switch is configured to measure the pressure of the refrigerant at a position where the pressure switch is mounted on the first line.
10. The system of claim 8, wherein the first measuring device comprises a temperature switch and the first operating parameter comprises the temperature of the refrigerant in the first line at the position where the first measuring device is mounted, and wherein the temperature switch is configured to measure the temperature of the refrigerant at a position where the temperature switch is mounted on the first line.

11. A method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system:

providing a control assembly configured to operationally connect to a compressor assembly of the HVAC system, wherein the compressor assembly comprises the compressor unit configured to operate at an outside ambient temperature;

wherein the control assembly comprises a first measuring device mounted to a first line of the compressor unit, and wherein the first measuring device is configured to switch states from a first state to a second state at a first switching value, wherein the first line comprises a channel for the flow of refrigerant with the HVAC system, wherein the first measuring device measures at least a first operating parameter at a position on the first line where the first measuring device is mounted;

switching, by the first measuring device, to the second state when the value of the measured first operating parameter reaches the first switching value;

estimating, by a controller, a first estimated value of the first operating parameter at the position where the first measuring device is mounted on the first line; and

determining, by the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

12. The method of claim 11, further comprising generating, by the controller, a first communication based on the determination of whether the first estimated value is within the first threshold percentage of the first switching value.

13. The method of claim 12, further comprising sending, by the controller, the first communication by a wireless connection with an external device.

14. The method of claim 12 or 13, further comprising determining whether the first measuring device has switched states from the first state to the second state.

15. The method of claim 14, further comprising changing demand on the compressor unit from a first load to a second load if the first measuring device has not switched states from the first state to the second state.

16. The method of claim 15, wherein changing the demand on the compressor unit comprises changing a speed of the compressor unit.

17. The method of claim 15 or 16, further comprising:
initiating, by the controller, a first mode of operation for calibrating operation of the compressor unit, wherein the initiation of the first mode of operation is based on the outside ambient temperature; and
operating, by the controller, the compressor unit under the second load for a first time period to change the measured first operating parameter at the first line from a first measured value to a second measured value, wherein the change in the first operating parameter at the first line from the first measured value to the second measured value of the first operating parameter causes the first measuring device to switch states.
18. The method of claim 17, further comprising:
measuring, by the controller, an outdoor temperature; and
changing, by the first measuring device, states when the compressor unit is operated at the outside ambient temperature within a first calibration range.
19. The method of claim 17 or 18, wherein the first measuring device comprises a pressure switch, and the first operating parameter comprises the pressure of the refrigerant in the first line at the position where the first measuring device is mounted, and wherein the pressure switch is configured to measure the pressure of the refrigerant at a position where the pressure switch is mounted on the first line.
20. The method of claim 17 or 18, wherein the first measuring device comprises a temperature switch and the first operating parameter comprises the temperature of the refrigerant in the first line at the position where the first measuring device is mounted, and wherein the temperature switch is configured to measure the temperature of the refrigerant at a position where the temperature switch is mounted on the first line.
21. A system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:
an indoor unit operatively connected to an outdoor unit;
wherein the outdoor unit comprises the compressor unit, the compressor unit comprising a suction line and a discharge line;
a control assembly configured to operationally connect to the compressor unit, wherein the

compressor unit operates at an outside ambient temperature;

a measuring device mounted on the discharge line of the compressor unit, wherein the measuring device is configured to measure at least a first operating parameter of the HVAC system and switch states from a first state to a second state when the value of the measured first operating parameter reaches a first switching value; and

a controller of the control assembly is configured to estimate a first estimated value of the first operating parameter of the HVAC and determine whether the first estimated value is within a first threshold percentage of the first switching value.

22. The system of claim 21, wherein the discharge line comprises a channel for the flow of refrigerant with the HVAC system.

23. The system of claim 21 or 22, wherein the controller is configured to generate a first communication based on the determination of whether the first estimated value is within the first threshold percentage of the first switching value.

24. The system of claim 23, wherein the controller is configured to send the first communication using a wireless connection with an external device.

25. The system of claim 23, wherein the controller is configured to determine whether the first measuring device has switched states from the first state to the second state.

26. The system of claim 25, wherein the controller is configured to change demand on the compressor unit from a first load to a second load if the measuring device has not switched states from the first state to the second state.

27. The system of claim 26, wherein changing the demand on the compressor unit comprises changing a speed of the compressor unit.

28. The system of claim 26 or 27, wherein:

the controller is configured to initiate a first mode of operation for calibrating operation of the compressor unit, wherein the initiation of the first mode of operation is based on the outside ambient temperature; and

the controller is configured to operate the compressor unit under the second load for a first

time period to change the measured first operating parameter of the HVAC system to cause the measuring device to switch states.

29. The system of claim 28, wherein the controller is configured to determine whether the outside ambient temperature is within a first calibration range and change states when the compressor unit is operated within the first calibration range.

30. The system of claim 29, wherein:
the measuring device comprises a pressure switch and the first operating parameter comprises a pressure of a refrigerant in the discharge line at a position where the measuring device is mounted; and

the pressure switch is configured to measure the pressure of the refrigerant at a position where the pressure switch is mounted on the first line.

31. The system of claim 29, wherein:
the measuring device comprises a temperature switch and the first operating parameter comprises a temperature of a refrigerant in the discharge line at a position where the measuring device is mounted; and

wherein the temperature switch is configured to measure the temperature of the refrigerant at a position where the temperature switch is mounted on the first line.

32. A method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system:

providing a control assembly configured to operationally connect to the compressor unit of the HVAC system, wherein the compressor unit is configured to operate at an outside ambient temperature;

mounting a measuring device on a discharge line of the compressor unit, wherein the measuring device is configured to measure at least a first operating parameter of the HVAC system and switch states from a first state to a second state when the value of the measured first operating parameter reaches a first switching value;

switching from the first state to the second state when the value of the measured first operating parameter reaches the first switching value;

estimating, using a controller, a first estimated value of the first operating parameter; and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

33. The method of claim 32, further comprising:

responsive to a determination that the first estimated value is within the first threshold percentage of the first switching value, generating, using the controller, a first communication.

34. The method of claim 33, further comprising sending the first communication to an external device using a wireless connection.

35. The method of claim 34, further comprising determining whether the measuring device has switched states from the first state to the second state.

36. The method of claim 35, further comprising:

responsive to a determination that the measuring device has not switched states from the first state to the second state, changing demand on the compressor unit from a first load to a second load.

37. The method of claim 36, wherein changing the demand on the compressor unit comprises changing a speed of the compressor unit.

38. The method of claim 36, further comprising:

initiating, using the controller, a first mode of operation for calibrating operation of the compressor unit, wherein the initiation of the first mode of operation is based on the outside ambient temperature; and

operating, using the controller, the compressor unit under the second load for a first time period to change the measured first operating parameter at the discharge line from a first measured value to a second measured value, wherein the change in the first operating parameter at the discharge causes the measuring device to switch states.

39. The method of claim 38, further comprising:

measuring, using the controller, an outdoor temperature; and

changing, using the measuring device, states when the compressor unit is operated at the outside ambient temperature within a first calibration range.

40. The method of claim 38, wherein:

the measuring device comprises a pressure switch, and the first operating parameter comprises a pressure of a refrigerant in the discharge line at a position where the measuring device is mounted; and

the pressure switch is configured to measure the pressure of the refrigerant at a position where the pressure switch is mounted on the first line.

41. A system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) unit, the system comprising:

a pressure switch positioned on a discharge line of the compressor unit and configured to measure refrigerant pressure in the discharge line and switch operation of the HVAC unit from a first operating state to a second operating state when a value of the measured refrigerant pressure reaches a first switching value; and

a controller configured to estimate a first estimated value of the refrigerant pressure and determine whether the first estimated value is within a first threshold percentage of the first switching value.

42. A method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the method comprising:

mounting a measuring device on a discharge line of the compressor unit, wherein the measuring device is configured to measure at least a first operating parameter of the HVAC system and switch states from a first state to a second state when a value of the measured first operating parameter reaches a first switching value;

determining whether the measuring device has switched states from the first state to the second state;

responsive to a determination that the measuring device has not switched states from the first state to the second state, changing demand on the compressor unit from a first load to a second load; and

switching from the first state to the second state when the value of the measured first operating parameter reaches the first switching value;

estimating a first estimated value of the first operating parameter;

determining whether the first estimated value is within a first threshold percentage of the first

switching value; and

responsive to a determination that the first estimated value is within the first threshold percentage of the first switching value, generating a first communication; and
sending the first communication to an external device using a wireless connection.

43. The method of claim 42, wherein changing the demand comprises changing a speed of the compressor unit.

44. The method of claim 42 or 43, wherein:

the measuring device comprises a pressure switch, and the first operating parameter comprises a pressure of a refrigerant in the discharge line at a position where the measuring device is mounted; and

the pressure switch is configured to measure the pressure of the refrigerant at a position where the pressure switch is mounted on the discharge line.

45. The method of claim 42 or 43, wherein:

the measuring device comprises a temperature switch, and the first operating parameter comprises a temperature of a refrigerant in the discharge line at a position where the measuring device is mounted; and

the temperature switch is configured to measure the temperature of the refrigerant at a position where the temperature switch is mounted on the discharge line.

46. A system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) unit, the system comprising:

a temperature switch positioned on a discharge line of the compressor unit and configured to measure refrigerant temperature in the discharge line and switch operation of the HVAC unit from a first operating state to a second operating state when a value of the measured refrigerant temperature reaches a first switching value; and

a controller configured to estimate a first estimated value of the refrigerant temperature and determine whether the first estimated value is within a first threshold percentage of the first switching value.

47. A system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:
- an indoor unit operatively connected to an outdoor unit;
 - wherein the outdoor unit comprises the compressor unit, the compressor unit comprising a suction line and a discharge line;
 - a control assembly configured to operationally connect to the compressor unit, wherein the compressor unit operates at an outside ambient temperature;
 - a pressure switch configured to measure refrigerant pressure in the discharge line and switch states from a first state to a second state when a value of the measured refrigerant pressure reaches a first switching value; and
 - a controller configured to estimate a first estimated value of the measured refrigerant pressure and determine whether the first estimated value is within a first threshold percentage of the first switching value.
48. A system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the system comprising:
- an indoor unit operatively connected to an outdoor unit;
 - wherein the outdoor unit comprises the compressor unit, the compressor unit comprising a suction line and a discharge line;
 - a control assembly configured to operationally connect to the compressor unit, wherein the compressor unit operates at an outside ambient temperature;
 - a temperature switch configured to measure refrigerant temperature in the discharge line and switch states from a first state to a second state when a value of the measured refrigerant temperature reaches a first switching value; and
 - a controller configured to estimate a first estimated value of the measured refrigerant temperature and determine whether the first estimated value is within a first threshold percentage of the first switching value.
49. A method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system:
- measuring, using a measuring device mounted on a discharge line of the compressor unit, at least a first operating parameter of the HVAC system, wherein the measuring device operates in at

least one of a first state and a second state;

determining, using a controller, whether a value of the measured first operating parameter reaches a first switching value;

responsive to a positive determination, switching from the first state to the second state;

estimating, using the controller, a first estimated value of the first operating parameter; and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

50. A method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the method comprising:

measuring, using a pressure switch mounted on a discharge line of the compressor unit, refrigerant pressure in the discharge line;

determining, using a controller, whether the measured refrigerant pressure reaches a first switching value;

responsive to a positive determination, switching from a first state to a second state;

estimating, using the controller, a first estimated value of the measured refrigerant pressure;

and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

51. A method for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) system, the method comprising:

measuring, using a temperature switch mounted on a discharge line of the compressor unit, refrigerant temperature in the discharge line;

determining, using a controller, whether the measured refrigerant temperature reaches a first switching value;

responsive to a positive determination, switching from a first state to a second state;

estimating, using the controller, a first estimated value of the measured refrigerant temperature; and

determining, using the controller, whether the first estimated value is within a first threshold percentage of the first switching value.

52. A system for calibrating operation of a compressor unit in a heating, ventilation, and air conditioning (HVAC) unit, the system comprising:

a pressure switch positioned on a discharge line of the compressor unit and configured to measure refrigerant pressure in the discharge line and switch operation of the HVAC unit from a first operating state to a second operating state when a value of the measured refrigerant pressure reaches a first switching value; and

a controller configured to:

estimate a first estimated value of the refrigerant pressure;

determine whether the first estimated value is within a first threshold percentage of the first switching value;

generate a first communication based on the determination of whether the first estimated value is within the first threshold percentage of the first switching value; and

send the first communication to a third party.

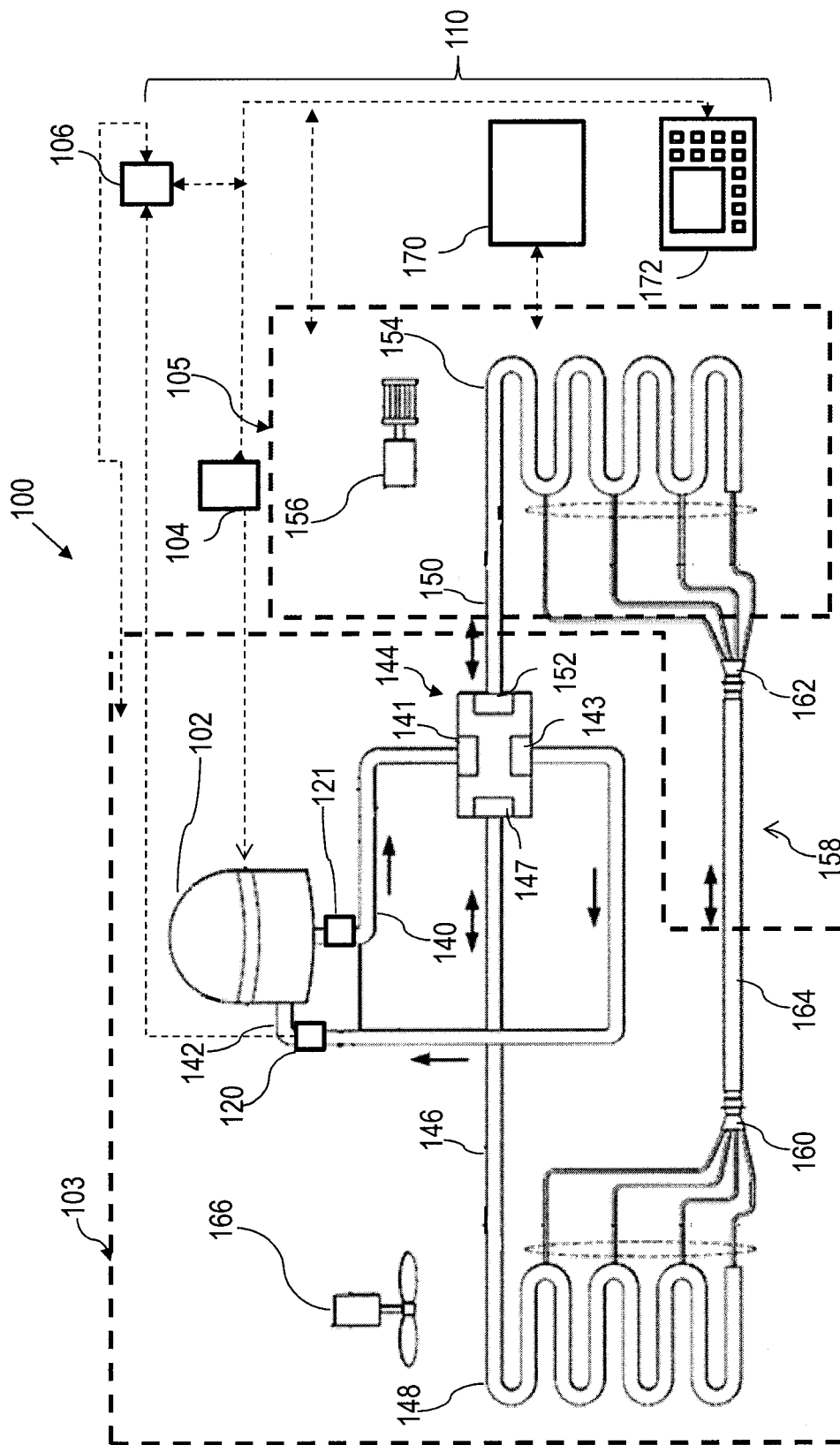


FIG. 1

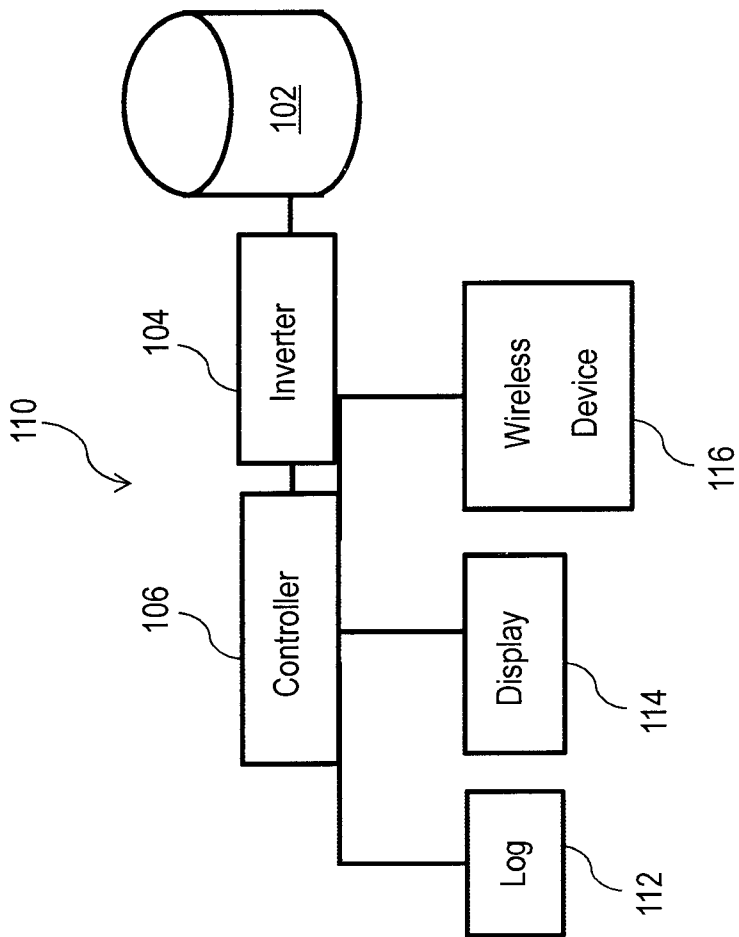


FIG. 2

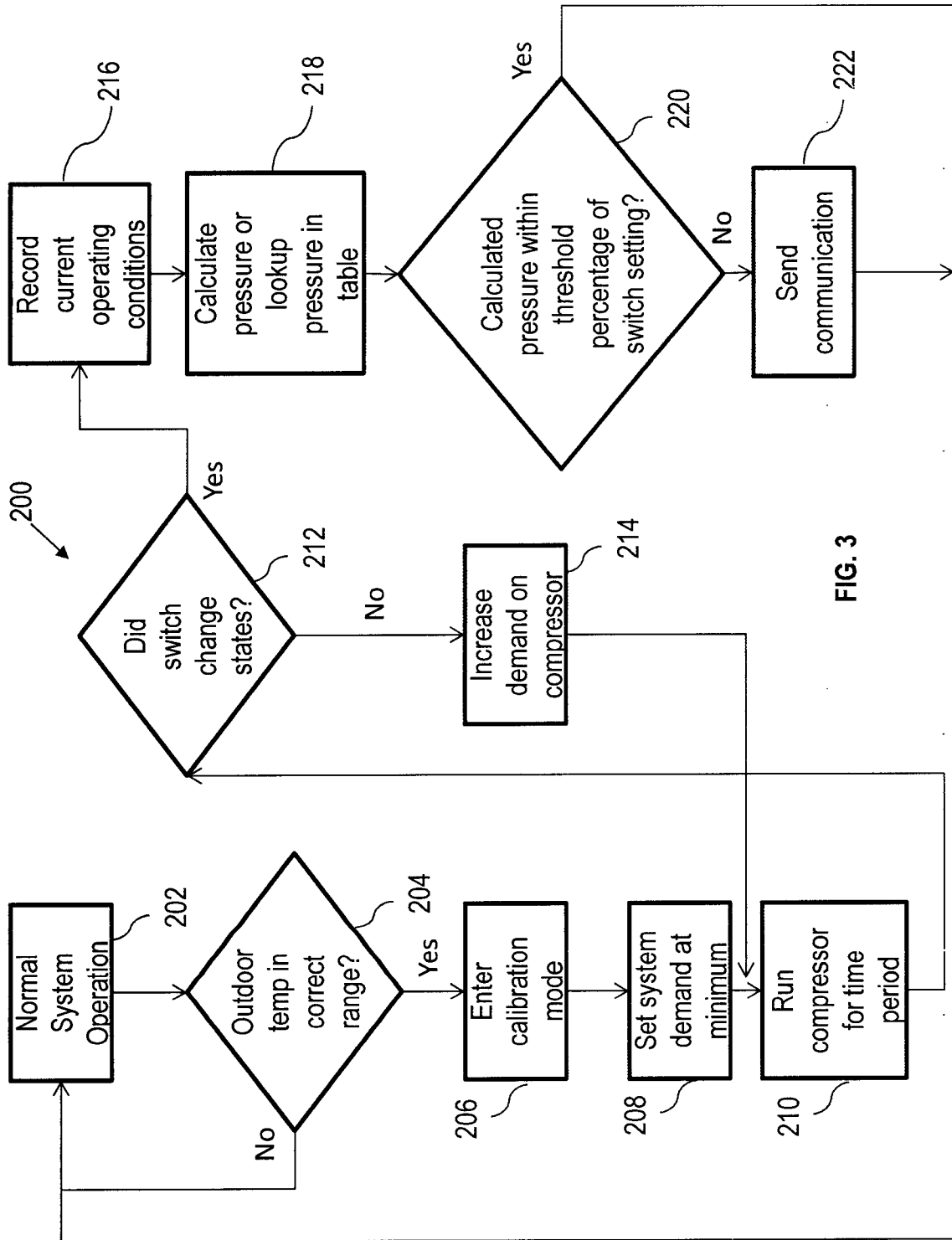


FIG. 3

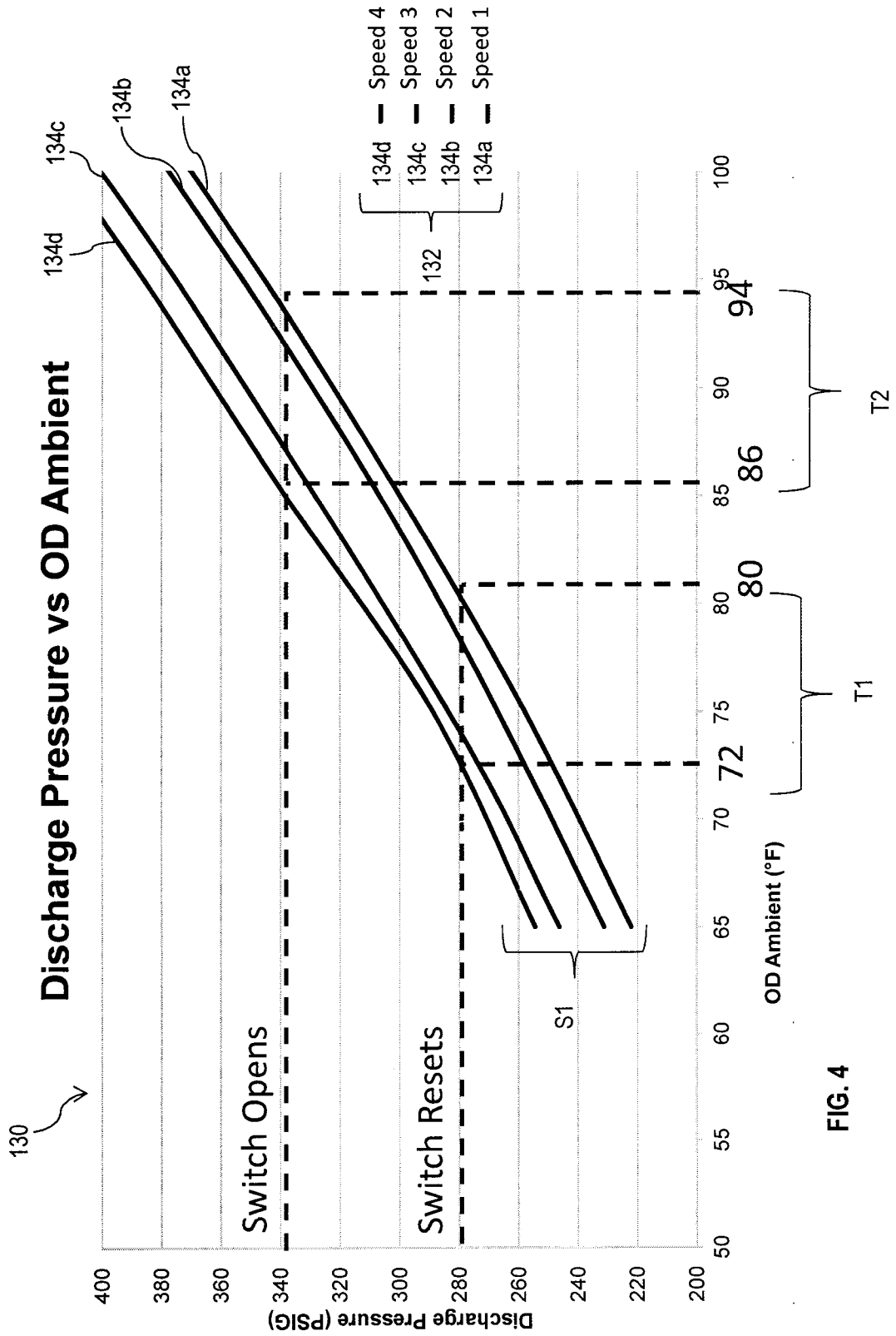


FIG. 4

