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United States Patent	12392509
Kind Code	B2
Date of Patent	August 19, 2025
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Coil assembly plate with compensator accommodation

Abstract

A heating, ventilation, and/or air conditioning (HVAC) system includes a refrigerant circuit configured to circulate refrigerant. The circuit includes a compressor, an indoor heat exchanger, an outdoor heat exchanger, and a reversing valve that transitions between a first configuration to direct the refrigerant from the compressor toward the outdoor heat exchanger and a second configuration to direct the refrigerant from the compressor toward the indoor heat exchanger. The system includes a compensator with a conduit that is part of the refrigerant circuit and configured to pass the refrigerant therethrough and a chamber disposed about the conduit. The chamber is also communicatively coupled to the refrigerant circuit, and configured to retain a portion of the refrigerant in the chamber. A coil assembly plate of the indoor heat exchanger or the outdoor heat exchanger includes a receptacle configured to receive the refrigerant charge compensator.

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Appl. No.: 18/232074

Filed: August 09, 2023

Prior Publication Data

Document Identifier	Publication Date
US 20240053030 A1	Feb. 15, 2024

Related U.S. Application Data

us-provisional-application US 63396520 20220809

Publication Classification

Int. Cl.: F24F3/00 (20060101); F24F3/06 (20060101)

U.S. Cl.:

CPC F24F3/001 (20130101); F24F3/06 (20130101);

Field of Classification Search

CPC: F25B (2345/00); F25B (45/00)

USPC: 165/50

References Cited

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
WO-2015056635	12/2014	WO	F25B 13/00

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application claims priority from and the benefit of U.S. Provisional Application Ser. No. 63/396,520, entitled “DELTA PLATE FOR COMPENSATOR FOR INDOOR MICROCHANNEL EVAPORATOR COIL,” filed Aug. 9, 2022, which is herein incorporated by reference in its entirety for all purposes.

BACKGROUND

(1) Residential, light commercial, commercial, and industrial heating, ventilation and/or air conditioning (HVAC) systems are used to control temperatures and air quality in residences and buildings. Generally, HVAC systems may circulate a refrigerant (also referred to as a working fluid) through a closed refrigeration circuit between an evaporator, where the refrigerant absorbs heat, and a condenser, where the refrigerant releases heat. When the HVAC system is an air conditioner or a heat pump in a cooling mode, an indoor heat exchanger disposed in a climate controlled space operates as the evaporator and an outdoor heat exchanger operates as the condenser. Thus, the climate controlled space is cooled by the process. A heat pump operating in a heating mode switches this operation. That is, the outdoor heat exchanger operates as the evaporator and the indoor heat exchanger operates as the condenser. Thus, the climate controlled space is warmed by the process.

(2) The refrigerant flowing within a HVAC system travels through multiple conduits and components of the refrigerant circuit and is generally formulated to undergo phase changes within normal operating temperatures and pressures of the system so that desired quantities of heat can be exchanged by virtue of the latent heat of vaporization of the refrigerant. However, operating in different modes can cause system imbalances. Further, traditional techniques for addressing such

imbalances can create other inefficiencies. Accordingly, there is a need for new and improved systems and methods for handling refrigerant flows in an efficient manner.

SUMMARY

(3) In an embodiment of a heating, ventilation, and/or air conditioning (HVAC) system includes a refrigerant circuit configured to circulate refrigerant. The circuit includes a compressor, an indoor heat exchanger, an outdoor heat exchanger, and a reversing valve that transitions between a first configuration to direct the refrigerant from the compressor toward the outdoor heat exchanger and a second configuration to direct the refrigerant from the compressor toward the indoor heat exchanger. The system includes a compensator with a conduit that is part of the refrigerant circuit and configured to pass the refrigerant therethrough and a chamber disposed about the conduit. The chamber is also communicatively coupled to the refrigerant circuit, and configured to retain a portion of the refrigerant in the chamber. A coil assembly plate of the indoor heat exchanger or the outdoor heat exchanger includes a receptacle configured to receive the refrigerant charge compensator.

(4) In an embodiment, a heat pump system includes a compressor of a refrigeration circuit, wherein the compressor is configured to drive refrigerant through the refrigeration circuit. The system also includes an indoor heat exchanger, an outdoor heat exchanger, and a reversing valve that operates to transition between a first configuration to direct the refrigerant from the compressor toward the outdoor heat exchanger and a second configuration to direct the refrigerant from the compressor toward the indoor heat exchanger. A refrigerant charge compensator including a conduit disposed along the refrigerant circuit and a chamber surrounding the conduit that is fluidly coupled to the refrigerant circuit is also included. Further, a coil assembly plate of the indoor heat exchanger or the outdoor heat exchanger includes a receptacle configured to receive the refrigerant charge compensator.

(5) In an embodiment, a heating, ventilation, and/or air conditioning (HVAC) system includes a heat exchanger, a first slab of the heat exchanger, a second slab of the heat exchanger, and coil assembly plates coupled to the first slab and the second slab such that an interior space is defined between the first slab, the second slab, and the coil assembly plates. The interior space is configured to guide airflow through the heat exchanger. The system also includes a receptacle in one coil assembly plate of the coil assembly plates, wherein the receptacle houses a refrigerant charge compensator such that a portion of the refrigerant charge compensator extends into the interior space.

(6) Other features and advantages of the present application will be apparent from the following, more detailed description of the embodiments, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the application.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a perspective view of a building having a HVAC system, in accordance with an embodiment of the present disclosure;

(2) FIG. 2 is a perspective view of a split HVAC system, which may be utilized with a residence or the building of FIG. 1, in accordance with an embodiment of the present disclosure;

(3) FIG. 3 is a schematic diagram of an embodiment of a refrigeration system having an efficiently positioned compensator to conserve space, in accordance with an embodiment of the present disclosure;

(4) FIG. 4 is a perspective view of an embodiment of a heat exchanger, a housing, and a compensator disposed in a coil assembly plate, in accordance with an embodiment of the present disclosure;

(5) FIG. 5 is a perspective view of an embodiment of a microchannel heat exchanger and a compensator disposed in a coil assembly plate, in accordance with an embodiment of the present disclosure; and

(6) FIG. 6 is a side view of an embodiment of a microchannel heat exchanger and a compensator disposed in an indentation or mold within a coil assembly plate, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

(7) The present disclosure relates generally to a heating, ventilation, and/or air conditioning (HVAC) system with an indoor heat exchanger (e.g., an indoor coil) and an outdoor unit, which includes an outdoor heat exchanger (e.g., an outdoor coil). The HVAC system may be a heat pump, wherein cooling operations and heating operations generally require different volumes of refrigerant due to operational differences (e.g., differences in indoor and outdoor heat exchanger sizes and utilization as a condenser or evaporator). For example, it is now recognized that heating mode operation of heat pumps can result in liquid refrigerant stacking up in the system. A substantial amount of the refrigerant charge for the system can back up into the indoor heat exchanger during such operation. This stacked up refrigerant creates inefficiencies, such as limiting refrigerant flow due to increased discharge pressure and corresponding inefficient heat exchange. Accordingly, to address such issues, an HVAC system may employ a refrigerant charge compensator (also herein referred to as a compensator) disposed along the refrigerant flow path to increase system efficiency by storing excess refrigerant during heating mode operation and returning refrigerant back into circulation during cooling mode operation.

(8) A refrigerant charge compensator may include a conduit surrounded by a chamber. The conduit can be integrated along the refrigerant circuit and may extend through the inside of the chamber. The chamber surrounds the conduit and includes an inlet or port that can receive at least a portion of the excess refrigerant charge into the chamber. In a traditional configuration, the conduit of the compensator couples with the outdoor heat exchanger such that refrigerant is received from the outdoor heat exchanger and expelled toward a suction side of a refrigerant circuit compressor (via a reversing valve), in a heating mode. The chamber of the compensator may be communicatively coupled (e.g., via tubing) to the refrigerant circuit at a position along the refrigerant circuit that is upstream (during the heating mode of operation) of the outdoor heat exchanger such that refrigerant can accumulate in the chamber instead of entering the outdoor heat exchanger in the heating mode. Indeed, during heating mode, the refrigerant passing out of the outdoor heat exchanger and through the conduit of the compensator will be relatively cold, which lowers pressure in the chamber of the compensator, which pulls the refrigerant from upstream of the outdoor heat exchanger into the chamber of the compensator. In contrast, when the system is operating in cooling mode, the refrigerant passing through the conduit will be relatively hot because it is being received from the outlet of the compressor via the reversing valve. This causes the chamber of the compensator to be heated and an associated higher pressure within the chamber, which pushes refrigerant out of the chamber. Thus, during heating mode, excess refrigerant is stored in the chamber while in the cooling mode essentially the full refrigerant charge is being employed, as designed.

(9) Typically, indoor heat exchangers are tube and fin heat exchangers. That is, indoor heat exchangers typically include tubing with fins thermally coupled thereto such that heat transfer operations are improved (e.g., based on the increased surface area provided by the fins). However, while present embodiments may employ a tube and fin design, present embodiments may also employ a microchannel design. For example, instead of using a tube and fin heat exchanger as the indoor heat exchanger, the indoor heat exchanger may include microchannel tubes. Microchannel tubes are generally formed from extrusion and may also be referred to as multi-channel extrusions. Microchannel tubes often have a rectangular cross-section with several channels formed there through such that heat transfer is improved based on a higher surface per volume ratio. By employing microchannel tubes instead of tube and fin designs, present embodiments may facilitate

use of a smaller heat exchanger that is equally as efficient or more efficient (e.g., uses less refrigerant and improves heat transfer efficiency). However, it is now recognized that, when using a microchannel tube heat exchanger as the indoor heat exchanger in a heat pump, system adjustments may be employed to facilitate desired operation and accommodate certain secondary functional differences (e.g., additional stacking of refrigerant in the system during heating mode operation). Present embodiments may include positioning a compensator (e.g., to the indoor heat exchanger) or multiple compensators in a manner (e.g., within a coil assembly plate or delta plate) that conserves space while still providing desired functionalities.

(10) While it is now recognized that utilizing a microchannel tube heat exchanger as the indoor heat exchanger and adding a compensator has clear advantages over traditional systems, it is further recognized that other challengers are created. For example, installing a refrigerant charge compensator or an additional refrigerant charge compensator may be a challenge due to limited availability of space. As a specific example, installation of a compensator with the indoor heat exchanger and/or the outdoor heat exchanger may be difficult because there may be size limitations (e.g., to facilitate installation, due to required specifications, because of industry standards, or the like). Indeed, the geometry of the heat exchangers (e.g., the indoor heat exchanger) and associated features (e.g., housing) may have limited available space. Further, airflow efficiency through the heat exchangers must be taken into consideration because certain placements of the compensator may create substantial interference with airflow over the respective heat exchanger, which may deplete heat exchange efficiency. For example, coils of an indoor and/or outdoor heat exchanger typically extend between coil assembly plates (e.g., delta plates) and the space between the boundaries (e.g., door and walls) of a typical housing and the coil assembly plates is approximately 2 or 3 inches, which is not sufficient for incorporating a typical compensator. Additionally, space between slabs (coils) of a particular heat exchanger or between housing boundaries and the slabs facilitate the airflow for heat transfer, which should not be substantially blocked (e.g., by positioning an entire compensator therein).

(11) In view of the foregoing, present embodiments incorporate a receptacle (e.g., a cutout, opening, recess, indentation) in or through the coil assembly plate (e.g., delta plate) to accommodate the compensator with the heat exchanger. While the present disclosure focuses on such a receptacle being included in a coil assembly plate of a multichannel heat exchanger due to relevant operational characteristics and benefits, present embodiments may include such a receptacle formed in a coil assembly plate for any type of indoor or outdoor heat exchanger. Indeed, present embodiments may generate spatial efficiency in numerous different configuration types. By employing a receptacle within a coil assembly plate to accommodate a compensator, as will be discussed in detail below, present embodiments may facilitate spatial efficiency and operational efficiency.

(12) Turning now to the drawings, FIG. 1 illustrates a heating, ventilation, and/or air conditioning (HVAC) system for building environmental management that may employ one or more HVAC units incorporating embodiments of the present disclosure. In the illustrated embodiment, a building **10** is cooled and/or warmed by a system that includes a HVAC unit **12**, which may include a heat pump with a compensator spatially accommodated within a coil assembly plate in accordance with present embodiments. The building **10** may be a commercial structure or a residential structure. 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 equipment rooms 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, such as the system shown in FIG. 2, which includes an outdoor HVAC unit **58** and an indoor HVAC unit **56**. As discussed below, present embodiments may provide particular benefits for microchannel heat exchangers of indoor units, such as the indoor HVAC unit **56**.

(13) The HVAC unit **12** is an air cooled device that implements a refrigeration cycle to provide conditioned air to the building **10**. Specifically, the 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. In the illustrated embodiment, the HVAC unit **12** is a rooftop unit (RTU) that conditions a supply air stream, such as environmental air and/or a return air flow from the building **10**. After the HVAC unit **12** conditions the air, the air is supplied to the building **10** via ductwork **14** extending throughout the building **10** from the 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 configured to operate in different modes. Present embodiments may provide specific benefits to a heat pump operating in a heating mode. In other embodiments, the HVAC unit **12** may include one or more refrigeration circuits for cooling an air stream and a furnace for heating the air stream.

(14) 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**.

(15) FIG. **2** illustrates an embodiment of a residential heating and cooling system **50**, in accordance with present techniques. The residential heating and cooling system **50** may provide heated and cooled air to a residential structure, as well as provide outside air for ventilation and provide improved indoor air quality (IAQ) through devices such as ultraviolet lights and air filters. In the illustrated embodiment, the residential heating and cooling system **50** is a split HVAC system. Moreover, as mentioned above, the HVAC unit **12** of FIG. **1** may be implemented as a split HVAC system. In general, the building **10** (e.g., residence, commercial building) conditioned by a split HVAC system may include refrigerant conduits **54** that operatively couple the indoor unit **56** to the outdoor unit **58**. The indoor unit **56** may be positioned in a utility room, an attic, a basement, and so forth. The outdoor unit **58** is typically situated adjacent to a side of building **10** and is covered by a shroud to protect the system components and to prevent leaves and other debris or contaminants from entering the unit. The refrigerant conduits **54** transfer refrigerant between the indoor unit **56** and the outdoor unit **58**, typically transferring primarily liquid refrigerant in one direction and primarily vaporized refrigerant in an opposite direction.

(16) When the system shown in FIG. **2** is operating as an air conditioner, a heat exchanger **60** (also referred to as outdoor heat exchanger **60**) in the outdoor unit **58** serves as a condenser for re-condensing vaporized refrigerant flowing from the indoor unit **56** to the outdoor unit **58** via one of the refrigerant conduits **54**. In these applications, a heat exchanger **62** (also referred to as indoor heat exchanger **62**) of the indoor unit **56** functions as an evaporator. Specifically, the heat exchanger **62** receives liquid refrigerant, which may be expanded by an expansion device, and evaporates the refrigerant before returning it to the outdoor unit **58**.

(17) The outdoor unit **58** draws environmental air through the heat exchanger **60** using a fan **64** and expels the air above the outdoor unit **58**. When operating as an air conditioner, the air is heated by the heat exchanger **60** within the outdoor unit **58** and exits the unit at a temperature higher than it entered. The indoor unit **56** includes a blower or fan **66** that directs air through or across the indoor heat exchanger **62**, where the air is cooled when the system is operating in air conditioning mode. Thereafter, the air is passed through ductwork **67** that directs the air to the building **10**. The overall

system operates to maintain a desired temperature as set by a system controller, such as the control device **16** discussed above. When the temperature sensed inside the building **10** is higher than the set point on the control device **16**, or the set point plus a small amount, the residential heating and cooling system **50** may become operative to refrigerate additional air for circulation through the building **10**. When the temperature reaches the set point, or the set point minus a small amount, the residential heating and cooling system **50** may stop the refrigeration cycle temporarily.

(18) As a heat pump, the residential heating and cooling system **50** may also operate in a heating mode. When operating in a heating mode of a heat pump, the roles of heat exchangers **60** and **62** are reversed. That is, the heat exchanger **60** of the outdoor unit **58** will serve as an evaporator to evaporate refrigerant and thereby cool air entering the outdoor unit **58** as the air passes over the outdoor heat exchanger **60**. The indoor heat exchanger **62** will receive a stream of air blown over it and will heat the air by condensing the refrigerant. In the heating mode, the operating conditions and the size of the indoor heat exchanger **62** may cause refrigerant to stack up in the residential heating and cooling system **50**. While the illustrated embodiment shows the indoor heat exchanger **62** as a fin and tube exchanger, in some embodiments the indoor heat exchanger **62** may be a microchannel tube heat exchanger, which may exacerbate this issue. Indeed, the small channels of a microchannel tube heat exchanger tend to have a more limited volume. Accordingly, to accommodate this, present embodiments may incorporate a compensator **68** within a compensator receptacle **69** of a coil assembly plate **70** (e.g., delta plate) of the indoor heat exchanger **62**. Because the indoor unit **56** has limited available space, incorporating this feature allows for employment of the compensator **68** without a substantial impact on size or performance. Indeed, even an overall footprint of the indoor heat exchanger **62** may not be extended such that there is no interference with an outer skin **71** of the indoor unit **56**.

(19) The overall system operates to maintain a desired temperature as set by the control device **16** (e.g., thermostat), in certain embodiments. For example, in a cooling mode of operation, when the temperature sensed inside the building **10** is higher than the set point on the control device **16** (plus a small amount), the air conditioner may operate to refrigerate additional air for circulation through the building **10**. When the temperature reaches the set point (minus a small amount), the unit may stop the refrigeration cycle temporarily.

(20) FIG. 3 is an embodiment of a vapor compression system **72** that can be used in any of the systems described above. The vapor compression system **72** may include a heat pump system that operates to circulate a refrigerant through a circuit starting with a compressor **74**. The circuit may also include a switching valve **75**, an indoor heat exchanger **76**, expansion valves **78** (also referred to as expansion devices **78**), non-return valves **79**, an outdoor heat exchanger **80**, and the compensator **68**. The expansion valves **78** and non-return valves **79** cooperate to block flow of refrigerant from proceeding backwards through the expansion valves **79**, which are positioned for operation in different modes (e.g., the expansion valve **79** adjacent the outdoor heat exchanger **80** operates in heating mode). The compensator **68** may be integrated or otherwise stored within a coil assembly plate of the indoor heat exchanger **76** or the outdoor heat exchanger **80**, in accordance with present embodiments.

(21) The vapor compression system **72** may further include a control panel **82** that has an analog to digital (A/D) converter **84**, a microprocessor **86**, a non-volatile memory **88**, and/or an interface board **90**. The control panel **82** and its components may function to regulate operation of the vapor compression system **72** based on feedback from an operator, from sensors of the vapor compression system **72** that detect operating conditions, and so forth. Further, the control panel **82** may control certain aspects of operation based on system layout, such as where the compensator **68** (or another compensator) is located and the nature (e.g., fin and tube or microchannel) of relevant heat exchangers.

(22) In some embodiments, the vapor compression system **72** may use one or more of a variable speed drive (VSDs) **92**, a motor **94**, the compressor **74**, the indoor heat exchanger **76**, the

expansion valve or device **78**, and/or the outdoor heat exchanger **80**. The motor **94** may drive the compressor **74** and may be powered by the variable speed drive (VSD) **92**. The VSD **92** 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 **94**. In other embodiments, the motor **94** may be powered directly from an AC or direct current (DC) power source. The motor **94** may include any type of electric motor that can be powered by a VSD 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.

(23) The compressor **74** (e.g., a centrifugal compressor) compresses a refrigerant vapor and delivers the vapor to the switching valve **75**. In a cooling mode, the switching valve **75** directs the refrigerant to the outdoor heat exchanger **80** through the compensator **68**. The refrigerant vapor delivered by the compressor **74** to the outdoor heat exchanger **80** may transfer heat to a fluid passing across the outdoor heat exchanger **80**, such as ambient or environmental air. The refrigerant vapor may condense to a refrigerant liquid in the outdoor heat exchanger **80** (operating as a condenser) as a result of thermal heat transfer with the environmental air. The liquid refrigerant from the outdoor heat exchanger **80** may flow through the expansion device **78** downstream of the outdoor heat exchanger **80** on its way to the indoor heat exchanger **76**.

(24) The liquid refrigerant delivered to the indoor heat exchanger **76** may absorb heat from another air stream, such as a supply air stream provided to the building. For example, the supply air stream may include ambient or environmental air, return air from a building, or a combination of the two. The liquid refrigerant in the indoor heat exchanger **76** (operating as an evaporator) may undergo a phase change from the liquid refrigerant to a refrigerant vapor. In this manner, indoor heat exchanger **76** may reduce the temperature of the supply air stream via thermal heat transfer with the refrigerant. Thereafter, the vapor refrigerant exits the indoor heat exchanger and returns to the compressor **74** by a suction line to complete the cycle.

(25) During operation of the vapor compression system **72** in a cooling mode, the refrigerant passing through a conduit **95** of the compensator **68** may be relatively hot. Accordingly, a chamber **96** of the compensator **68** disposed about the conduit **95** may also be relatively warm. Thus, the chamber **96** will not operate to pull refrigerant into it from another location **97** along the refrigerant circuit, such as from between an exit of the outdoor heat exchanger **80** and an entry into the indoor heat exchanger **76** where the chamber **96** is connected in the illustrated embodiment. However, in a heating mode of operation, the reversing valve **75** operates to reverse the flow of refrigerant such that the outdoor heat exchanger **80** operates as the evaporator and the indoor heat exchanger **76** operates as the condenser. In this mode of operation, the refrigerant passing through the conduit **95** is relatively cold having just passed the expansion valve **79** entering the outdoor heat exchanger **80** and then passing through the outdoor heat exchanger **80** itself, while it is operating as an evaporator. Accordingly, refrigerant backed up toward the indoor heat exchanger **76**, while operating in the heating mode, may be pulled into the chamber **96** based on a cooling effect within the chamber **96**.

(26) As noted above, the compensator **68** may be stored or located within a receptacle of a coil assembly plate (e.g., a delta plate) of one of the indoor heat exchanger **76**, the outdoor heat exchanger **80**, or both. Hot air from an indoor space may blow across the indoor heat exchanger **76** (e.g., in a cooling mode) and the compensator **68**, which may push liquid refrigerant out of the compensator **68** (out of the chamber **96**) or cold air from the indoor space blowing across the heat exchanger **76** (e.g., in a heating mode) and compensator **68** may pull liquid refrigerant into the compensator **68** (into the chamber **96**). Further, multiple compensators **68** may be employed with different source points along the refrigerant circuit for supplying the chamber **96** where appropriate and under desired operating conditions.

(27) As used herein, “refrigerant” refers to any operating fluid contained within the vapor compression system **72** and employed to facilitate cooling, including any suitable refrigerant or

refrigerant mixture having additives such as oils, indicators, stabilizers, dyes, fragrances, or any combination thereof. The term “refrigerant” may broadly reference commercial refrigerants and may exclude contaminants, such as water.

(28) FIG. 4 is a perspective view of a portion of an HVAC unit **100** according to an embodiment of the present disclosure. Specifically, the illustrated portion of the HVAC unit **100** may represent a housing **102** with a coil assembly **104** disposed therein. The coil assembly **104** may correspond to the indoor heat exchanger **62** of FIG. 2 and the housing **102** may correspond to a portion of the outer skin **71** of the indoor unit **56**. In some embodiments, the coil assembly **104** may be a fin and tube or microchannel heat exchanger that is configured to receive chilled refrigerant or other liquid through tubes **103** to condense, cool, and/or dehumidify air that moves across the tubes **103**. Particularly, the air may be pulled or forced across the tubes **103** by an air mover, such as the blower or fan **66** to facilitate heat exchange operations to achieve desired climate management of an indoor space. The coil assembly **104** and related components of the housing **102** may be installed in a particular position that suits a desired operation. For example, the illustrated portion of the HVAC unit **100** may be designed for up-flow. However, in other orientations, it may facilitate down-flow, horizontal right-flow, or horizontal left-flow. Up-flow, down-flow, horizontal right-flow, and horizontal left-flow describe paths that air may flow relative to the coil assembly. Other flow paths are also presently contemplated.

(29) The coil assembly **104**, depending on orientation, may be considered an A-type coil assembly or a V-type coil assembly. Indeed, the coil assembly **104** includes a pair of heat exchanger slabs that generally form an A-shape or V-shape because they essentially come together at one side creating a triangular shape. It is to be understood the present embodiments are not limited to such embodiments and may be implemented with other types of coil assemblies as well, such as an N-type coil assembly. However, for ease of discussion, the illustrated and discussed examples focus on an A-type coil assembly.

(30) Although, FIG. 4 illustrates what is generally referred to as a vertically oriented coil assembly **104**, which facilitates up-flow discharge of air or down-flow discharge of air through the coil assembly **104**, it is to be understood that present embodiments can be employed in any orientation. In one example, a vertically oriented coil assembly may be employed to provide upward discharge of air for transferring heated air inside an enclosed space during cold climate or downward discharge of air (e.g., in a rooftop installation) for transferring cold air inside an enclosed space during warm climate. The coil assembly **104** may represent a tube and fin heat exchanger, a microchannel tube heat exchanger, or another type of heat exchanger slab. While only certain aspects are illustrated and described in detail, the illustrated portion of the HVAC unit **100** can include additional components that facilitate operations.

(31) In addition to the coil assembly **104**, the illustrated embodiment includes a drain pan **105**. As air moves across the coil assembly **104** to achieve the heat exchange discussed above, moisture or water within the air may condense and gather about tubes of the coil assembly **104**. As the water from the air continues to condense, the condensate or condensed water may drop along the first slab **106** and/or the second slab **108** into the drain pan **105**, which is positioned vertically below the coil assembly **104**. In certain embodiments, an air mover may blow or draw the condensate off of the coil assembly **104** and into the drain pan **105**. In other embodiments, the condensate may be pulled into the drain pan **105** by gravity.

(32) As noted above, the coil assembly **104** is an A-type coil assembly. The coil assembly includes a first slab **106** and a second slab **108**, which are coupled together via a couple of coil assembly plates **70** (also referred to as delta plates **70**). Only the front coil assembly plate **70** is clearly visible in the depicted perspective. In addition to the first slab **106** and the second slab **108**, the coil assembly **104** includes an apex end **114**, a first end **116**, and a second end **118**. The apex end **114** is defined as abutting ends or proximate ends of the first slab **106** and the second slab **108**. The first end **116** is an end of the first slab **106** that is opposite of the apex end **114**. Similarly, the second

end **118** is an end of the second slab **108** that is opposite of the apex end **114**. Both the first end **116** and the second end **118** are spaced apart from each other.

(33) The coil assembly **104** is coupled with and supported by the pair of coil assembly plates **70**. The coil assembly plates **70** are provided on either side of the coil assembly **104**. Only one of the coil assembly plates **70** (referred to as the front assembly plate **70**) is clearly visible in FIG. **4**. The coil assembly plates **70** couple with the first slab **106** and the second slab **108** such that they hold the first slab **106** and the second slab **108** together, thus providing general structural support. However, the coil assembly plates **70** also function to direct air flowing through the portion of the HVAC unit **100** through the coil assembly **104** to encourage proper heat exchange. Indeed, the coil assembly plates **70** cooperate to guide airflow through the first slab **106** and the second slab **108** and prevent airflow from escaping through what would otherwise be an opening to bypass the coil assembly **104**. In an embodiment, the first end **116** of the first slab **106** and the second end **118** of the second slab **108** are coupled to the drain pan **105** or any other suitable support structure of the housing **102**.

(34) As discussed above, refrigerant may stack up due to certain system operations. For example, in the heating mode of a heat pump utilizing the coil assembly **104** as an indoor coil, may cause refrigerant in liquid form to fill portions of the system. This may be exacerbated when the coil assembly **104** is a microchannel tube heat exchanger. Accordingly, to accommodate this, present embodiments may incorporate one or more compensators **68**. Specifically, in the illustrated embodiment the compensator **68** is disposed within the compensator receptacle **69** of the coil assembly plate **70**, which is positioned in alignment with boundaries the housing **102**. In the illustrated embodiment, the compensator **68** and the associated compensator receptacle **69** may be described as positioned horizontally (e.g., transverse to the direction of airflow exiting through a top of the coil assembly **104**). However, in other embodiments, the compensator **68** and the compensator receptacle **69** may be positioned in any orientation that avoids impacting (e.g., deforming) heat exchange tubes. Because the housing **102** has limited available space, incorporating the compensator **68** in the compensator receptacle **69** in this manner (i.e., extending through the coil assembly plate **70**) allows for improved system operation (as provide by use of the compensator **68**) without a substantial impact on size or performance. For example, the compensator **68** is positioned within the boundaries or an envelope of the housing **102** and does not substantially interfere with airflow therethrough.

(35) The housing **102** in FIG. **4** is shown to include a plurality of panels that engage with the drain pan **105**. Specifically, the housing **102** is illustrated as including a first panel **120**, a second panel **122**, and a third panel **124**. The housing **102** may be provided with one or more access panels **126** configured to engage with the first panel **120** and the second panel **122**. The first panel **120** and the second panel **122** are substantially parallel to each other, whereas the third panel **124** and the access panel **126** are substantially parallel to each other when the access panel **126** is in an installed configuration. The third panel **124** is substantially orthogonal to the first panel **120** and the second panel **122**. For example, the shape of housing **102** can be of rectangular shape, cubic shape, and any other geometrical shape. In another example, the first panel **120**, the second panel **122**, and the third panel **124** may have a C-shaped profile or U-shaped profile. In a configuration in which the access panel **126** is removed, as shown in the illustrated embodiment, the compensator **68** can be accessed (e.g., for maintenance). When the access panel **126** is installed, the positioning of the compensator **68** within the compensator receptacle **69** (e.g., an opening or an indentation) of the coil assembly plate **70** may prevent the compensator from substantially engaging with (e.g., deforming the access panel **126** or any other panel of the housing **102**). In some embodiments, the access panel **126** or some other panel of the housing **102** may be designed to accommodate some minor outward extension of the compensator **68** from the coil assembly plate **70**.

(36) FIG. **5** is a perspective view of a microchannel indoor coil **300** (indoor heat exchanger) in accordance with an embodiment of the present disclosure. The indoor coil **300** may be employed as

the coil assembly **104**. A delta plate **302**, such as one of the pair of delta plates **70**, is disposed between first slab **304** and second slab **306** of the indoor coil **300**. Further, the delta plate **302** houses a compensator **310**. Specifically, the delta plate **302** includes a receptacle **312** in which the compensator **310** is disposed. The receptacle **312** may include an opening that passes entirely through the delta plate **70** or a recess (e.g., an indentation) in the delta plate **302**. Using a recess instead of an opening as the receptacle **312** may relatively limit airflow escape through the delta plate **302** compared to a full opening.

(37) In the illustrated embodiment, the delta plate **302** is secured over end sheets **316** of the indoor coil **300**. The end sheets **316** run along a perimeter of the delta plate **302**. The receptacle **312** (e.g., a notch or recess) is located in an interior area of the delta plate **302** so that the receptacle **312** does not puncture or deform the end sheets **316** (e.g., microchannel tubes on the outer edges of the slabs **304**, **306**). The location, shape, and depth of the receptacle **312** is configured to fit the compensator **310** without having to modify an associated housing (e.g., the housing **102**). The receptacle **312** is enabled to at least partially receive the compensator **310** therein. For example, a distance between housing doors (e.g., access panel **126**) and the delta plate **302** may be fixed (e.g., approximately 2 or 3 inches). This fixed distance may be used to determine the maximum protrusion of the compensator **310** from a surface of the delta plate **302**, and, in turn, determine the depth of receptacle **312** or a coupling position of the compensator **310** within the receptacle **312** (e.g., when the receptacle **312** is a hole that passes entirely through the delta plate **302**). The receptacle **312** may be designed to correspond to the size, shape, and dimensions of a compensator to prevent excess air from escaping through the receptacle **312** and to keep the air flowing across the microchannel slabs **304**, **306**. In some embodiments, the receptacle **312** is cut, shaped, or impressed into the delta plate **312**. For example, the receptacle **312** may be an opening or a whole that is not big enough to allow the compensator **310** to completely pass therethrough (e.g., a height of the receptacle **312** may be smaller than a diameter of the compensator **310**). The receptacle may be in the shape of a rectangle, a square, an oval, a triangle, a polygon, a circle, or any geometric shape that correlates to a profile of the compensator **310** and allows engagement therewith. In the illustrated embodiment, the receptacle **312** is oriented at an angle relative to the drain pan **105**. However, in accordance with present embodiments, the receptacle **312** may be oriented in any direction and located anywhere in the delta plate **302**.

(38) In the illustrated embodiment, a bracket **322** is affixed to the delta plate **302** to secure, stabilize, and/or lock down the charge compensator **310** in the receptacle **312**. The bracket **322** is configured to hold the charge compensator in the receptacle **4312** and/or against the delta plate **302**. The bracket **322** can be removably affixed to either side of the delta plate **302** and proximate the receptacle **312**. The bracket **322** may represent multiple such brackets and brackets may be employed on both sides of the delta plate **302** when the receptacle is an opening that passes completely through the delta plate **302**. The bracket **322** and the receptacle **312** can be made from any materials including metals commonly used to manufacture the delta plate, i.e., stainless steel, aluminum, etc. The receptacle **312** may be formed from the delta plate **302** (e.g. impressed into the delta plate, cut through the delta plate) but may also be separately formed and attached to the delta plate **302** (e.g., a recess formed in plastic or metal and secured through a separate opening through the delta plate **302**).

(39) In the illustrated embodiment of FIG. 5, the receptacle **312** is an angled rectangular hole cut into an interior of the delta plate **302**. The dimensions of the receptacle **312** are sized to the length and diameter of the charge compensator **310** and the receptacle **312** opens to the inside space between the microchannel slabs **304**, **306**. The compensator **310** lies lengthwise in the hole, with circular ends of the compensator **310** abutting or adjacent (e.g., less than an inch away) from the edges at the width of the receptacle **312**.

(40) In the illustrated embodiment, the bracket **322** is a strip of stainless steel or aluminum. A middle portion **324** of the bracket **322** juts out and follows a contour (e.g., a curved circumference)

of the compensator **310**. The bracket's curved length (the middle portion **324**) abuts the compensator's round perimeter surface. Flat ends **326** of the bracket lie against a surface of the delta plate **302** and couple thereto. For example, each of the flat ends **326** of the bracket may have holes that receive screws or other fasteners that extend therethrough and into the delta plate **302**. Thus, the bracket **322** may be secured directly to delta plate **302** and retain the compensator **310** in the receptacle **312**. In some embodiments, a first bracket is coupled to an outside surface of the delta plate **302** and another bracket is coupled to an inside surface of the delta plate **302**. In other embodiments, more than one bracket may be positioned on each side of the delta plate **302**.

(41) FIG. **6** is a cross-sectional side view of the indoor coil **300**, wherein the receptacle **312** is an indentation (e.g., a pressed or stamped form that is disposed in or coupled to the delta plate **302**), in accordance with an embodiment of the present disclosure. The receptacle **312** of FIG. **6** is essentially a depression or recess in the surface of the delta plate **302** that operates to house approximately half of the compensator **310** such that the rest of the compensator extends outwardly from the delta plate **302** (and from the receptacle **312**) toward a boundary (e.g., a footprint perimeter defined by edges of the drain plate **105**) of the indoor coil **300**. Instead of a hole or opening through the delta plate **302** that is open to the inside space between the microchannel slabs, the receptacle **312** illustrated in FIG. **6** is closed off to that space. Thus, airflow through that space may be guided around the compensator **310** and retained within that space by a side of the receptacle **312** facing away from the compensator **310**. The bracket **322** is illustrated with a curvature matching a round surface of the compensator **310** and a depth corresponding to the compensator's protrusion into the inside space between the first slab **304** (not shown in FIG. **6**) and the second slab **306**. As previously noted, in some embodiments, the receptacle **312** is a separately formed piece that is secured within an opening through the delta plate **302** such that the receptacle **312** blocks air from passing through the opening in the delta plate **302** from an the inside space between the slabs **304**, **306**, while acting as a “cradle” or “seat” for the compensator **310**. While an indentation in the delta plate **302** or a separately formed receptacle **312** may assist in defining the interior space defined by the delta plates **302** and slabs **304**, **306**, they may be referred to as extending into the space defined by these features, as would be understood by one of ordinary skill in the art.

(42) In some embodiments, more than one compensator is installed. A single receptacle can be made to house multiple compensators or separate receptacles may be made for each of several compensators. Similarly, one bracket with a longer extended projected middle portion may be employed to encompass multiple compensators or multiple brackets can be made to accommodate multiple compensators.

(43) The construction and arrangement of the systems and methods as shown in the various exemplary embodiments are illustrative only. Although only a few embodiments have been described in detail in this disclosure, many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.). For example, the position of elements can be reversed or otherwise varied and the nature or number of discrete elements or positions can be altered or varied. Accordingly, all such modifications are intended to be included within the scope of the present disclosure. The order or sequence of any process or method steps can be varied or re-sequenced according to alternative embodiments. Other substitutions, modifications, changes, and omissions can be made in the design, operating conditions and arrangement of the exemplary embodiments without departing from the scope

(44) While only certain features and embodiments of the present disclosure 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 including temperatures, pressures, and so forth, mounting arrangements, use of materials, 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. Furthermore, in an effort to provide a concise description of the embodiments, all features of an actual implementation may not have been described, such as those unrelated to the presently contemplated best mode of carrying out the disclosure, or those unrelated to enabling the claimed features. 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.

Claims

1. A heating, ventilation, and/or air conditioning (HVAC) system, comprising: a refrigerant circuit configured to circulate refrigerant therethrough, the refrigerant circuit comprising a compressor, an indoor heat exchanger, an outdoor heat exchanger, and a reversing valve configured to transition between a first configuration to direct the refrigerant from the compressor toward the outdoor heat exchanger and a second configuration to direct the refrigerant from the compressor toward the indoor heat exchanger; a refrigerant charge compensator; a conduit of the refrigerant charge compensator, wherein the conduit is part of the refrigerant circuit and configured to pass the refrigerant therethrough; a chamber of the refrigerant charge compensator, wherein the chamber is disposed about the conduit, communicatively coupled to the refrigerant circuit, and configured to retain a portion of the refrigerant therein; and a coil assembly plate of the indoor heat exchanger or the outdoor heat exchanger, wherein the coil assembly plate comprises a receptacle configured to receive the refrigerant charge compensator.
2. The HVAC system of claim 1, wherein the indoor heat exchanger comprises a microchannel tube heat exchanger.
3. The HVAC system of claim 1, wherein the coil assembly plate is one of a pair of coil assembly plates that couple with a first slab and a second slab of the indoor heat exchanger or the outdoor heat exchanger and cooperate to guide airflow through the indoor heat exchanger or the outdoor heat exchanger.
4. The HVAC system of claim 1, wherein the receptacle comprises a hole through the coil assembly plate with dimensions corresponding to a perimeter of the refrigerant charge compensator.
5. The HVAC system of claim 1, wherein the receptacle comprises an indentation in the coil assembly plate with dimensions of the indentation corresponding to dimensions of the refrigerant charge compensator.
6. The HVAC system of claim 1, wherein the receptacle comprises a molded form defining a recess with dimensions of the recess corresponding to dimensions of the refrigerant charge compensator, wherein the molded form couples with the coil assembly plate and extends through an opening in the coil assembly plate.
7. The HVAC system of claim 1, wherein the indoor heat exchanger is a microchannel heat exchanger and the coil assembly plate is coupled with or part of the indoor heat exchanger.
8. The HVAC system of claim 1, wherein the refrigerant charge compensator is positioned within the receptacle such that the refrigerant charge compensator does not extend beyond a footprint or envelope defined by the indoor heat exchanger or the outdoor heat exchanger.
9. The HVAC system of claim 8, wherein the footprint or envelope is defined by a drain pan or a housing of the indoor heat exchanger or the outdoor heat exchanger.
10. The HVAC system of claim 1, wherein the receptacle is angled such that a surface or the

receptacle or the refrigerant charge compensator will not touch any tubes of the indoor heat exchanger or the outdoor heat exchanger.

11. The HVAC system of claim 1, wherein the refrigerant charge compensator is configured to receive the refrigerant into the conduit from the compressor and pass the refrigerant into the outdoor heat exchanger in a cooling mode.

12. The HVAC system of claim 11, wherein the chamber of the refrigerant charge compensator is fluidly coupled to the refrigerant circuit via communicative coupling between the outdoor heat exchanger and the indoor heat exchanger.

13. A heat pump system, comprising a compressor of a refrigeration circuit, wherein the compressor is configured to drive refrigerant through the refrigeration circuit; an indoor heat exchanger of the refrigeration circuit; an outdoor heat exchanger of the refrigeration circuit; a reversing valve of the refrigeration circuit, wherein the reversing valve is configured to transition between a first configuration to direct the refrigerant from the compressor toward the outdoor heat exchanger and a second configuration to direct the refrigerant from the compressor toward the indoor heat exchanger; a refrigerant charge compensator comprising a conduit disposed along the refrigerant circuit and a chamber surrounding the conduit that is fluidly coupled to the refrigerant circuit; and a coil assembly plate of the indoor heat exchanger or the outdoor heat exchanger, wherein the coil assembly plate comprises a receptacle configured to receive the refrigerant charge compensator.

14. The heat pump system of claim 13, wherein the coil assembly plate is coupled or integrated with the indoor heat exchanger, which is a microchannel tube heat exchanger.

15. The heat pump system of claim 13, wherein the receptacle comprises a hole through the coil assembly plate with dimensions corresponding to a perimeter of the refrigerant charge compensator.

16. The heat pump system of claim 13, wherein the receptacle comprises an indentation in the coil assembly plate with dimensions of the indentation corresponding to dimensions of the refrigerant charge compensator.

17. The heat pump system of claim 13, wherein the receptacle comprises a molded form defining a recess with dimensions of the recess corresponding to dimensions of the refrigerant charge compensator, wherein the molded form couples with the coil assembly plate and extends through an opening in the coil assembly plate.

18. A heating, ventilation, and/or air conditioning (HVAC) system, comprising: a heat exchanger; a first slab of the heat exchanger; a second slab of the heat exchanger; coil assembly plates coupled to the first slab and the second slab such that an interior space is defined between the first slab, the second slab, and the coil assembly plates, wherein the interior space is configured to guide airflow through the heat exchanger; and a receptacle in one coil assembly plate of the coil assembly plates, wherein the receptacle houses a refrigerant charge compensator such that a portion of the refrigerant charge compensator extends into the interior space.

19. The HVAC system of claim 18, wherein the receptacle comprises a form or indentation that extends into the interior space and cradles the refrigerant charge compensator.

20. The HVAC system of claim 18, wherein the first slab and the second slab comprises microchannel tubes.
