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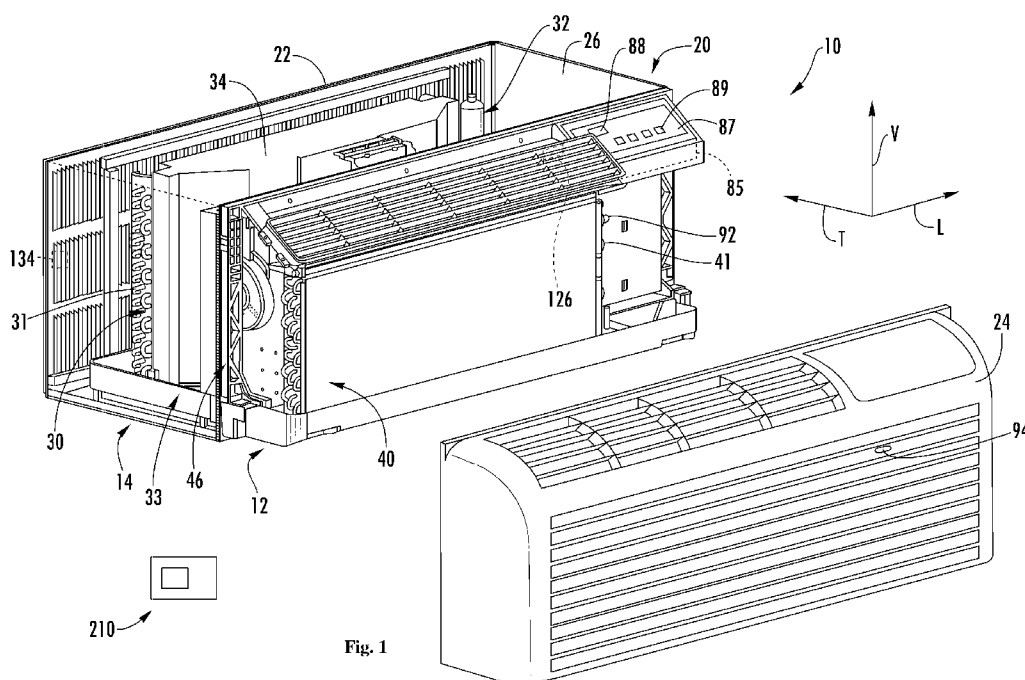


Fig. 1

(57) Abstract: A single-package air conditioner (10), includes a cabinet (20), an indoor heat exchanger (40), an outdoor heat exchanger (30), a compressor (32), an internal temperature sensor (92, 94, 126), a remote temperature sensor (132, 134), and a controller (85). The outdoor heat exchanger (30) may be disposed in an outdoor portion (14) that comprising an outdoor heat exchanger (30) and an outdoor fan (33). The indoor heat exchanger (40) may be disposed in an indoor portion (12) that comprising an indoor heat exchanger (40) and an indoor fan (42). The compressor (32) may be in fluid communication with the outdoor heat exchanger (30) and the indoor heat exchanger (40). The internal temperature sensor (92, 94, 126) may be attached to the cabinet (20) within the indoor portion (12). The remote temperature sensor (210) may be spaced apart from the cabinet (20). The controller (85) may be in operative communication with the compressor (32), the internal temperature sensor (92, 94, 126), and the remote temperature sensor (210). The controller (85)

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SINGLE-PACKAGE AIR CONDITIONER AND METHODS OF OPERATION

FIELD OF THE INVENTION

The present subject matter relates generally to single-package air conditioner units, including methods of operating such units with a remote temperature sensor.

BACKGROUND OF THE INVENTION

Air conditioner units are conventionally utilized to adjust the temperature within structures such as dwellings and office buildings. In particular, one-unit type or single-package room air conditioner units, such as window units, single-package vertical units (SPVU), vertical packaged air conditioners (VPAC), or package terminal air conditioners (PTAC) may be utilized to adjust the temperature in, for example, a single room or group of rooms of a structure. A typical one-unit type air conditioner or air conditioning appliance includes an indoor portion and an outdoor portion. The indoor portion generally communicates (e.g., exchanges air) with the area within a building, and the outdoor portion generally communicates (e.g., exchanges air) with the area outside a building. Accordingly, the air conditioner unit generally extends through, for example, a wall of the structure. Generally, a fan may be operable to rotate to motivate air through the indoor portion. Another fan may be operable to rotate to motivate air through the outdoor portion. A sealed cooling system including a compressor is generally housed within the air conditioner unit to treat (e.g., cool or heat) air as it is circulated through, for example, the indoor portion of the air conditioner unit. One or more control boards are typically provided to direct the operation of various elements of the particular air conditioner unit.

A typical air conditioner unit includes one or more temperature sensors for sensing various indoor or outdoor temperatures. Attempts have been made to use a remote temperature sensor, mounted away from the air conditioner unit to detect a room temperature that is then used to control the air conditioner unit. Although such remote temperature sensors may provide a more accurate representation of temperature within the entirety or majority of the corresponding room, difficulties may arise.

For instance, while remote temperature sensors may be mounted apart from an air conditioner unit, a wired or wireless connection is generally required to permit communication. If the connection is interrupted, such as by interference, loss of power, severance of the connection, etc., the air conditioner unit will be unable to detect temperature. Performance may be negatively affected. In some instances, the air conditioner unit may be inoperable without a steady connection to the remote temperature sensor. Performance may also be negatively impacted by a failure of the temperature sensor, such as one that might cause the remote temperature sensor to erroneously detect inappropriate temperatures.

Accordingly, it may be useful to provide an air conditioner unit addressing one or more of the above-identified issues. In particular, it may be advantageous to provide an air conditioner unit or method of operation that can accommodate connection losses or inappropriate temperature readings, such as from a remote temperature sensor.

BRIEF DESCRIPTION OF THE INVENTION

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.

In one exemplary aspect of the present disclosure, a method of operating an air conditioner unit is provided. The method may include receiving a remote temperature value from a remote temperature sensor, and evaluating the remote temperature value according to one or more predetermined criteria. The method may also include receiving an internal temperature value from an internal temperature sensor. The method may further include making a selection between the remote temperature value and the internal temperature value based on the evaluation, and directing a sealed system based on the selection.

In another exemplary aspect the present disclosure, a single-package air conditioner unit is provided. The single-package air conditioner unit may include a cabinet, an outdoor heat exchanger, a compressor, an internal temperature sensor, a remote temperature sensor, and a controller. The cabinet may define an outdoor portion and an indoor portion. The outdoor heat exchanger may be disposed in the outdoor portion and comprising an outdoor heat exchanger and an outdoor fan. The indoor heat exchanger may be disposed in the indoor portion and comprising an indoor heat exchanger and an indoor fan. The compressor may be in fluid communication with the outdoor heat exchanger and the indoor heat exchanger to circulate a refrigerant between the outdoor heat exchanger and the indoor heat exchanger. The internal temperature sensor may be attached to the cabinet within the indoor portion. The remote temperature sensor may be spaced apart from the cabinet. The controller may be in operative communication with the compressor, the internal temperature sensor, and the remote temperature sensor. The controller may be configured to initiate a conditioning operation. The conditioning operation may include receiving a remote temperature value from the remote temperature sensor, evaluating the remote temperature value according to one or more predetermined criteria, receiving an internal temperature value from the internal temperature sensor, making a selection between the remote temperature value and the internal temperature value based on the evaluation, and directing the compressor based on the selection.

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

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.

FIG. 1 provides a perspective view of an air conditioner unit, with a room front exploded from a remainder of the air conditioner unit for illustrative purposes, in accordance with exemplary embodiments of the present disclosure.

FIG. 2 is a perspective view of components of an indoor portion of an air conditioner unit in accordance with exemplary embodiments of the present disclosure.

FIG. 3 is a rear perspective view of a bulkhead assembly in accordance with exemplary embodiments of the present disclosure.

FIG. 4 is another perspective view of components of an indoor portion of an air conditioner unit in accordance with exemplary embodiments of the present disclosure.

FIG. 5 provides a schematic view of an air conditioner unit according to exemplary embodiments of the present disclosure.

FIG. 6 provides a flow chart illustrating a method of operating an air conditioner unit according to exemplary embodiments of the present disclosure.

FIG. 7 provides a flow chart illustrating a method of operating an air conditioner unit according to exemplary embodiments of the present disclosure.

DETAILED DESCRIPTION

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 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.

The terms “includes” and “including” are intended to be inclusive in a manner similar to the term “comprising.” Similarly, the term “or” is generally intended to be inclusive (i.e., “A or B” is intended to mean “A or B or both”). The phrase “in one embodiment,” does not necessarily refer to the same embodiment, although it may. The terms “first,” “second,” and “third” may be used interchangeably to distinguish one component from another and are not intended to signify location or importance of the individual components. The terms “upstream” and “downstream” refer to the relative flow direction with respect to fluid flow in a fluid pathway. For example, “upstream” refers to the flow direction from which the fluid flows, and “downstream” refers to the flow direction to which the fluid flows.

Referring now to the figures, in FIGS. 1 through 5, an air conditioner 10 according to various exemplary embodiments is provided. The air conditioner 10 is generally a one-unit type air conditioner, also conventionally referred to as a room air conditioner or package terminal air conditioner unit (PTAC). The air conditioner 10 includes an indoor portion 12 and an outdoor portion 14, and defines a vertical direction V, a lateral direction L, and a transverse direction T. Each direction V, L, T is perpendicular to each other, such that an orthogonal coordinate system is generally defined.

Although described in the context of a PTAC, an air conditioner unit as disclosed herein may be provided as a window unit, single-package vertical unit (SPVU), vertical packaged air conditioner (VPAC), or any other suitable single-package air conditioner. The air conditioner 10 is intended only as an exemplary unit and does not otherwise limit the scope of the present disclosure. Thus, it is understood that the present disclosure may be equally applicable to other types of air conditioner units

Generally, a cabinet 20 of the air conditioner 10 contains various other components of the air conditioner 10. Cabinet 20 may include, for example, a rear grill 22 and a room front 24 that may be spaced apart along the transverse direction T by a wall sleeve 26. The rear grill 22 may be part of the outdoor portion 14, while the room front 24 is part of the indoor portion 12.

Components of the outdoor portion 14, such as an outdoor heat exchanger 30, outdoor fan 33 (FIG. 5), and compressor 32 may be housed within the wall sleeve 26. A casing 34 may additionally enclose the outdoor fan 33, as shown.

Referring now also to FIG. 2, indoor portion 12 may include, for example, an indoor heat exchanger 40, a blower fan 42, and a heating unit 44. These components may, for example, be housed behind the room front 24. Additionally, a bulkhead 46 may generally support or house various other components or portions thereof of the indoor portion 12, such as the blower fan 42 and the heating unit 44. Bulkhead 46 may generally separate and define the indoor portion 12 and outdoor portion 14.

Outdoor and indoor heat exchangers 30, 40 may be components of a thermodynamic assembly (i.e., sealed system), which may be operated as a refrigeration assembly (and thus perform a refrigeration cycle) and, in the case of the heat pump unit embodiment, a heat pump (and thus perform a heat pump cycle). Thus, as is understood, exemplary heat pump unit embodiments may be selectively operated perform a refrigeration cycle at certain instances (e.g., while in a cooling mode) and a heat pump cycle at other instances (e.g., while in a heating mode). By contrast, exemplary A/C exclusive unit embodiments may be unable to perform a heat pump cycle (e.g., while in the heating mode), but still perform a refrigeration cycle (e.g., while in a cooling mode).

In optional embodiments, such as exemplary heat pump unit embodiments, the sealed system includes a reversible refrigerant valve 110 (FIG. 5). Reversible refrigerant valve 110 selectively directs compressed refrigerant from compressor 32 to either indoor heat exchanger 40 or outdoor heat exchanger 30. For example, in a cooling mode, reversible refrigerant valve 110 is arranged or configured to direct compressed refrigerant from compressor 32 to outdoor heat exchanger 30. Conversely, in a heating mode, reversible refrigerant valve 110 is arranged or configured to direct compressed refrigerant from compressor 32 to indoor heat exchanger 40. Thus, reversible refrigerant valve 110 permits the sealed system to adjust between the heating mode and the cooling mode, as will be understood by those skilled in the art.

The assembly may, for example, further include compressor 32 and an expansion valve, both of which may be in fluid communication with the heat exchangers 30, 40 to flow refrigerant therethrough, as is generally understood. Optionally, the compressor 32 may be a variable speed compressor or, alternatively, a single speed compressor. When the assembly is operating in a cooling mode, and thus performs a refrigeration cycle, the indoor heat exchanger 40 acts as an evaporator and the outdoor heat exchanger 30 acts as a condenser. In heat pump unit embodiments, when the assembly is operating in a heating mode, and thus performs a heat pump cycle, the indoor heat exchanger 40 acts as a condenser and the outdoor heat exchanger 30 acts as an evaporator. The outdoor and indoor heat exchangers 30, 40 may each include coils 31, 41, as illustrated, through which a refrigerant may flow for heat exchange purposes, as is generally understood.

Bulkhead 46 may include various peripheral surfaces that define an interior 50 thereof. For example, and additionally referring to FIG. 3, bulkhead 46 may include a first sidewall 52 and a second sidewall 54 which are spaced apart from each other along the lateral direction L. A rear wall 56 may extend laterally between the first sidewall 52 and second sidewall 54.

The rear wall 56 may, for example, include an upper portion 60 and a lower portion 62. Upper portion 60 may for example have a generally curvilinear cross-sectional shape, and may

accommodate a portion of the blower fan 42 when blower fan 42 is housed within the interior 50. Lower portion 62 may have a generally linear cross-sectional shape, and may be positioned below upper portion 60 along the vertical direction V. Rear wall 56 may further include an indoor facing surface 64 and an opposing outdoor facing surface. The indoor facing surface 64 may face the interior 50 and indoor portion 12, and the outdoor facing surface 66 may face the outdoor portion 14.

Bulkhead 46 may additionally extend between a top end 61 and a bottom end 63 along vertical axis V. Upper portion 60 may, for example, include top end 61, while lower portion 62 may, for example, include bottom end 63.

Bulkhead 46 may additionally include, for example, an air diverter 68, which may extend between the sidewalls 52, 54 along the lateral direction L and through which air may flow.

In exemplary embodiments, blower fan 42 may be a tangential fan. Alternatively, however, any suitable fan type may be utilized. Blower fan 42 may include a blade assembly 70 and a motor 72. The blade assembly 70, which may include one or more blades disposed within a fan housing 74, may be disposed at least partially within the interior 50 of the bulkhead 46, such as within the upper portion 60. As shown, blade assembly 70 may for example extend along the lateral direction L between the first sidewall 52 and the second sidewall 54. The motor 72 may be connected to the blade assembly 70, such as through the fan housing 74 to the blades via a shaft. Operation of the motor 72 may rotate the blades, thus generally operating the blower fan 42. Further, in exemplary embodiments, motor 72 may be disposed exterior to the bulkhead 46. Accordingly, the shaft may for example extend through one of the sidewalls 52, 54 to connect the motor 72 and blade assembly 70.

In exemplary embodiments, heating unit 44 includes one or more heater banks 80. Each heater bank 80 may be operated as desired to produce heat. In some embodiments, three heater banks 80 may be utilized, as shown. Alternatively, however, any suitable number of heater banks 80 may be utilized. Each heater bank 80 may further include at least one heater coil or coil pass 82, such as in exemplary embodiments two heater coils or coil passes 82. Alternatively, other suitable heating elements may be utilized. As is understood, each heater coil pass 82 may be provided as a resistive heating element configured to generate heat in response to resistance to an electrical current flowed therethrough.

The operation of air conditioner 10 including compressor 32 (and thus the sealed system generally) blower fan 42, fan 33, heating unit 44, and other suitable components may be controlled by a control board or controller 85. Controller 85 may be in communication (via for example a suitable wired or wireless connection) to such components of the air conditioner 10. By way of example, the controller 85 may include a memory and one or more processing devices such as microprocessors, CPUs or the like, such as general or special purpose microprocessors operable to execute programming instructions or micro-control code associated with operation of air conditioner 10. The memory may be a separate component from the processor or may be included onboard within the processor. The memory may represent random access memory such as DRAM, or read only memory such as ROM or FLASH. Generally, the processor executes programming instructions stored in memory.

Air conditioner 10 may additionally include a control panel 87 and one or more user inputs 89, which may be included in control panel 87. The user inputs 89 may be in communication with the controller 85. A user of the air conditioner 10 may interact with the

user inputs 89 to operate the air conditioner 10, and user commands may be transmitted between the user inputs 89 and controller 85 to facilitate operation of the air conditioner 10 based on such user commands. A display 88 may additionally be provided in the control panel 87, and may be in communication with the controller 85. Display 88 may, for example be a
5 touchscreen or other text-readable display screen, or alternatively may simply be a light that can be activated and deactivated as required to provide an indication of, for example, an event or setting for the air conditioner 10.

Referring now to FIGS. 1, 4, and 5, a first indoor temperature sensor 92 (e.g., indoor refrigerant temperature sensor) and a second indoor temperature sensor 94 (e.g., indoor
10 ambient temperature sensor) may be disposed within the indoor portion 12. In optional embodiments, a third indoor temperature sensor 126 (e.g., indoor outlet temperature sensor) (as indicated in phantom lines) is disposed within the indoor portion 12. In alternative embodiments, indoor portion 12 is free of any such third indoor temperature sensor 126. Each temperature sensor may be configured to sense the temperature of its surroundings. For
15 example, each temperature sensor may be a thermistor or a thermocouple. The indoor temperature sensors 92, 94, 126 may be in communication with the controller 85, and may transmit temperatures sensed thereby to the controller 85 (e.g., as one or more voltages or signals, which the controller 85 is configured to interpret as temperature values). Optionally, the voltages or signal transmitted to the controller 85 may be transmitted in response to a
20 polling request or signal received by one or more of the indoor temperature sensors 92, 94, 126. For example, a polling request or signal may be transmitted to one or more of the indoor temperature sensors 92, 94, 126 from the controller 85.

First indoor temperature sensor 92 may be disposed proximate the indoor heat exchanger 40 (such as relative to the second indoor temperature sensor 94). For example, in some
25 embodiments, first indoor temperature sensor 92 may be in contact with the indoor heat exchanger 40, such as with a coil 41 thereof. The first indoor temperature sensor 92 may be configured to detect a temperature for the indoor heat exchanger 40. Second indoor temperature sensor 94 may be spaced from the indoor heat exchanger 40, such as in the transverse direction T. For example, the second indoor temperature sensor 94 may be in contact
30 with the room front 24, as illustrated in FIG. 1. Second indoor temperature sensor 94 may be configured to detect a temperature of air entering the indoor portion 12. Third indoor temperature sensor 126 may be spaced apart from and disposed downstream of both the first indoor temperature sensor 92 and the second indoor temperature sensor 94. For example, the third indoor temperature sensor 126 may be attached to or in contact with the air diverter 68.
35 The third indoor temperature sensor 126 may be configured to detect a temperature for air exiting the indoor portion 12. During certain operations (e.g., cooling operations), air may thus generally flow across or adjacent to the second indoor temperature sensor 94, the first indoor temperature sensor 92, and then the third indoor temperature sensor 126.

Referring especially to FIGS. 1 and 5, some embodiments, such as exemplary heat pump
40 unit embodiments, a first outdoor temperature sensor 132 (e.g., outdoor refrigerant temperature sensor) (as indicated in phantom lines) and a second outdoor temperature sensor 134 (e.g., outdoor ambient temperature sensor) (as indicated in phantom lines) are disposed within the outdoor portion 14. Each temperature sensor may be configured to sense the temperature of its surroundings. For example, each temperature sensor may be a thermistor or a thermocouple.

The outdoor temperature sensors 132, 134 may be in communication with the controller 85, and may transmit temperatures sensed thereby to the controller 85 (e.g., as one or more voltage signals, which the controller 85 is configured to interpret as temperature readings).

First outdoor temperature sensor 132 may be disposed proximate the outdoor heat exchanger 30 (such as relative to the second outdoor temperature sensor 134). For example, in some embodiments, first outdoor temperature sensor 132 may be in contact with the outdoor heat exchanger 30, such as with a coil 31 (FIG. 1) thereof. The first outdoor temperature sensor 132 may be configured to detect a temperature for the outdoor heat exchanger 30. Second outdoor temperature sensor 134 may be spaced from the outdoor heat exchanger 30, such as in the transverse direction T. For example, the second outdoor temperature sensor 134 may be in contact with the rear grill 22 (FIG. 1). The second outdoor temperature sensor 134 may be configured to detect a temperature for air entering the outdoor portion 14. During certain operations (e.g., heating operations), air may thus generally flow across or adjacent to the second outdoor temperature sensor 134 and then the first outdoor temperature sensor 132.

In some embodiments, a remote temperature sensor 210, such as a remote thermostat, is provided at a location separate and apart from the cabinet 20. For instance, the remote temperature sensor 210 may be spaced apart from cabinet 20 while remaining in selective communication with the controller 85 (e.g., via for example a suitable wired or wireless connection). Thus, the remote temperature sensor 210 may be mounted or positioned within the same room as the indoor and outdoor portions 12, 14, while selectively detecting a temperature that is not immediately adjacent to either the indoor and outdoor portions 12, 14. Additionally or alternatively, the remote temperature sensor 210 may be independently movable relative to the cabinet 20.

Generally, the remote temperature sensor 210 includes a remote body 212 that houses or supports a suitable temperature circuit 214 for detecting temperature. For instance, the remote temperature sensor 210 may include a temperature circuit 214 that is or includes one or more thermocouples, thermistors, optical temperature sensors, infrared temperature sensors, etc. Within the remote body 212, a secondary controller 216 may be provided (e.g., in communication with or as part of temperature circuit 214). In additional or alternative embodiments, a network interface 218 may be mounted within the remote body 212 (e.g., to selectively communicate with the controller 85).

In some embodiments, the secondary controller 216 includes one or more memory devices and one or more processors. The processors of the secondary controller 216 can be any combination of general or special purpose processors, CPUs, or the like that can execute programming instructions or control code associated with operation of remote temperature sensor 210. The memory devices (i.e., memory) of the secondary controller 216 may represent random access memory such as DRAM or read only memory such as ROM or FLASH. In certain embodiments, the processor of the secondary controller 216 executes programming instructions stored in the memory of the secondary controller 216. The memory of the secondary controller 216 may be a separate component from the processor or may be included onboard within the processor. Alternatively, the secondary controller 216 may be constructed without using a processor, for example, using a combination of discrete analog or digital logic circuitry (such as switches, amplifiers, integrators, comparators, flip-flops, AND gates, and the like) to perform control functionality instead of relying upon software.

In optional embodiments, the secondary controller 216 includes a network interface 218 (e.g., on or off board secondary controller 216) such that secondary controller 216 can connect to and communicate over one or more networks (e.g., wireless communications network 220) with the controller 85. In some such embodiments, network interface 218 includes one or more transmitting, receiving, or transceiving components for transmitting/receiving communications with the controller 85 via wireless communications network 220. In exemplary embodiments, the wireless communications network 220 may be a wireless sensor network (such as a Bluetooth communication network), a wireless local area network (WLAN), a point-to-point communication networks (such as radio frequency identification networks, near field communications networks, etc.), or a combination of two or more of the above communications networks.

In certain embodiments, the secondary controller 216 is configured to transmit (e.g., wirelessly transmit) one or more detected temperature values (i.e., signals corresponding to a value of a temperature detected at remote temperature sensor 210) to the controller 85. For example, the secondary controller 216 may be configured to transmit detected temperature values unprompted by any outside request, such as a polling request that might otherwise be transmitted to the secondary controller 216 from the controller 85. Thus, the secondary controller 216 may determine to transmit remote temperature values independently of the controller 85 or any other device. The receipt of remote temperature values by the controller 85 may be entirely passive or unprompted by the controller 85. In some such embodiments, the remote temperature values from the secondary controller 216 are transmitted asynchronously or, alternatively, according to a predetermined scheduled (e.g., programmed within the secondary controller 216). Advantageously, the lack of a request-polling signal may conserve power (e.g., at the remote temperature sensor 210) and improve communication between the secondary controller 216 and controller 85.

Once received, a temperature value from the remote temperature sensor 210 (i.e., a remote temperature value) may be stored (e.g., temporarily) within controller 85, such as within a temporary or detected field. If the value meets one or more predetermined criteria, the value within the temporary or detected field may be utilized as an operating temperature (e.g., within an operating temperature field), which the controller 85 may treat as a measure of current temperature within a given room (e.g., as the controller 85 directs the sealed system in order to achieve a temperature setpoint provided by a user).

Referring now to FIGS. 6 and 7, the present disclosure may further be directed to methods (e.g., method 600 or 700) of operating an air conditioner or air conditioning appliance, such as air conditioner 10. In exemplary embodiments, the controller 85 may be operable to perform various steps of a method in accordance with the present disclosure.

The methods (e.g., 600 or 700) may occur as, or as part of, a conditioner operation (i.e., a cooling or heating operation) of the air conditioner 10. In particular, the methods disclosed herein may advantageously ensure continuous operation of the air conditioner 10, irrespective of a connection to the remote temperature sensor 210. Additionally or alternatively, the methods (e.g., 600 or 700) may advantageously facilitate accurate determination of the temperature of a room or area in which the air conditioner 10 is provided.

It is noted that the order of steps within methods 600 and 700 are for illustrative purposes. Moreover, neither method 600 nor 700 is mutually exclusive. In other words, methods within

the present disclosure may include either or both of methods 600 and 700. Both may be adopted or characterized as being fulfilled in a common operation. Except as otherwise indicated, one or more steps in the below method 600 or 700 may be changed, rearranged, performed in a different order, or otherwise modified without deviating from the scope of the present disclosure.

Turning especially to FIG. 6, at 610, the method 600 includes receiving a remote temperature value from the wireless remote temperature sensor. As discussed above, the remote temperature value may be a detected temperature value corresponding to a temperature at the wireless remote temperature sensor. In some embodiments, the remote temperature value is received wirelessly (e.g., through the wireless communications network).

In optional embodiments, receipt of the remote temperature value may be unprompted (e.g., by the controller within the air conditioner, as discussed above). For example, the remote temperature value may be received unprompted by any polling request. In some such embodiments, receipt of the remote temperature value is completely passive on the part of the controller within the air conditioning appliance.

In certain embodiments, the secondary controller is configured to transmit (e.g., wirelessly transmit) one or more detected temperature values (i.e., signals corresponding to a value of a temperature detected at remote temperature sensor) to the controller. For example, the secondary controller may be configured to transmit detected temperature values unprompted by any outside request, such as a polling request that might otherwise be transmitted to the secondary controller from the controller. Thus, the secondary controller may determine to transmit remote temperature values independently of the controller or any other device. The receipt of remote temperature values by the controller may be entirely passive or unprompted by the controller (or any other step of the method 600). In some such embodiments, the remote temperature values are transmitted asynchronously or, alternatively, according to a predetermined scheduled (e.g., programmed within the secondary controller).

Upon being received, the remote temperature value may be saved or stored (e.g., within the memory of the controller within the air conditioner). Additionally or alternatively, a preset timer (e.g., corresponding to a predetermined time period, such as might be denoted in seconds) may be initiated after (e.g., in response to) receipt of the remote temperature value. In some such embodiments, the remote temperature value is saved or stored for the duration of the preset timer or predetermined time period. Optionally, following (e.g., immediately following) expiration of the preset timer, the remote temperature value may be deleted or discarded.

In optional embodiments, 610 occurs following an extended period of operation of the air conditioner. The remote temperature value received at 610 may not be the first (e.g., first in time) temperature value that is utilized at the air conditioner for a given operation or cycle. In optional embodiments, the remote temperature value at 610 may be received subsequent to receipt of a previous temperature value or a failed detection event.

As an example, the detected temperature value of 610 may be detected within a predetermined time period following detection of a previous temperature value. The previous temperature value may be detected at the remote temperature sensor and correspond to a previous temperature at the wireless remote temperature sensor.

As an additional or alternative example, the detected temperature value of 610 may be detected following a failed temperature detection event wherein no value was received from

the remote temperature sensor (e.g., within a predetermined time period). The failed temperature event may indicate communication between the remote temperature sensor and the controller within the cabinet of the air conditioner has been interrupted or that one or more functions of the remote temperature sensor have been halted (e.g., as a result of the remote temperature sensor losing power, malfunctioning, etc.).

Additionally or alternatively, the remote temperature value at 610 may replace a previous temperature value or a preset failing temperature value within a portion of the air conditioner unit (e.g., within a temporary or detected field of a program for controlling the air conditioner).

At 620, the method 600 includes evaluating the remote temperature value received at 610 according to one or more predetermined criteria. Generally, the predetermined criteria may correspond to reasonable expectations for the received remote temperature value. For example, the one or more predetermined criteria may include a criterion that the remote temperature value is within a predetermined temperature range (e.g., maximum limit or minimum limit). Thus, 620 may include determining whether the received remote temperature value falls within the predetermined range. In optional embodiments, the predetermined range includes values that fall below (i.e., are less than or equal to) a preset maximum limit (e.g., 50° Celsius, 65° Celsius, or 70° Celsius, which would be virtually impossible to reach in the course of typical operations). In additional or alternative embodiments, the predetermined range includes values that rise above (i.e., are greater than or equal to) a preset minimum limit (e.g., -10° Celsius, -15° Celsius, or -25° Celsius, which would be virtually impossible to reach in the course of typical operations). In further additional alternative embodiments, the predetermined range includes values that are between the preset maximum limit and the preset minimum limit.

At 630, the method 600 includes receiving an internal temperature value from an internal temperature sensor, such as an indoor ambient temperature sensor, as described above (e.g., as a voltage signal that is interpreted as a temperature value by the controller within the air conditioner). In some such embodiments, the internal temperature value is received in response to transmission of a polling signal to the internal temperature sensor.

At 640, the method 600 includes making a selection between the remote temperature value and the internal temperature value based on the evaluation. In other words, based on the evaluation at 620, either the remote temperature value or the internal temperature value will be selected (e.g., for the operating temperature field of a program controlling the air conditioner).

In some embodiments, 640 includes selecting the remote temperature value in response to the remote temperature value meeting the one or more predetermined criteria. Thus, if the remote temperature value meets the predetermined criteria at 620, the remote temperature value is selected. For instance, in response to the remote temperature value being evaluated as within the predetermined temperature range, the remote temperature value may be selected.

In additional or alternative embodiments, 640 includes selecting the internal temperature value in response to the remote temperature value failing to meet the one or more predetermined criteria. Thus, if the remote temperature value does not meet the predetermined criteria at 620, the internal temperature value is selected. For instance, in response to the internal temperature value being evaluated as outside of the predetermined temperature range, the internal temperature value may be selected.

At 650, the method 600 includes directing the sealed system (e.g., at the compressor) based on the selection. Additionally or alternatively, the heating assembly may be activated, as

described above. In some such embodiments, the air conditioner can use the selected remote temperature value or internal temperature value as a detected variable (e.g., within an operating temperature field) for cooling or heating a room. For instance, the detected variable may be provided within a temperature-contingent feedback loop using a provided setpoint, as is understood.

It is further understood, that the method 600 may include repeating one or more of the above steps. For instance, upon expiration of the preset timer or predetermined time period, steps 610 through 650 may be repeated. Additionally or alternatively, operation of the air conditioner subsequent to expiration of the preset timer or predetermined time period may be based on whether a new remote temperature value is received from the remote temperature sensor. For instance, the saved or stored temperature value from the earlier 610 may be discarded or deleted.

In some such embodiments, if a new remote temperature value is received from the remote temperature sensor within the preset timer or predetermined time period (e.g., subsequent to initiation and prior to expiration thereof), the new remote temperature value may be saved or stored in place of a previous temperature value. In other words, the new remote temperature value may replace the previous temperature value. For instance, the new remote temperature value may replace the previous temperature value as a temporarily saved value within a detected field. Subsequently, steps 620 through 650 may be repeated.

In additional or alternative embodiments, if a new remote temperature value is not received from the remote temperature sensor within the preset timer or predetermined time period (e.g., subsequent to initiation and prior to expiration thereof), a failed detection event may be identified. Identification of the failed detection event may prompt saving or storing a preset failing temperature value in place of a previous temperature value. For example, the preset failing temperature value may be temporarily saved within a detected field of the memory of the controller within the air conditioner. In some instances, the preset failing temperature value may replace the previous temperature value as a temporarily saved value within a detected field. The preset failing temperature value may be a value known to be outside of the predetermined criteria (e.g., not within the predetermined temperature range). Subsequently, steps 620 through 650 may be repeated. Thus, the previous remote temperature value may be replaced with a value that is predetermined as failing to meet the predetermined criteria, ensuring that the internal temperature sensor will be selected and used to direct the sealed system.

Turning especially to FIG. 7, at 710, the method 700 includes determining whether a remote temperature value has been received (e.g., within a predetermined time period). In some such embodiments, the predetermined time period may be monitored or tracked by a preset timer that is initiated in response to a prior event (e.g., initiation of the method 700 or receipt of a previous remote temperature value).

As discussed above, the remote temperature value may be a detected temperature value corresponding to a temperature at the wireless remote temperature sensor. In some embodiments, the remote temperature value is received wirelessly (e.g., through the wireless communications network).

In optional embodiments, receipt of the remote temperature value may be unprompted (e.g., by the controller within the air conditioner, as discussed above). For example, the remote

temperature value may unprompted by any polling request. In some such embodiments, receipt is completely passive on the part of the controller within the air conditioning appliance.

In certain embodiments, the secondary controller is configured to transmit (e.g., wirelessly transmit) one or more detected temperature values (i.e., signals corresponding to a value of a temperature detected at remote temperature sensor) to the controller. For example, the secondary controller may be configured to transmit detected temperature values unprompted by any outside request, such as a polling request that might otherwise be transmitted to the secondary controller from the controller. Thus, the secondary controller may determine to transmit remote temperature values independently of the controller or any other device. The receipt of remote temperature values by the controller may be entirely passive or unprompted by the controller (or any other step of the method 700). In some such embodiments, remote temperature values can be transmitted asynchronously or, alternatively, according to a predetermined scheduled (e.g., programmed within the secondary controller).

If a remote temperature value is received at 710, the method 700 may proceed to 720. By contrast, if no remote temperature value is received at 710, the method may proceed to 730.

At 720, the method 700 includes storing the remote temperature value (e.g., within a temporary or detected field of the memory of the controller within the air conditioner). For instance, the remote temperature value may be temporarily stored within a detected field of the controller of the air conditioner. If a previous temperature value is already stored within the detected field, 720 may include deleting the previous temperature value from the detected field. Following 720, the method 700 may proceed to 740 or 750.

At 730, the method 700 includes storing a preset failing value (e.g., within a temporary or detected field of the memory of the controller within the air conditioner). For instance, a preset failing value, already saved within another portion of the controller of the air conditioner, may be duplicated and stored within the detected field. If a previous temperature value is already stored within the detected field, 730 may include deleting the previous temperature value from the detected field. Following 730, the method 700 may proceed to 740 or 750.

At 740, the method 700 includes receiving an internal temperature value from an internal temperature sensor, such as an indoor ambient temperature sensor, as described above (e.g., as a voltage signal that is interpreted as a temperature value by the controller within the air conditioner). In some such embodiments, the internal temperature value is received in response to transmission of a polling signal to the internal temperature sensor.

At 750, the method 700 includes evaluating the stored value from 720 or 730 according to one or more predetermined criteria. In other words, if the remote temperature value is stored within the detected field, 750 includes evaluating the stored remote temperature value according to the one or more predetermined criteria. If the preset failing value is stored within the detected field, 750 includes evaluating the stored preset failing temperature value according to the one or more predetermined criteria.

Generally, the predetermined criteria may correspond to reasonable expectations for a temperature value. For example, the one or more predetermined criteria may include a criterion that the stored value is within a predetermined temperature range (e.g., maximum limit or minimum limit). Thus, 750 may include determining whether the stored value falls within the predetermined range. In optional embodiments, the predetermined range includes values that fall below (i.e., are less than or equal to) a preset maximum limit (e.g., 50° Celsius, 65° Celsius,

or 70° Celsius, which would be virtually impossible to reach in the course of typical operations). In additional or alternative embodiments, the predetermined range includes values that rise above (i.e., are greater than or equal to) a preset minimum limit (e.g., -10° Celsius, -15° Celsius, or -25° Celsius, which would be virtually impossible to reach in the course of typical operations). In further additional alternative embodiments, the predetermined range includes values that are between the preset maximum limit and the preset minimum limit.

In response to a determination that the stored value does meet the predetermined criteria at 750, the method 700 may proceed to 760. By contrast, in response to a determination that the stored value does not meet the predetermined criteria at 750, the method 700 may proceed to 770.

At 760, the method may include directing the sealed system (e.g., at the compressor) based on the received remote temperature value (e.g., from 710). Additionally or alternatively, the heating assembly may be activated, as described above. In some embodiments, the air conditioner can use the received remote temperature value as a detected variable (e.g., within an operating temperature field) for cooling or heating a room. For instance, the received remote temperature value may be provided within a temperature-contingent feedback loop using a provided setpoint, as is understood. Moreover, the preset timer may be reset to again monitor or track an instance of the predetermined time period. Subsequently, the method 700 may be repeated (e.g., by returning to 710).

At 770, the method may include directing the sealed system (e.g., at the compressor) based on the received internal temperature value (e.g., from 740). Additionally or alternatively, the heating assembly may be activated, as described above. In some embodiments, the air conditioner can use the received remote internal temperature value as a detected variable (e.g., within an operating temperature field) for cooling or heating a room. For instance, the received internal temperature value may be provided within a temperature-contingent feedback loop using a provided setpoint, as is understood. Moreover, the preset timer may be reset to again monitor or track an instance of the predetermined time period. Subsequently, the method 700 may be repeated (e.g., by returning to 710).

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.

CLAIMS

1. A method of operating an air conditioner comprising a cabinet and a remote temperature sensor spaced apart from the cabinet, the cabinet housing an internal temperature sensor and a sealed system, the sealed system comprising an outdoor heat exchanger disposed in an outdoor portion and an indoor heat exchanger disposed in an indoor portion, the method comprising:

receiving a remote temperature value from the remote temperature sensor;

evaluating the remote temperature value according to one or more predetermined criteria;

receiving an internal temperature value from the internal temperature sensor;

making a selection between the remote temperature value and the internal temperature value based on the evaluation; and

directing the sealed system based on the selection.

2. The method of claim 1, wherein the remote temperature value is a detected temperature value corresponding to a temperature at the remote temperature sensor.

3. The method of claim 2, wherein the detected temperature value is detected within a predetermined time period following detection of a previous temperature value corresponding to a previous temperature at the remote temperature sensor.

4. The method of claim 2, wherein the detected temperature value is detected following a failed temperature detection event wherein no value was received from the remote temperature sensor.

5. The method of claim 1, wherein the remote temperature value replaces a preset failing temperature value stored within the air conditioner, the preset failing temperature value being predetermined to fail the one or more predetermined criteria.

6. The method of claim 1, wherein making the selection comprises selecting the remote temperature value in response to the remote temperature value meeting the one or more predetermined criteria.

7. The method of claim 1, wherein making the selection comprises selecting the internal temperature value in response to the remote temperature value failing to meet the one or more predetermined criteria.

8. The method of claim 1, wherein the internal temperature value is received in response to transmission of a polling signal to the internal temperature sensor.

9. The method of claim 1, wherein the one or more predetermined criteria includes a criterion that the remote temperature value is within a predetermined temperature range.

10. A single-package air conditioner unit defining a mutually-perpendicular vertical direction, lateral direction, and transverse direction, the single-package air conditioner unit comprising:

a cabinet defining an outdoor portion and an indoor portion;

an outdoor heat exchanger disposed in the outdoor portion and comprising an outdoor heat exchanger and an outdoor fan;

an indoor heat exchanger disposed in the indoor portion and comprising an indoor heat exchanger and an indoor fan;

a compressor in fluid communication with the outdoor heat exchanger and the indoor heat exchanger to circulate a refrigerant between the outdoor heat exchanger and the indoor heat

exchanger;

an internal temperature sensor attached to the cabinet within the indoor portion;

a remote temperature sensor spaced apart from the cabinet; and

a controller in operative communication with the compressor, the internal temperature
5 sensor, and the remote temperature sensor, the controller being configured to initiate a conditioning operation, the conditioning operation comprising

receiving a remote temperature value from the remote temperature sensor,

evaluating the remote temperature value according to one or more predetermined
criteria,

10 receiving an internal temperature value from the internal temperature sensor,

making a selection between the remote temperature value and the internal
temperature value based on the evaluation, and

directing the compressor based on the selection.

11. The single-package air conditioner unit of claim 10, wherein the remote temperature
15 value is a detected temperature value corresponding to a temperature at the remote temperature sensor.

12. The single-package air conditioner unit of claim 11, wherein the detected temperature
value is detected within a predetermined time period following detection of a previous
temperature value corresponding to a previous temperature at the remote temperature sensor.

20 13. The single-package air conditioner unit of claim 11, wherein the detected temperature
value is detected following a failed temperature detection event wherein no value was received
from the remote temperature sensor.

14. The single-package air conditioner unit of claim 10, wherein the remote temperature
value replaces a preset failing temperature value stored within the single-package air
25 conditioner unit, the preset failing temperature value being predetermined to fail the one or
more predetermined criteria.

15. The single-package air conditioner unit of claim 10, wherein making the selection
comprises selecting the remote temperature value in response to the remote temperature value
meeting the one or more predetermined criteria.

30 16. The single-package air conditioner unit of claim 10, wherein making the selection
comprises selecting the internal temperature value in response to the remote temperature value
failing to meet the one or more predetermined criteria.

17. The single-package air conditioner unit of claim 10, wherein the internal temperature
value is received in response to transmission of a polling signal to the internal temperature
35 sensor.

18. The single-package air conditioner unit of claim 10, wherein the one or more
predetermined criteria includes a criterion that the remote temperature value is within a
predetermined temperature range.

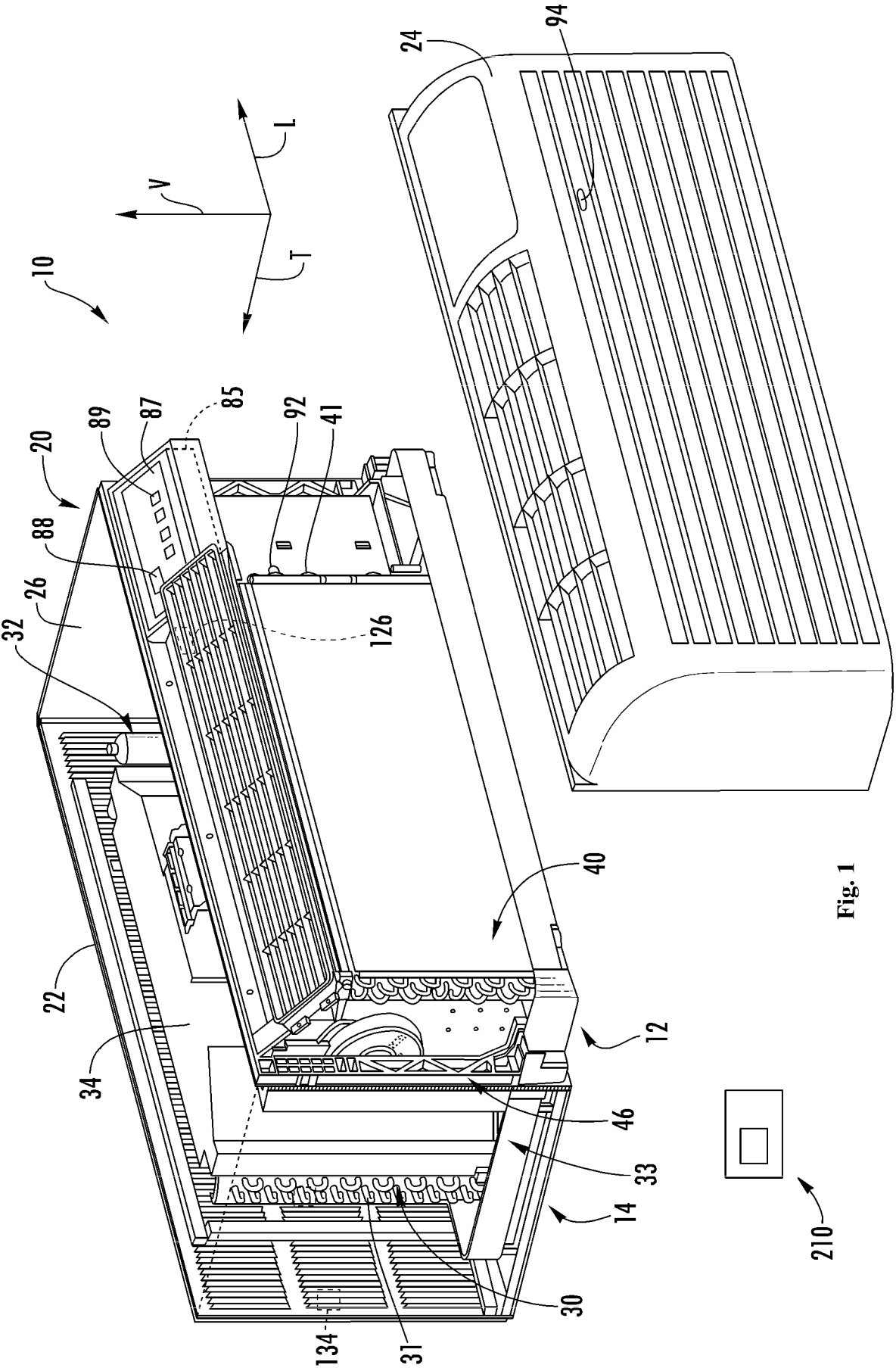


Fig. 1

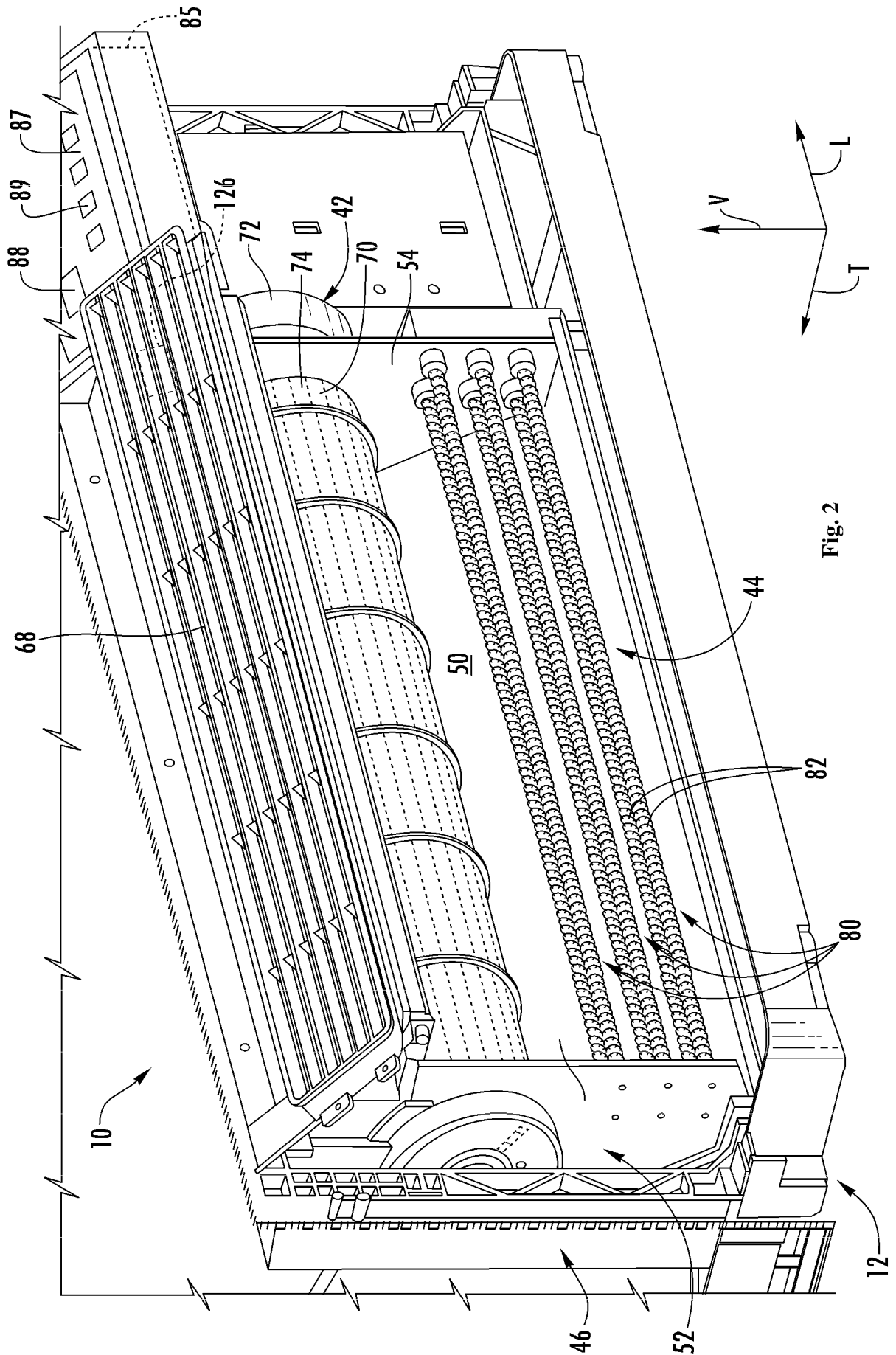


Fig. 2

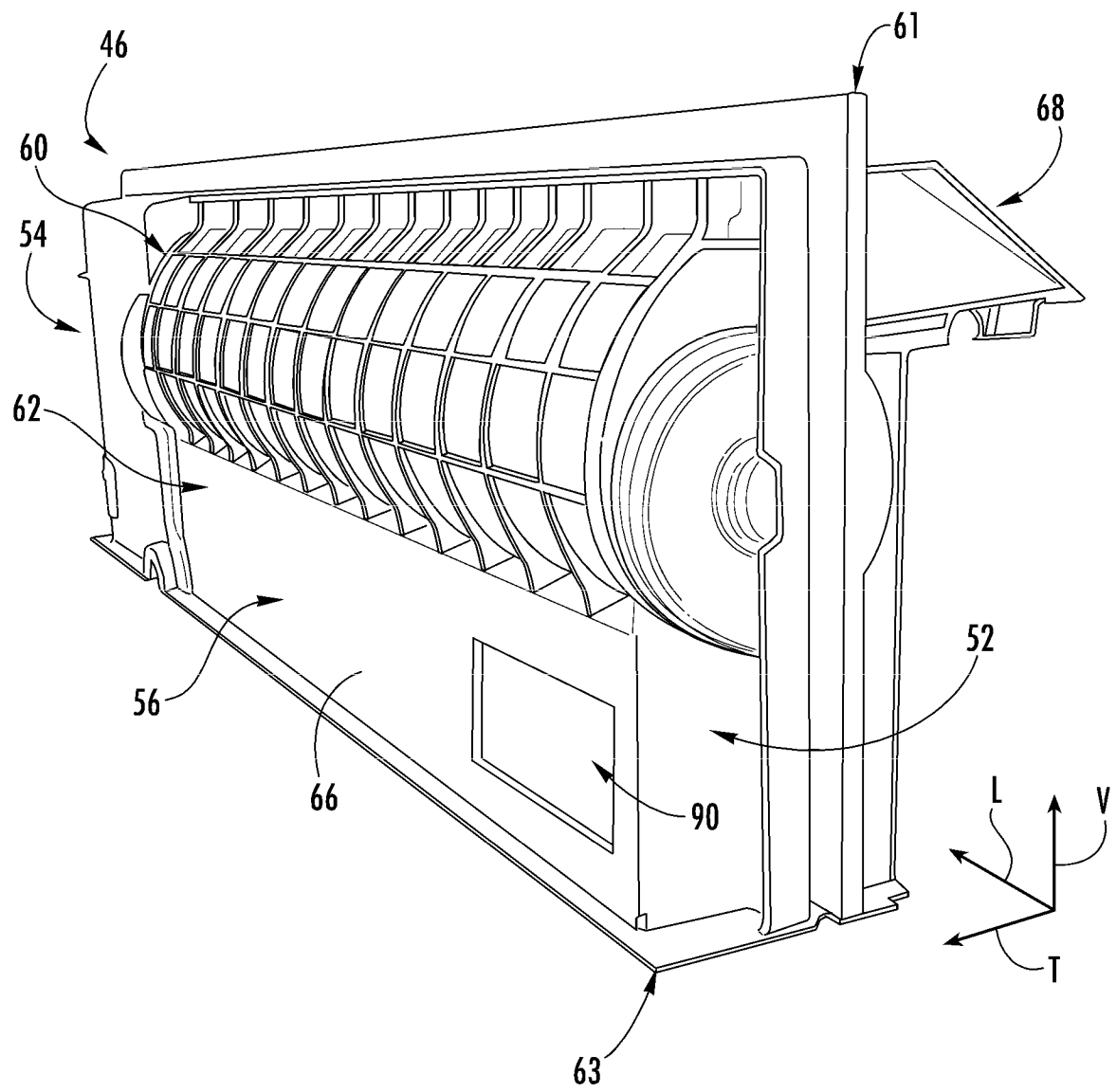
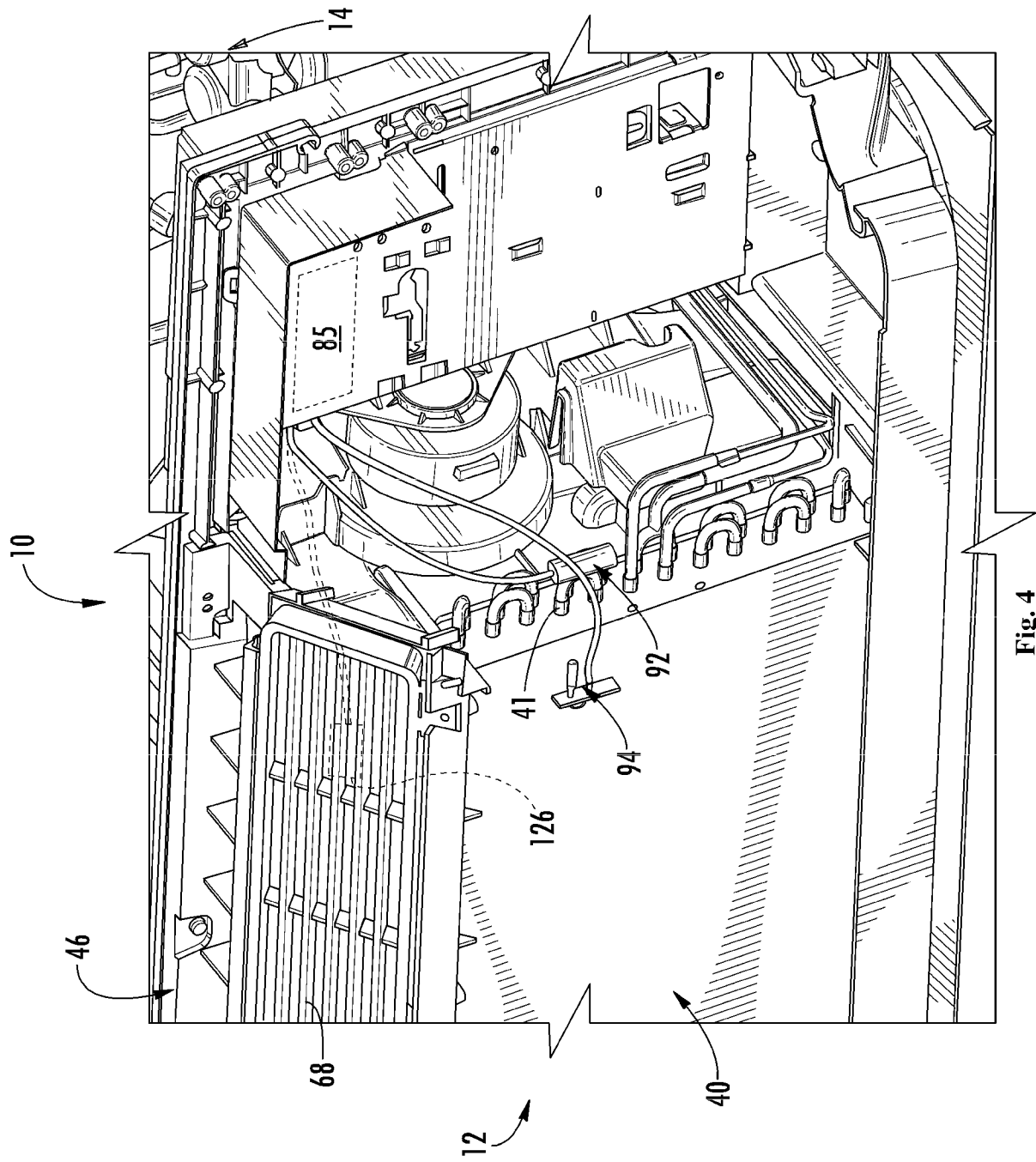


Fig. 3



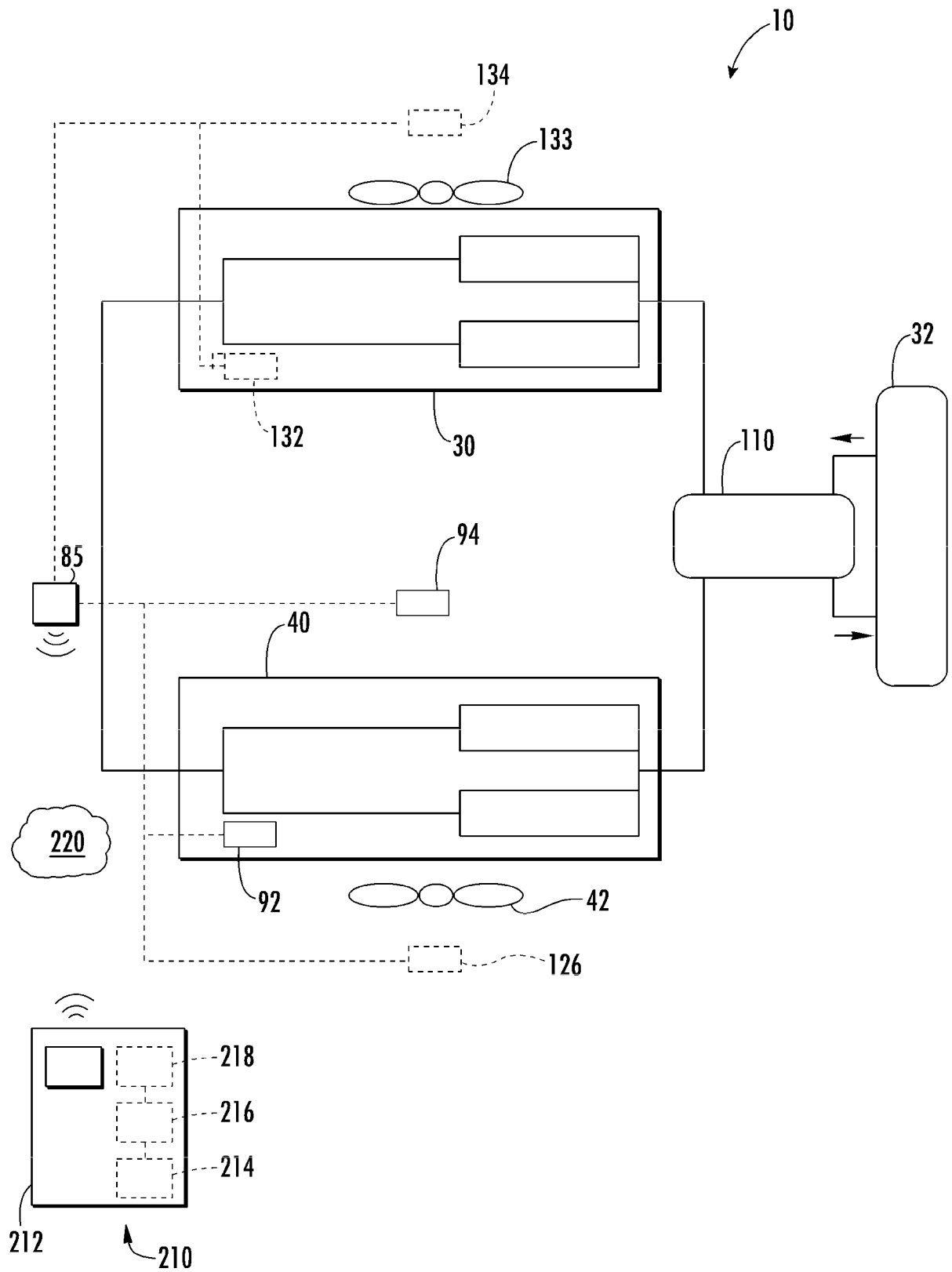


Fig. 5

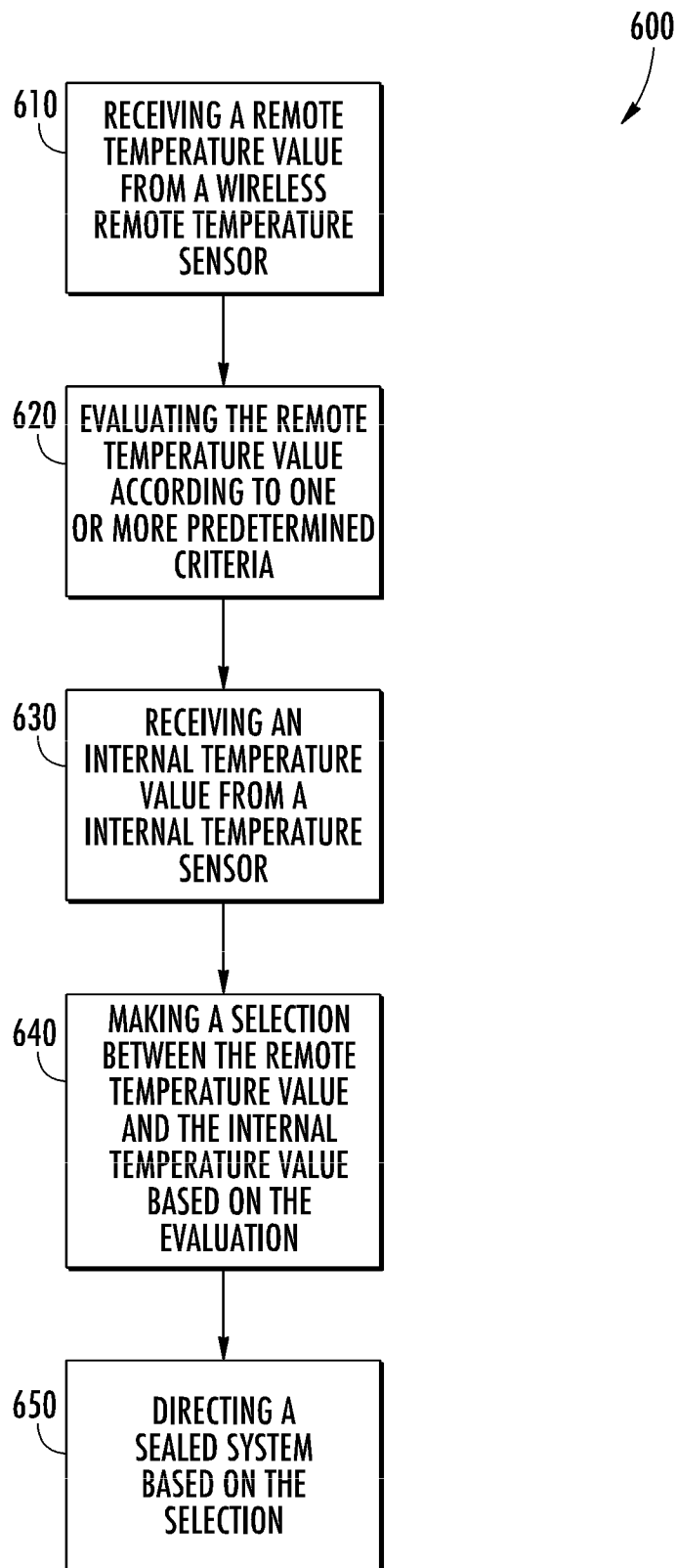


Fig. 6

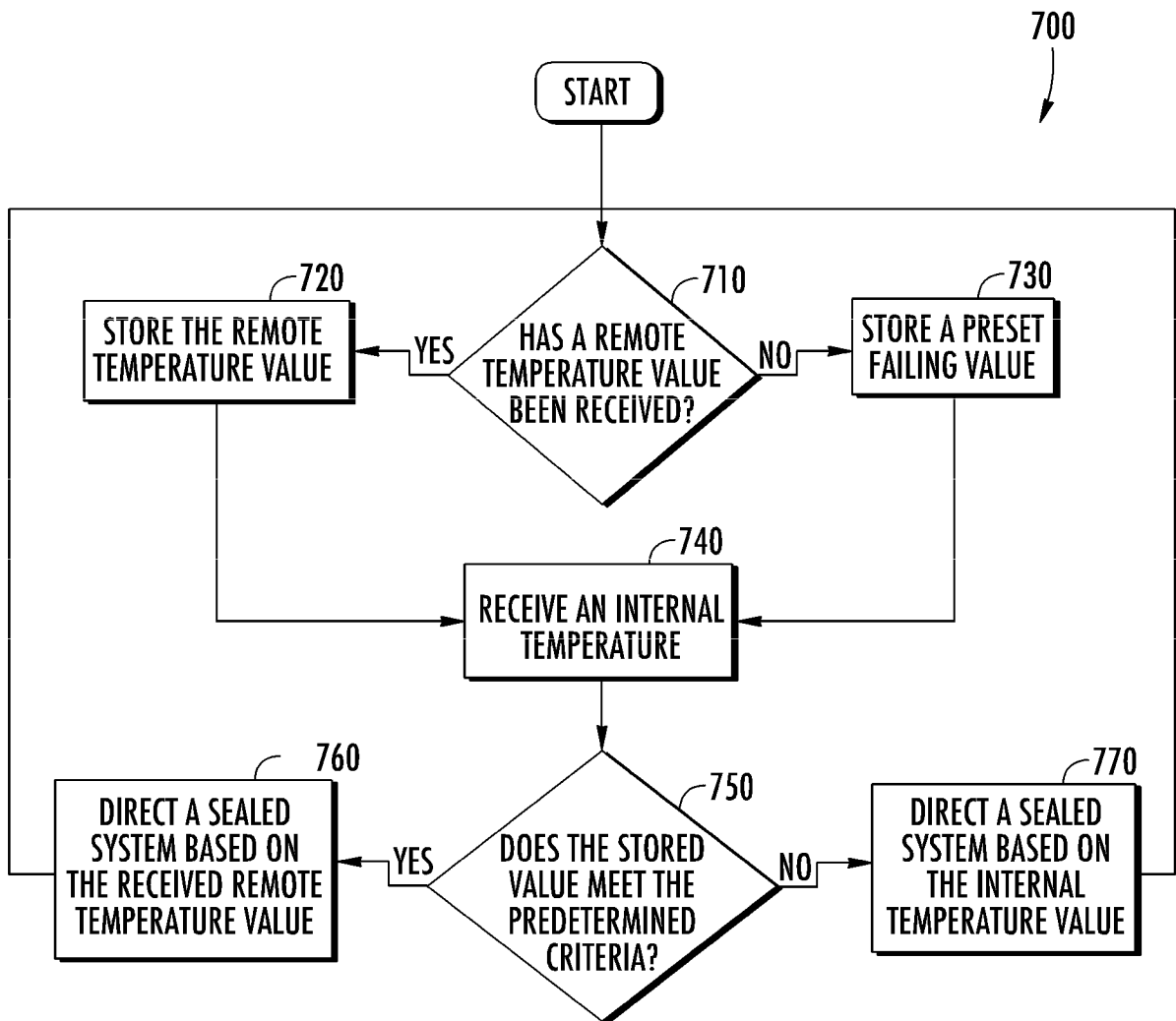


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/090046

A. CLASSIFICATION OF SUBJECT MATTER

F24F 11/00(2018.01)i; F24F 11/49(2018.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS,CNKI,DWPI,VEN single-package, one-unit type, air conditioner, cabinet, outdoor, indoor, heat exchanger, compressor, internal temperature sensor, remote temperature sensor, controller, indoor portion, outdoor portion, communication, operat+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 107990496 A (GREE ELECTRIC APPLIANCES INC ZHUHAI) 04 May 2018 (2018-05-04) description paragraphs [0048]-[0094]; figures 1-3	1-18
X	CN 102494391 A (HISENSE KELON ELEC HOLDINGS CO et al.) 13 June 2012 (2012-06-13) description paragraphs [0002]-[0022]; figures 1-3	1-18
X	JP 0972600 A (SOTOMA YASUO) 18 March 1997 (1997-03-18) description paragraphs [0002]-[0013]; figures 1-2	1-18
X	JP 2001012789 A (MITSUBISHI ELECTRIC CORP) 19 January 2001 (2001-01-19) description paragraphs [0028]-[0045]; figures 8-9	1-18
A	JP 2001165465 A (MITSUBISHI HEAVY IND LTD) 22 June 2001 (2001-06-22) the whole document	1-18
A	CN 106091295 A (SUZHOU HUA AI ELECTRONIC CO LTD) 09 November 2016 (2016-11-09) the whole document	1-18
A	CN 204963096 U (UNIV HENAN POLYTECHNIC) 13 January 2016 (2016-01-13) the whole document	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

01 July 2020

Date of mailing of the international search report

08 July 2020

Name and mailing address of the ISA/CN

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Telephone No. 62085188

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/090046**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 107621041 A (FOSHAN CHUANDONG MAGNETOELECTRICITY CO LTD) 23 January 2018 (2018-01-23) the whole document	1-18
A	CN 207214365 U (HEFEI HUALING CO LTD et al.) 10 April 2018 (2018-04-10) the whole document	1-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2020/090046

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN	107990496	A	04 May 2018	CN 107990496 B	20 September 2019
CN	102494391	A	13 June 2012	None	
JP	0972600	A	18 March 1997	None	
JP	2001012789	A	19 January 2001	None	
JP	2001165465	A	22 June 2001	None	
CN	106091295	A	09 November 2016	None	
CN	204963096	U	13 January 2016	None	
CN	107621041	A	23 January 2018	None	
CN	207214365	U	10 April 2018	None	