US Patent & Trademark Office
Patent Public Search | Text View

United States Patent	12392503
Kind Code	B2
Date of Patent	August 19, 2025
Inventor(s)	Rightmier; Earl John et al.

Dedicated outdoor air system configuration systems and methods

Abstract

A direct outdoor air system may include an enclosure having an air inlet to direct environmental air into the enclosure, a heat exchanger section to receive the environmental air and direct conditioned air to an air outlet of the enclosure, and a blower section to receive the environmental air from the air inlet and direct the environmental air to the heat exchanger section via an air flow path between the blower section and the heat exchanger section. The air outlet may direct the conditioned air to a conditioned space. The direct outdoor air system may also include a heat exchanger disposed in the heat exchanger section to condition the environmental air, generating the conditioned air, and a blower disposed in the blower section to motivate the environmental air through the air flow path. Additionally, a heat exchange area of the heat exchanger may be oriented vertically relative to gravity.

Inventors: **Rightmier; Earl John (Marcy, NY), Rizzuto; Randi Rae (York, PA), Alvarez Cavazos; Karla Daniela (Stewartstown, PA), Prasad; Kajal Durga (Austin, TX), Bardia; Ashish Nandkumar (Pune, IN)**

Applicant: **Johnson Controls Tyco IP Holdings LLP** (Milwaukee, WI)

Family ID: **1000008765369**

Assignee: **TYCO FIRE & SECURITY GMBH (Neuhausen am Rheinfall, CH)**

Appl. No.: **18/463937**

Filed: **September 08, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20240085033 A1	Mar. 14, 2024

Related U.S. Application Data

Publication Classification

Int. Cl.: **F24F1/0035** (20190101); **F24F1/0063** (20190101)

U.S. Cl.:

CPC **F24F1/0035** (20190201); **F24F1/0063** (20190201); F24F2221/34 (20130101)

Field of Classification Search

CPC: F24F (1/0035); F24F (1/0063); F24F (2221/34); F24F (1/0011)

USPC: 165/122

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
3174541	12/1964	Brandt	415/214.1	F24F 13/20
3678993	12/1971	Pierce	165/137	F24F 13/20
4478056	12/1983	Michaels, Jr.	165/250	F25D 16/00
6101829	12/1999	Robinson	62/298	F24F 13/20
8056352	12/2010	Kang	62/298	F04D 25/064
10473340	12/2018	Tomoigawa	N/A	F24F 1/0033
11079120	12/2020	Zhou	N/A	F24F 1/005
2009/0209193	12/2008	Kloster	454/241	B60H 1/3204
2011/0097988	12/2010	Lord	454/329	F24F 11/77
2020/0309402	12/2019	Reardon	N/A	F24F 1/03

Primary Examiner: Tanenbaum; Steve S

Attorney, Agent or Firm: Fletcher Yoder, PC

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application claims priority to and the benefit of U.S. Provisional Application No. 63/404,832, entitled “AN HVAC SYSTEM,” filed Sep. 8, 2022, which is hereby incorporated by reference in its entirety for all purposes.

BACKGROUND
(1) The present disclosure relates generally to an environmental control system, and, more particularly, a dedicated outdoor air heating, ventilation, and/or conditioning (HVAC) system.
(2) Environmental control systems are utilized in residential, commercial, and industrial environments to control environmental properties, such as temperature and humidity, for occupants of a conditioned space. The environmental control system may control the environmental properties by regulating an air flow delivered to the conditioned space. For example, a dedicated

outdoor air system may receive an air flow that originates outside a conditioned space (e.g., building or other structure), condition the air flow, and provide the conditioned air flow to the conditioned space. Furthermore, the dedicated outdoor air system may include one or more heat exchangers to transfer thermal energy to and/or from the air flow. However, the arrangement of the heat exchanger(s) within the dedicated outdoor air system relative to the air may lead to inefficiencies that may be improved.

SUMMARY

(3) A summary of certain embodiments disclosed herein is set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of these certain embodiments and that these aspects are not intended to limit the scope of this disclosure. Indeed, this disclosure may encompass a variety of aspects that may not be set forth below.

(4) The present disclosure relates to direct outdoor air system, which may include an enclosure having an air inlet to direct environmental air into the enclosure, a heat exchanger section to receive the environmental air and direct conditioned air to an air outlet of the enclosure, and a blower section to receive the environmental air from the air inlet and direct the environmental air to the heat exchanger section via an air flow path between the blower section and the heat exchanger section. The air outlet may direct the conditioned air to a conditioned space. The direct outdoor air system may also include a heat exchanger disposed in the heat exchanger section to condition the environmental air, generating the conditioned air, and a blower disposed in the blower section to motivate the environmental air through the air flow path. Additionally, a heat exchange area of the heat exchanger may be oriented vertically relative to gravity.

(5) The present disclosure also relates to a direct outside air system having an enclosure with an air inlet in a side wall of the enclosure and an air outlet in a bottom wall of the enclosure, perpendicular to the side wall. The air inlet may receive an environmental air flow, and the air outlet may direct a conditioned air flow to a conditioned space. The direct outside air system may also include a heat exchanger, disposed in a plane parallel with the side wall, to condition the environmental air flow, generating the conditioned air flow. Additionally, the direct outside air system may also include a blower, disposed within the enclosure, to motivate the environmental air flow from the air inlet to the heat exchanger.

(6) The present disclosure further relates to a direct outside air system that includes an enclosure having an air inlet to direct environmental air into the enclosure in a first direction, a heat exchanger section to receive the environmental air and direct conditioned air to an air outlet out the enclosure, and a blower section to receive the environmental air from the air inlet and direct the environmental air to the heat exchanger section via an air flow path between the blower section and the heat exchanger section. The air outlet may direct the conditioned air to a conditioned space in a second direction, perpendicular to the first direction. The direct outside air system may also include a heat exchanger, disposed in the heat exchanger section, to condition the environmental air, generating the conditioned air, and a blower, disposed in the blower section, to motivate the environmental air through the air flow path. Furthermore, a plane of a heat exchange area of the heat exchanger may be parallel to the second direction.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Various aspects of this disclosure may be better understood upon reading the following detailed description and upon reference to the drawings in which:

(2) FIG. **1** is a perspective view of an embodiment of a building incorporating a heating, ventilation, and/or air conditioning (HVAC) system in a commercial setting, in accordance with an aspect of the present disclosure;

(3) FIG. **2** is a perspective view of two direct outdoor air system HVAC units, illustrating distinctions between a first configuration and a second configuration, in accordance with an aspect of the present disclosure; and
(4) FIG. **3** is a schematic diagram of an embodiment of a vapor compression system used in an HVAC system, in accordance with an aspect of the present disclosure.

DETAILED DESCRIPTION

(5) One or more specific embodiments of the present disclosure will be described below. These described embodiments are examples of the presently disclosed techniques. Additionally, in an effort to provide a concise description of these embodiments, all features of an actual implementation may not be described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.
(6) When introducing elements of various embodiments of the present disclosure, the articles “a,” “an,” and “the” are intended to mean that there are one or more of the elements. The terms “comprising,” “including,” and “having” are intended to be inclusive and mean that there may be additional elements other than the listed elements. Additionally, it should be understood that references to “one embodiment” or “an embodiment” of the present disclosure are not intended to be interpreted as excluding the existence of additional embodiments that also incorporate the recited features.
(7) As used herein, the terms “approximately,” “generally,” and “substantially,” and so forth, are intended to convey that the property value being described may be within a relatively small range of the property value, as those of ordinary skill would understand. For example, when a property value is described as being “approximately” equal to (or, for example, “substantially similar” to) a given value, this is intended to mean that the property value may be within +/−5%, within +/−4%, within +/−3%, within +/−2%, within +/−1%, of the given value or even closer. Similarly, when a given feature is described as being “substantially parallel” to another feature, “generally perpendicular” to another feature, and so forth, this is intended to mean that the given feature is within +/−5%, within +/−4%, within +/−3%, within +/−2%, within +/−1%, or even closer, to having the described nature, such as being parallel to another feature, being perpendicular to another feature, and so forth. Further, it should be understood that mathematical terms, such as “planar,” “slope,” “perpendicular,” “parallel,” and so forth are intended to encompass features of surfaces or elements as understood to one of ordinary skill in the relevant art, and should not be rigidly interpreted as might be understood in the mathematical arts. For example, a “planar” surface is intended to encompass a surface that is machined, molded, or otherwise formed to be substantially flat or smooth (within related tolerances) using techniques and tools available to one of ordinary skill in the art. Similarly, a surface having a “slope” is intended to encompass a surface that is machined, molded, or otherwise formed to be oriented at an angle (e.g., incline) with respect to a point of reference using techniques and tools available to one of ordinary skill in the art.
(8) Heating, ventilation, and/or air conditioning (HVAC) systems may be used to thermally regulate a conditioned space within a building, home, or other suitable structure. Furthermore, different types of HVAC systems may be better suited for different implementations, depending on, for example, the characteristics of the conditioned space, conditioning loads, air quality concerns, etc. In particular, a dedicated outdoor air system (DOAS) may receive an air flow from outside the space, condition the air flow, and provide the conditioned air flow to the conditioned space. Contrary to many types of HVAC systems, a DOAS may not utilize a return air flow from the conditioned space, but rather utilize a fresh air flow from the environment, such as outside of the

conditioned space.
(9) Furthermore, the DOAS may include one or more heat exchangers to condition the air flow via an exchange of thermal energy between the air flow and the heat exchanger(s). For example, in some embodiments a DOAS includes a heating system having an electric or gas heating coil that heats the air flow. Furthermore, the HVAC system may include a vapor compression system or a heat exchanger thereof that transfers thermal energy between a working fluid, such as a refrigerant, and a fluid to be conditioned, such as the air flow. The vapor compression system includes heat exchangers (e.g. a condenser, an evaporator) that are fluidly coupled to one another via one or more conduits to form a refrigerant circuit. A compressor may be used to circulate the refrigerant through the refrigerant circuit and enable the transfer of thermal energy between components of the vapor compression system (e.g., the condenser, the evaporator) and one or more thermal loads (e.g., the air flow). As should be appreciated, the vapor compression system may be utilized to cool the air flow, such as when operating in an air conditioning mode, or utilized to heat the air flow, such as when operating in a heat pump mode.
(10) Additionally, the DOAS may include one or more fans or blowers that draw air in from the environment, direct the air flow across a heat exchange area of a heat exchanger to enable conditioning (e.g., heating, cooling, dehumidification) of the air, and provide the conditioned air flow to a conditioned space, such as via ductwork. Furthermore, in some embodiments, the DOAS may include a blower section and a heat exchanger section of a housing. However, the arrangement of components of the DOAS, such as an air inlet, blower, heat exchanger, and/or air outlet, in reference to the blower section and heat exchanger sections may affect the air flow efficiency through the housing of the DOAS. For example, in some scenarios, the air inlet may draw the air flow into the blower section horizontally (e.g., relative to an orientation of the DOAS housing) and the air outlet may direct the air flow out of the heat exchanger section vertically (e.g., relative to an orientation of the DOAS housing). Traditionally, in such an arrangement, the heat exchanger may be disposed horizontally within the heat exchanger section, such that the air flow through the heat exchanger is vertical (e.g., parallel with the air outlet). To accommodate the horizontally disposed heat exchanger, a knee wall is disposed between the blower section and the heat exchanger section to prevent or reduce the air flow from circumventing the heat exchanger. However, it is now recognized that the knee wall may reduce the size of the air flow path of the air flow through the DOAS, which may decrease air flow efficiency by increasing a backpressure of the blower section and effecting an increased pressure drop between the blower section and the heat exchanger section. Additionally, it is now recognized that the horizontal orientation of the heat exchanger may increase the horizontal size (e.g., footprint) of the heat exchanger section and, thus, the DOAS.
(11) As discussed further below, in accordance with an embodiment of the present disclosure, a DOAS may include a vertically disposed heat exchanger such that the air flow through the heat exchanger is horizontal relative to the orientation of the DOAS housing. Furthermore, the DOAS may include a blower section and a heat exchanger section without a knee wall therebetween. As such, an air flow efficiency through the DOAS housing may be increased relative to traditional systems. Moreover, by disposing the heat exchanger vertically, a footprint of the DOAS housing may be reduced relative to traditional systems.
(12) Turning now to the drawings, FIG. **1** illustrates an embodiment of a heating, ventilation, and/or air conditioning (HVAC) system for environmental management that employs one or more HVAC units in accordance with the present disclosure. As used herein, an HVAC system includes any number of components that enable regulation of parameters related to climate characteristics, such as temperature, humidity, air flow, pressure, air quality, and so forth. For example, an “HVAC system” as used herein is defined as conventionally understood and as further described herein. Components or parts of an “HVAC system” may include, but are not limited to, all, some of, or individual parts such as a heat exchanger, a heater, an air flow control device, such as a fan, a sensor to detect a climate characteristic or operating parameter, a filter, a control device to regulate

operation of an HVAC system component, a component to enable regulation of climate characteristics, or a combination thereof. An “HVAC system” is a system that provides functions such as heating, cooling, ventilation, dehumidification, pressurization, refrigeration, filtration, or any combination thereof. The embodiments described herein may be utilized in a variety of applications to control climate characteristics, such as residential, commercial, industrial, transportation, or other applications where climate control is desired.

(13) In the illustrated embodiment, a building **10** is air conditioned by a system that includes an HVAC unit **12**, in accordance with present embodiments. Although the HVAC unit **12** is depicted and discussed herein as being utilized to condition an air flow to a building **10**, as should be appreciated, the building **10** is given as an example, and the HVAC unit **12** of the present disclosure may be utilized with any commercial structure, residential structure, temporary structure, vehicle structure (e.g., refrigerated trailer), or any enclosed or partially enclosed space desired to be conditioned. As shown, the HVAC unit **12** is disposed on the roof of the building **10**. However, the HVAC unit **12** may be located in other locations such as equipment rooms having fluid access to outside air and/or areas adjacent the building **10**. The HVAC unit **12** may be a single package unit containing other equipment, such as a blower, integrated air handler, and/or auxiliary heating unit. In other embodiments, the HVAC unit **12** may be part of a split HVAC system, where a second portion of a vapor compression system, such as a condenser unit, is disposed in a separate housing.

(14) Different types of HVAC systems may be better suited for different implementations, depending on, for example, user preferences, the characteristics of the conditioned space, conditioning loads, air quality concerns, etc. As discussed herein, the HVAC unit **12** may be a dedicated outdoor air system (DOAS) that draws fresh air from an environment outside of the building **10**, as opposed to a return air flow from within the building **10**. Such DOAS HVAC units **12** may be desirable when fresh air is desired to be consistently introduced into the conditioned space, such as to avoid recirculation of air from within the building **10**, if return air (e.g., via ductwork **14**) is unavailable or unviable, if a positive pressure environment is desired within the building **10**, and/or for temporary structures without the infrastructure for a other type HVAC installations. In some embodiments, the DOAS HVAC unit **12** is an air-cooled device that implements a refrigeration cycle to provide conditioned air to the building **10**. Specifically, the DOAS HVAC unit **12** may include one or more heat exchangers, across which an air flow is passed to condition the air flow before the air flow is supplied to the building **10**. After the DOAS HVAC unit **12** conditions the air flow, the air flow is supplied to the building **10** via ductwork **14**, which may extend throughout the building **10** from the DOAS HVAC unit **12**. For example, the ductwork **14** may extend to various individual floors or other sections of the building **10**. In certain embodiments, the HVAC unit **12** may be a heat pump that provides both heating and cooling to the building with one refrigeration circuit that operates in different modes. In other embodiments, the HVAC unit **12** may include one or more refrigeration circuits for cooling an air stream and/or a furnace for heating the air stream. For example, in some embodiments, the HVAC unit **12** may include an electric heat coil and/or a gas heat coil.

(15) A control device **16**, one type of which may be a thermostat, may be used to designate the temperature of the conditioned air. The control device **16** also may be used to control the flow of air through the ductwork **14**. For example, the control device **16** may be used to regulate operation of one or more components of the HVAC unit **12** or other components, such as dampers and fans, within the building **10** that may control flow of air through and/or from the ductwork **14**. In some embodiments, other devices may be included in the system, such as pressure and/or temperature transducers or switches that sense the temperatures and pressures of the supply air, return air, and so forth. Moreover, the control device **16** may include computer systems that are integrated with or separate from other building control or monitoring systems, and even systems that are remote from the building **10**.

(16) As discussed herein, the components of a DOAS HVAC unit **12**, may be arranged in different

configurations within an enclosure thereof. To help illustrate, FIG. **2** is a perspective view of two DOAS HVAC units **12** illustrating distinctions between a first configuration **18** and a second configuration **20**. In the illustrated embodiment, the DOAS HVAC unit **12** includes a blower section **22** and heat exchanger section **24** disposed within and/or forming at least a portion of an enclosure **26**. The enclosure **26** may surround the DOAS HVAC unit **12** and provide structural support and protection to the internal components thereof from environmental and other contaminants. In some embodiments, the enclosure **26** may be constructed of galvanized steel and insulated with aluminum foil faced insulation. Moreover, the enclosure **26** may have access panels to allow access for maintenance or installation. The blower section **22** may include one or more fans or blowers **28** that draw an air flow **30** into the blower section **22** through an air inlet **32** (e.g., an opening in the enclosure **26**) from the environment, such as outside the building **10** or other structure. Furthermore, the blower **28** may direct the air flow **30** across a heat exchange area of a heat exchanger **34** to enable conditioning (e.g., heating, cooling, dehumidification) of the air flow **30**, and provide motivation (e.g., pressure) to direct the conditioned air flow **36** through an air outlet **38** (e.g., an opening in the enclosure **26**) to a conditioned space (e.g., building **10**), such as via ductwork **14**. As used herein, the heat exchange area may be used to describe a planer area of the heat exchanger **34**, which may be perpendicular to the general direction of the air flow **30** through the heat exchanger **34**.

(17) The heat exchanger section **24** may include one or more heat exchangers **34** to condition the air flow **30** via an exchange of thermal energy between the air flow **30** and the heat exchanger(s) **34**. In some embodiments the DOAS HVAC unit **12** includes a heating system, and the one or more heat exchangers **34** may include an electric heating coil and/or a gas heating coil that heats the air flow **30**. For example, an optional additional section **40** of the enclosure **26** may include a combustion chamber to generate a heated gas that passes through the heat exchanger **34** (e.g., as a gas heat coil). Additionally or alternatively, the heat exchanger(s) **34** may include a resistive heat element that produces heat when an electrical current is supplied. Furthermore, as discussed herein, the DOAS HVAC unit **12** system may include a vapor compression system as discussed below with regard to FIG. **3**, and the one or more heat exchangers **34** (e.g., condenser or evaporator) may transfer thermal energy between a working fluid, such as a refrigerant, and the air flow. As should be appreciated, the vapor compression system may be utilized to cool the air flow **30**, such as when operating in an air conditioning mode, or utilized to heat the air flow **30**, such as when operating in a heat pump mode. Moreover, in scenarios where the DOAS HVAC unit **12** includes a vapor compression system, the additional section **40**, if implemented, may include a compressor and/or a secondary heat exchanger, such as a condenser or evaporator depending on if the vapor compression system is operated in the heat pump mode or not.

(18) In some configurations, such as the first configuration **18** and the second configuration **20**, the air inlet **32** may direct the air flow **30** into the blower section **22** (e.g., motivated by the blower **28**) in a horizontal direction (e.g., x-direction **42**) through a side wall **43** of the enclosure **26**. Additionally, the air outlet **38** may direct the conditioned air flow **36** out of the heat exchanger section **24** in a vertical direction (e.g., z-direction **44** parallel to gravity), such as out a bottom **46** of the enclosure **26**. Additionally or alternatively, other air inlets **32** may draw the air flow **30** from the environment from different side walls of the enclosure **26**, such as in the y-direction **48**, and/or in the vertical direction (e.g., z-direction **44**) from a top **50** or bottom **46** of the enclosure **26**. Moreover, in some embodiments, the air outlet **38** may direct the conditioned air flow **36** out the top **50** of the enclosure and/or in a horizontal direction (e.g., x-direction **42** and/or y-direction **48**).

(19) In the first configuration, the heat exchanger **34** may be disposed horizontally (e.g., in the x-y plane) within the heat exchanger section **24**, such that the air flow **30** through the heat exchanger **34** is vertical (e.g., in the z-direction **44**) and parallel with the air outlet **38**. To accommodate the horizontally disposed heat exchanger **34**, a knee wall **52** is disposed between the blower section **22** and the heat exchanger section **24** to prevent or reduce the air flow **30** from circumventing the heat

exchanger **34**. However, the knee wall **52** may reduce the size of the air flow path **54** between the blower section **22** and the heat exchanger section **24**, which may decrease air flow efficiency by increasing a backpressure of the blower section **22** and/or effecting an increased pressure drop between the blower section **22** and the heat exchanger section **24**. Additionally, the horizontal orientation of the heat exchanger **34** may increase the horizontal size (e.g., footprint in the x-y plane) of the heat exchanger section **24** and, thus, the DOAS HVAC unit **12**.
(20) In the second configuration **20**, the heat exchanger **34** is disposed vertically (e.g., in the y-z plane) such that the air flow **30** through the heat exchanger **34** travels horizontally (e.g., in the x-direction **42**) relative to the vertical air outlet **38**. Furthermore, the DOAS HVAC unit **12** (e.g., in the second configuration **20**) may be arranged without a knee wall **52** between the blower section **22** and the heat exchanger section **24**. By removing the knee wall **52**, the cross section of the air flow path **54** between the blower section **22** and the heat exchanger section **24** may be increased, which may reduce a pressure drop between the blower section **22** and the air outlet **38**, increasing air flow efficiency (e.g., blower load vs. volumetric flow rate) and/or the air flow rate. Additionally, in some embodiments, the vertical orientation of the heat exchanger **34** may improve an interaction between the air flow **30** and the heat exchanger **34**. For example, instead of making a turn (e.g., 90 degree turn) before crossing the heat exchanger **34**, the air flow **30** may be directed directly from the blower section **22** to the heat exchanger **34**, which may improve thermal efficiency (e.g., heat transfer efficiency), and the conditioned air flow **36** may make the turn to the air outlet **38** after the heat exchanger **34**. As such, by orienting the heat exchanger **34** vertically, such as in-line with the air flow path **54** from the blower section **22** and perpendicular to the air outlet **38**, the air flow efficiency and/or thermal efficiency of the DOAS HVAC unit **12** may be increased.
(21) Furthermore, in realizing the increased size of the air flow path **54**, in some embodiments, the size of the air flow path **54** between the blower section **22** and the heat exchanger section **24** may be at least the co-planar size of the heat exchanger **34**, which may improve air flow efficiency and/or thermal efficiency, as discussed above. Additionally or alternatively, in some embodiments, the size of the air flow path **54** between the blower section **22** and the heat exchanger section **24** may be the entire width **56**, greater than 80% of the width **56**, or greater than 60% of the width **56** (e.g., in the y-direction **48**) and/or the entire height **58**, greater than 80% of the height **58**, or greater than 60% of the height **58** (e.g., in the z-direction **44**) of the blower section **22** and/or the heat exchanger section **24**, such as defined by fluid retaining walls of the exterior of the enclosure **26** or internal walls defining fluid retaining chambers of the blower section **22** and/or the heat exchanger section **24**. Furthermore, in some embodiments, the air flow path **54** may be inline (e.g., parallel) with the air inlet **32**. Moreover, in some embodiments, the heat exchanger **34** may be disposed in a parallel plane with the side wall **43** having the air inlet **32**.
(22) Moreover, by disposing the heat exchanger vertically, a footprint of the enclosure **26** may be reduced. For example, a depth **60** (e.g., in the x-direction) of the heat exchanger section **24** may be smaller in the second configuration **20** than in the first configuration **18**.
(23) Additionally, in some embodiments, a DOAS HVAC unit **12** in the first configuration **18** may be modified **61** to the second configuration **20** to achieve at least a portion of the benefits of the second configuration **20**, such as increased thermal efficiency and/or air flow efficiency. For example, in some embodiments, a DOAS HVAC unit **12** in the first configuration **18** may be modified **61** by removing the heat exchanger **34** and reassembling (e.g., affixing to the enclosure **26**) the heat exchanger **34** in the heat exchanger section **24** in a vertical orientation. Moreover, the modification **61** of the DOAS HVAC unit **12** in the first configuration **18** may include removing the knee wall **52**. As such, DOAS HVAC unit **12** may be arranged in the second configuration **20** for increased thermal efficiency and/or air flow efficiency.
(24) As discussed above, in some embodiments, the heat exchanger **34** of the DOAS HVAC unit **12** may be part of a heating system. For example, the DOAS HVAC unit **12** may include at least a portion of a furnace system. Such a furnace system may include a burner assembly (e.g., in the

additional section **40** or implemented in a separate enclosure) and a heat exchanger (e.g., heat exchanger **34**), among other components. Fuel may be provided to the burner assembly of the furnace where it is mixed with air and combusted to form combustion products. The combustion products may pass through tubes or piping of the heat exchanger **34**, such that the air flow **30** directed by the blower **28** passes over the tubes or pipes and extracts heat from the combustion products. The conditioned air flow **36** may then be routed from the air outlet **38** to the building **10** or other structure.

(25) Furthermore, as discussed above, such a heating system may supplement or supplant a heat pump mode of a vapor compression system. As should be appreciated, a heating system and vapor compression system may be operated in series or parallel (e.g., having two separate heat exchangers **34**) and may be operated simultaneously or separately. To help illustrate, FIG. **4** is a schematic view of a vapor compression system **62** that can be used in any of the systems described herein. The vapor compression system **62** may circulate a refrigerant through a circuit motivated by a compressor **63**. The circuit may also include a condenser **64** (e.g., heat exchanger **34**), an expansion valve(s) or device(s) **66**, and an evaporator **68** (e.g., heat exchanger **34**). The vapor compression system **62** may further include a control panel **70** that has an analog to digital (A/D) converter **72**, a microprocessor **74**, a non-volatile memory **76**, and/or an interface board **78**. The control panel **70** and its components may function to regulate operation of the vapor compression system **62** based on feedback from an operator (e.g., via control device **16**), from sensors (e.g., control device **16**) of the vapor compression system **62** that detect operating conditions, and so forth.

(26) In some embodiments, the vapor compression system **62** may use a variable speed drive (VSDs) **80** and/or a motor **82** to drive the compressor **63**. The VSD **80** receives alternating current (AC) power having a particular fixed line voltage and fixed line frequency from an AC power source, and provides power having a variable voltage and frequency to the motor **82**. In other embodiments, the motor **82** may be powered directly from an AC or direct current (DC) power source. The motor **82** may include any type of electric motor that can be powered by a VSD **80** or directly from an AC or DC power source, such as a switched reluctance motor, an induction motor, an electronically commutated permanent magnet motor, or another suitable motor.

(27) The compressor **63** compresses a refrigerant vapor and delivers the vapor to the condenser **64** through a discharge passage. In some embodiments, the compressor **63** may be a centrifugal compressor. The refrigerant vapor delivered by the compressor **63** to the condenser **64** may transfer heat to a first air stream **84** or other fluid passing across the condenser **64**, such as ambient (e.g., outside/environmental) air. The refrigerant vapor may condense to a refrigerant liquid in the condenser **64** as a result of thermal heat transfer with a first air stream **84** (e.g., outside/environmental air). The liquid refrigerant from the condenser **64** may flow through the expansion device **66** to the evaporator **68**.

(28) The liquid refrigerant delivered to the evaporator **68** may absorb heat from a second air stream **86**, such as the air flow **30**, when operated in a cooling mode. For example, the second air stream **86** may include outside air (e.g., air flow **30**) drawn into the DOAS HVAC unit **12** via the blower **28**. The liquid refrigerant in the evaporator **68** may undergo a phase change from the liquid refrigerant to a refrigerant vapor. In this manner, the evaporator **68** may reduce the temperature of the second air stream **86** via thermal heat transfer with the refrigerant. As discussed above, the vertical orientation of the heat exchanger **34**, which may be implemented as an evaporator **68**, may provide increased thermal efficiency (e.g., heat transfer efficiency) and/or air flow efficiency through the heat exchanger **34**. The vapor refrigerant exits the evaporator **68** and returns to the compressor **63** by a suction line to complete the cycle. Moreover, the cycle may be effectively reversed when operating as a heat pump. As should be appreciated, the heat exchanger **34** of the DOAS HVAC unit **12** may be a part of a condenser **64** and/or evaporator **68** and the roles of each may be reversed depending on implementation (e.g., operating as an air conditioner or heat pump).

(29) As set forth above, embodiments of the present disclosure may provide one or more technical effects useful for efficient configuration of a DOAS HVAC unit **12**. Indeed, by orienting a heat exchanger **34** vertically, such that an air flow **30** from a blower section **22** is perpendicular to the vertical plane of the heat exchanger **34** (e.g., despite potentially being parallel to the air outlet **38** requiring a turn of the conditioned air flow **36** after the heat exchanger **34**), the size of the air flow path **54** may be increased along with the thermal and/or air flow efficiency of the air flow **30**. It should be understood that the technical effects and technical problems in the specification are examples and are not limiting. Indeed, it should be noted that the embodiments described in the specification may have other technical effects and can solve other technical problems.
(30) While only certain features and embodiments have been illustrated and described, many modifications and changes may occur to those skilled in the art, such as variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, such as temperatures and pressures, mounting arrangements, use of materials, colors, orientations, and so forth, without materially departing from the novel teachings and advantages of the subject matter recited in the claims. The order or sequence of any process or method steps may be varied or re-sequenced according to alternative embodiments. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the disclosure.
(31) Furthermore, in an effort to provide a concise description of the exemplary embodiments, all features of an actual implementation may not have been described, such as those unrelated to the presently contemplated best mode, or those unrelated to enablement. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation specific decisions may be made. Such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure, without undue experimentation.
(32) The techniques presented and claimed herein are referenced and applied to material objects and concrete examples of a practical nature that demonstrably improve the present technical field and, as such, are not abstract, intangible or purely theoretical. Further, if any claims appended to the end of this specification contain one or more elements designated as “means for [perform]ing [a function] . . . ” or “step for [perform]ing [a function] . . . ”, it is intended that such elements are to be interpreted under 35 U.S.C. 112(f). However, for any claims containing elements designated in any other manner, it is intended that such elements are not to be interpreted under 35 U.S.C. 112(f).

Claims

1. A direct outside air system, comprising: an enclosure comprising: an air inlet configured to direct environmental air into the enclosure; a heat exchanger section configured to receive the environmental air and direct conditioned air to an air outlet; a blower section configured to receive the environmental air and direct the environmental air to the heat exchanger section via an air flow path between the blower section and the heat exchanger section; and the air outlet configured to direct the conditioned air to a conditioned space; a heat exchanger disposed in the heat exchanger section and configured to condition the environmental air to generate the conditioned air; and a blower disposed in the blower section and configured to motivate the environmental air through the air flow path, wherein a heat exchange area of the heat exchanger is oriented parallel relative to gravity in an installed configuration of the direct outside air system.
2. The direct outside air system of claim 1, wherein the air flow path does not include a knee wall.
3. The direct outside air system of claim 1, wherein the heat exchanger comprises an electrical heating coil.
4. The direct outside air system of claim 1, wherein the heat exchanger comprises a gas heat coil.

5. The direct outside air system of claim 1, wherein the heat exchanger comprises an evaporator of a vapor compression system.
6. The direct outside air system of claim 1, wherein the conditioned air comprises the environmental air does not include a return air from the conditioned space.
7. The direct outside air system of claim 1, wherein the air outlet is configured to direct the conditioned air in a first direction vertically from the enclosure.
8. The direct outside air system of claim 7, wherein the air inlet is configured to direct the environmental air into the enclosure in a second direction perpendicular to the first direction.
9. The direct outside air system of claim 8, wherein a first plane of a cross-section of the air flow path perpendicular to a direction of flow of the environmental air through the air flow path is parallel with a second plane of the heat exchange area of the heat exchanger.
10. The direct outside air system of claim 1, wherein the air flow path comprises a first width and a first height, wherein the first width is at least 80% of a second width of the blower section, and wherein the first height is at least 80% of a second height of the blower section.
11. The direct outside air system of claim 10, wherein the air flow path comprises a cross-sectional area greater than or equal to a size of the heat exchange area of the heat exchanger.
12. A direct outside air system comprising: an enclosure comprising an air inlet in a side wall of the enclosure and an air outlet in a bottom wall of the enclosure, perpendicular to the side wall, the air inlet configured to receive an environmental air flow, and the air outlet configured to direct a conditioned air flow to a conditioned space; a heat exchanger disposed in a plane parallel with the side wall and configured to condition the environmental air flow to generate the conditioned air flow; and a blower disposed within the enclosure and configured to motivate the environmental air flow from the air inlet to the heat exchanger.
13. The direct outside air system of claim 12, wherein an air flow path between the blower and the heat exchanger does not include a knee wall.
14. The direct outside air system of claim 13, wherein the air flow path comprises a cross-sectional area greater than or equal to a size of a heat exchange area of the heat exchanger.
15. The direct outside air system of claim 14, wherein the conditioned air flow comprises the environmental air flow and does not include a return air flow from the conditioned space.
16. The direct outside air system of claim 15, wherein the heat exchanger comprises a gas heat coil.
17. A direct outside air system, comprising: an enclosure comprising: an air inlet configured to direct environmental air into the enclosure in a first direction; a heat exchanger section configured to receive the environmental air and direct conditioned air to an air outlet; a blower section configured to receive the environmental air and direct the environmental air to the heat exchanger section via an air flow path between the blower section and the heat exchanger section; and the air outlet configured to direct the conditioned air to a conditioned space in a second direction, perpendicular to the first direction; a heat exchanger disposed in the heat exchanger section and configured to condition the environmental air to generate the conditioned air; and a blower disposed in the blower section and configured to motivate the environmental air through the air flow path, wherein a plane of a heat exchange area of the heat exchanger is parallel to the second direction.
18. The direct outside air system of claim 17, wherein the enclosure comprises an additional section comprising a combustion chamber, wherein combusted gases from the combustion chamber are operationally directed through coils of the heat exchanger.
19. The direct outside air system of claim 17, wherein the air flow path comprises a cross-sectional area greater than or equal to 80% of a size of the heat exchange area of the heat exchanger.
20. The direct outside air system of claim 19, wherein the air flow path between the blower and the heat exchanger does not include a knee wall.