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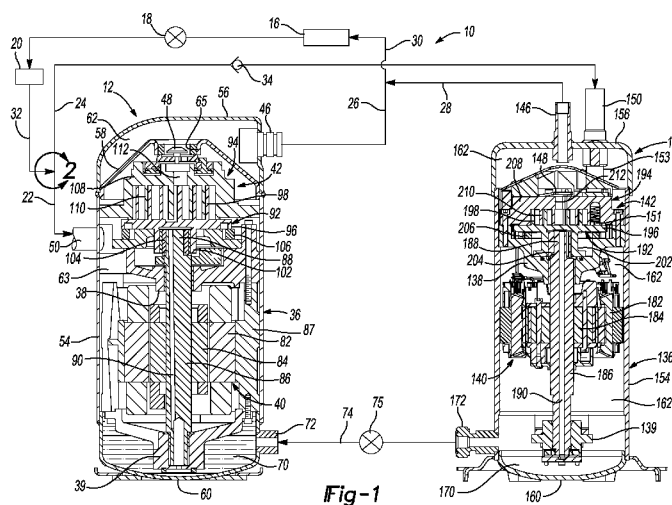
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(54) Title: SYSTEM INCLUDING HIGH-SIDE AND LOW-SIDE COMPRESSORS



(57) Abstract: A heat pump system may be operable to circulate fluid between first and second heat exchangers in a first direction in a heating mode and in a second direction in a cooling mode. The heat pump system may include a suction conduit, a low-side compressor and a high-side compressor. The low-side and high-side compressors may both be in fluid communication with the suction conduit.

SYSTEM INCLUDING HIGH-SIDE AND LOW-SIDE COMPRESSORS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Patent Application No. 14/189,200, filed on February 25, 2014, U.S. Patent Application No. 14/189,248, filed on February 25, 2014, and claims the benefit of U.S. Provisional Application No. 61/769,255, filed on February 26, 2013. The entire disclosures of the above applications are incorporated herein by reference.

10 FIELD

[0002] The present disclosure relates to a system including high-side and low-side compressors.

BACKGROUND

15 **[0003]** This section provides background information related to the
present disclosure and is not necessarily prior art.

[0004] Heat-pump systems and other working fluid circulation systems include a fluid circuit having an outdoor heat exchanger, an indoor heat exchanger, an expansion device disposed between the indoor and outdoor heat exchangers, and one or more compressors circulating a working fluid (e.g., refrigerant or carbon dioxide) between the indoor and outdoor heat exchangers. Efficient and reliable operation of the compressors is desirable to ensure that the heat-pump system in which the compressors are installed is capable of effectively and efficiently providing a cooling and/or heating effect on demand.

25 SUMMARY

[0005] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

[0006] In one form, the present disclosure provides a system operable to circulate fluid between first and second heat exchangers and including a suction line, a low-side compressor, a high-side compressor and a discharge line. The low-side and high-side compressors may both be in fluid communication with the suction and discharge lines.

[0007] In some embodiments, the suction line is fluidly coupled to a low-side suction inlet and a high-side suction inlet.

[0008] In some embodiments, a shell of the low-side compressor is disposed between the suction line and the high-side suction inlet, such that fluid passes through a suction chamber defined by the shell after exiting the suction line and before entering the high-side compressor.

[0009] In some embodiments, a discharge outlet of the high-side compressor feeds compressed fluid to the low-side suction inlet.

[0010] In some embodiments, the high-side suction inlet receives fluid discharged by the low-side compressor.

[0011] In some embodiments, the system includes a bypass conduit directly coupling the suction line with the high-side suction inlet.

[0012] In some embodiments, the high-side compressor includes a shell having first and second inlets. The first inlet may receive fluid from the low-side compressor at a first pressure. The second inlet may receive fluid discharged from the low-side compressor at a second pressure that is higher than the first pressure.

[0013] In some embodiments, the high-side compressor includes a compression mechanism defining at least one compression pocket that receives fluid from the first inlet and is fluidly isolated from fluid received by the high-side compressor from the second inlet.

[0014] In some embodiments, a discharge chamber of the high-side compressor and a suction chamber of the low-side compressor are at substantially equal pressures when the high-side and low-side compressors are operating at approximately one-hundred percent capacity.

[0015] In some embodiments, the system includes an oil conduit fluidly connecting oil sumps of the low-side and high-side compressors. In some embodiments, the system includes a control module controlling a valve disposed in the oil conduit. In some embodiments, the control module is operable to control a capacity of at least one of the high-side and low-side compressors.

[0016] In some embodiments, the system includes a control module that operates one of the low-side and high-side compressors and prevent operation of another of the low-side and high-side compressors when the system is operating

in a heating mode. In some embodiments, the control module is operable to operate the other of said low-side and high-side compressors and prevent operation of the one of said low-side and high-side compressors when the system is operating in a cooling mode.

5 **[0017]** In some embodiments, the system includes an outdoor unit including an outdoor heat exchanger and one of the low-side and high-side compressors; and an indoor unit including an indoor heat exchanger and the other of the low-side and high-side compressors.

10 **[0018]** In another form, the present disclosure provides a compressor that may include a shell, a first compression mechanism and a second compression mechanism. The shell may define a first chamber containing fluid at a first fluid-pressure. The first compression mechanism may include first orbiting and first non-orbiting scrolls disposed in the first chamber and discharging compressed fluid into the first chamber at the first fluid-pressure. The second
15 compression mechanism may include second orbiting and second non-orbiting scrolls disposed in the first chamber and defining a suction inlet and a discharge outlet. The suction inlet may receive fluid at the first fluid-pressure from the first chamber. The discharge outlet may discharge fluid at a second fluid-pressure out of the shell.

20 **[0019]** In some embodiments, the shell defines a second chamber at the second fluid-pressure. In some embodiments, the second chamber includes a discharge muffler.

25 **[0020]** In some embodiments, the compressor includes a driveshaft disposed in the first chamber and drivingly engaging the first and second orbiting scrolls.

[0021] In some embodiments, the compressor includes a motor disposed within the shell and driving both of the first and second orbiting scrolls.

30 **[0022]** In some embodiments, the compressor includes a suction conduit extending through the shell and engaging a suction inlet of the first compression mechanism and transferring fluid at a third fluid-pressure to the first compression mechanism. The third fluid-pressure may be less than the first and second fluid-pressures.

[0023] In some embodiments, the shell defines a single lubricant sump supplying lubricant to both of the first and second compression mechanisms.

[0024] In another form, the present disclosure provides a heat pump system that may be operable to circulate fluid between first and second heat exchangers in a first direction in a heating mode and in a second direction in a cooling mode. The heat pump system may include a suction conduit, a low-side compressor and a high-side compressor. The low-side and high-side compressors may both be in fluid communication with the suction conduit.

[0025] In some embodiments, the heat pump system includes an oil conduit and a control module. The oil conduit may fluidly connect oil sumps of the low-side and high-side compressors. The control module may control a valve disposed in the oil conduit.

[0026] In some embodiments, the heat pump system includes a control module operating one of the low-side and high-side compressors when the heat pump system is operating in the heating mode and preventing operation of another of the low-side and high-side compressors when the heat pump system is operating in the heating mode.

[0027] In some embodiments, the control module is operable to operate the other of the low-side and high-side compressors when the heat pump system is operating in the cooling mode and prevent operation of said one of said low-side and high-side compressors when the heat pump system is operating in the cooling mode.

[0028] In some embodiments, the heat pump system includes an outdoor unit and an indoor unit. The outdoor unit may include an outdoor heat exchanger and one of the low-side and high-side compressors. The indoor unit may include an indoor heat exchanger and another of the low-side and high-side compressors.

[0029] In some embodiments, the heating mode includes a first heating mode in which both of the high-side and low-side compressors are operating and a second heating mode in which the high-side compressor is operating and the low-side compressor is shut down.

[0030] In some embodiments, the cooling mode includes a first cooling mode in which both of the high-side and low-side compressors are operating and

a second cooling mode in which the low-side compressor is operating and the high-side compressor is shut down.

[0031] In some embodiments, an interior volume of one of the high-side and low-side compressors is operable as a suction accumulator accumulating working fluid therein during the heating mode.

[0032] In some embodiments, the interior volume of the one of the high-side and low-side compressors is operable as a suction accumulator accumulating working fluid therein during the cooling mode.

[0033] In some embodiments, an interior volume of another of the high-side and low-side compressors is operable as a suction accumulator accumulating working fluid therein during the cooling mode.

[0034] In another form, the present disclosure provides a heat pump system operable in a first heating mode and in a first cooling mode. The heat pump system may include high-side and low-side compressors and a discharge conduit. The high-side compressor may include a first suction inlet and a first suction outlet. The low-side compressor may include a second suction inlet and a second suction outlet. The discharge conduit may receive compressed working fluid from the low-side compressor in the first heating mode and may receive compressed working fluid from the high-side compressor in the first cooling mode.

[0035] In some embodiments, fluid communication between the low-side compressor and the discharge conduit is restricted in the first cooling mode, and fluid communication between said high-side compressor and said discharge conduit is restricted in said first heating mode.

[0036] In some embodiments, fluid communication between the high-side compressor and the discharge conduit is restricted in a second cooling mode, and fluid communication between the low-side compressor and the discharge conduit is restricted in a second heating mode.

[0037] In some embodiments, fluid communication between the low-side compressor and the discharge conduit is restricted in the second cooling mode, and fluid communication between the high-side compressor and the discharge conduit is restricted in the second heating mode.

[0038] In some embodiments, both of the low-side and high-side compressors operate during the first heating mode and during the first cooling

mode, and only one of the high-side and low-side compressors operates during the second heating mode and the second cooling mode.

5 **[0039]** In some embodiments, the high-side compressor operates during the second heating mode and the low-side compressor is shut down during the second heating mode.

[0040] In some embodiments, the low-side compressor operates during the second cooling mode and the high-side compressor is shut down during the second cooling mode.

10 **[0041]** In some embodiments, the second suction inlet of the low-side compressor receives working fluid at a suction pressure. The low-side compressor may include an outlet through which working fluid at the suction pressure exits the low-side compressor.

15 **[0042]** In some embodiments, the heat pump system includes a suction conduit in fluid communication with the first and second suction inlets in the first heating mode and in the first cooling mode.

20 **[0043]** In some embodiments, the heat pump system includes a high-side bypass conduit having a first control valve and a low-side bypass conduit having a second control valve. Working fluid may flow through the low-side bypass conduit in the first heating mode and may be restricted from flowing through the low-side bypass conduit in the first cooling mode. Working fluid may flow through the high-side bypass conduit in the first cooling mode and may be restricted from flowing through the high-side bypass conduit in the first heating mode.

25 **[0044]** In some embodiments, the both of the low-side and high-side compressors operate during the first heating mode and during the first cooling mode. In some embodiments, only one of the high-side and low-side compressors operate during a second heating mode and a second cooling mode. Working fluid may flow through the low-side bypass conduit in the second heating mode and may be restricted from flowing through the low-side bypass conduit in the second cooling mode. Working fluid may flow through the high-side bypass conduit in the second cooling mode and may be restricted from flowing through the high-side bypass conduit in the second heating mode.

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[0045] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

5

DRAWINGS

[0046] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

10 **[0047]** Figure 1 is a schematic representation of a working-fluid circuit including cross-sectional views of a high-side compressor and a low-side compressor according to the principles of the present disclosure;

[0048] Figure 2 is a partial cross-sectional view of a suction-gas passageway according to the principles of the present disclosure;

15 **[0049]** Figure 3 is a schematic representation of another working-fluid circuit including high-side and low-side compressors according to the principles of the present disclosure;

[0050] Figure 4 is a schematic representation of another working-fluid circuit including high-side and low-side compressors according to the principles of
20 the present disclosure;

[0051] Figure 5 is a schematic representation of another working-fluid circuit including high-side and low-side compressors according to the principles of the present disclosure;

[0052] Figure 6 is a partial cross-sectional view of a compressor
25 including first and second compression mechanisms according to the principles of the present disclosure;

[0053] Figure 7 is a schematic representation of a working-fluid circuit including high-side and low-side compressors according to the principles of the present disclosure;

30 **[0054]** Figure 8 is a schematic representation of another working-fluid circuit including high-side and low-side compressors according to the principles of the present disclosure;

[0055] Figure 9 is a schematic representation of another working-fluid circuit including high-side and low-side compressors according to the principles of the present disclosure; and

[0056] Figure 10 is a schematic representation of another working-fluid circuit including high-side and low-side compressors according to the principles of the present disclosure.

[0057] Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

10 DETAILED DESCRIPTION

[0058] Example embodiments will now be described more fully with reference to the accompanying drawings.

[0059] Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

[0060] The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

[0061] When an element or layer is referred to as being "on," "engaged to," "connected to," or "coupled to" another element or layer, it may be directly on, engaged, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to," "directly connected to," or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0062] Although the terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as "first," "second," and other numerical terms when used herein do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example embodiments.

[0063] Spatially relative terms, such as "inner," "outer," "beneath," "below," "lower," "above," "upper," and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. Spatially relative terms may be intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the example term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0064] With reference to Figure 1, a system 10 is provided and may include a low-side compressor 12, a high-side compressor 14, a first heat exchanger 16, an expansion device 18, and a second heat exchanger 20. The system 10 may be an air conditioning system, a refrigeration system, or a heat pump system, for example, and may be operable to circulate a working fluid (e.g., refrigerant, carbon dioxide, etc.) between the first and second heat exchangers 16, 20 to heat or cool a space on demand. In configurations where the system 10 is operable as a heat pump system, a reversing valve (not shown) may be provided to direct a flow of working fluid through the system 10 in a first direction in a heating mode and in a second direction in a cooling mode.

[0065] The low-side and high-side compressors 12, 14 may be in fluid communication with the first and second heat exchangers 16, 20 and may circulate working fluid through the system 10. The low-side and high-side compressors 12, 14 may receive low-pressure working fluid from first and second suction lines 22, 24, respectively, and may discharge high-pressure working fluid to first and second discharge lines 26, 28, respectively. The low-side and high-side compressors 12, 14 may be arranged in a parallel compression arrangement (or a tandem compressor arrangement).

[0066] In the operational mode depicted in Figure 1, the first heat exchanger 16 may operate as a condenser or gas cooler and may remove heat from high-pressure working fluid received from the low-side and high-side compressors 12, 14. That is, the first heat exchanger 16 may be fluidly coupled to a main discharge line 30 that receives high-pressure working fluid from the first and second discharge lines 26, 28.

[0067] The expansion device 18 may include any suitable type of expansion device, such as an electronic expansion valve, a thermal expansion valve, a stepper motor valve, or capillary tube, for example. The expansion device 18 may be disposed between and fluidly communicate with the first and second heat exchangers 16, 20. In the depicted operational mode, the expansion device 18 may expand high-pressure working fluid received from the first heat exchanger 16. In a reversed operational mode, the expansion device 18 may expand high-pressure working fluid received from the second heat exchanger 20.

[0068] In the depicted operational mode, the second heat exchanger 20 may operate as an evaporator transferring heat to the working fluid flowing therethrough. A main suction line 32 may receive low-pressure fluid from the second heat exchanger 20 and may communicate the fluid to the low-side and high-side compressors 12, 14 via the first and second suction lines 22, 24, respectively.

[0069] It will be appreciated that in configurations where the system 10 is a heat pump system, the reversing valve may be connected to the main discharge line 30, the main suction line 32, the first heat exchanger 16 and the second heat exchanger 20. In one operational mode, the reversing valve may fluidly connect the main discharge line 30 with the first heat exchanger 16, and fluidly connect the main suction line 32 with the second heat exchanger 20 (as shown in Figure 1). In the other operational mode, the reversing valve may fluidly connect the main discharge line 30 with the second heat exchanger 20, and fluidly connect the main suction line 32 with the first heat exchanger 16.

[0070] The low-side compressor 12 is depicted in the figures as a scroll compressor, however, in some embodiments, the low-side compressor 12 may be any other type of compressor such as a rotary, reciprocating piston, screw, or centrifugal compressor, for example. The low-side compressor 12 may include a hermetic shell assembly 36, first and second bearing assemblies 38, 39, a motor assembly 40, a compression mechanism 42, a discharge fitting 46, and a suction inlet fitting 50. The shell assembly 36 may form a compressor housing and may include a cylindrical shell 54, an end cap 56 at an upper end thereof, a transversely extending partition 58, and a base 60 at a lower end thereof. The end cap 56 and the partition 58 may define a discharge chamber 62. The partition 58 may separate the discharge chamber 62 from a suction chamber 63. The discharge chamber 62 may contain high-pressure working fluid received from the compression mechanism 42. The suction chamber 63 may contain low-pressure working fluid received from the first suction line 22.

[0071] The partition 58 may include a discharge passage 65 extending therethrough to provide communication between the compression mechanism 42 and the discharge chamber 62. A discharge valve 48 may allow compressed fluid to flow from the compression mechanism 42 to the discharge chamber 62 and

may restrict or prevent fluid-flow from the discharge chamber 62 to the compression mechanism 42 or suction chamber 63. The discharge fitting 46 may be attached to the end cap 56 and may provide fluid communication between the discharge chamber 62 and the first discharge line 26. The suction inlet fitting 50
5 may be attached to shell assembly 36 and may provide fluid communication between the first suction line 22 and the suction chamber 63.

[0072] The base 60 of the shell assembly 36 may at least partially define a lubricant sump 70. A first lubricant fitting 72 may engage the shell assembly 36 and may provide fluid communication between the lubricant sump 70
10 and a lubricant conduit 74 extending between the low-side and high-side compressors 12, 14. The first lubricant fitting 72 may be disposed at any suitable location, such as at, above or below a predetermined or normal lubricant level of the lubricant sump 70.

[0073] The motor assembly 40 may be disposed within the suction
15 chamber 63 and may include a motor stator 82, a rotor 84, and a drive shaft 86. The motor stator 82 may be press fit into a stator housing 87 or press fit directly into the shell 54. The rotor 84 may be press fit on the drive shaft 86 and may transmit rotational power to the drive shaft 86. The drive shaft 86 may be rotatably supported by the first and second bearing assemblies 38, 39. The drive
20 shaft 86 may include an eccentric crank pin 88 and a lubricant passageway 90. Lubricant may be transmitted through the lubricant passageway 90 from the lubricant sump 70 to various compressor components such as an Oldham coupling 106, the compression mechanism 42, the first bearing assembly 38 and/or the second bearing assembly 39, for example.

[0074] The compression mechanism 42 may be disposed entirely or at
25 least partially within the suction chamber 63 and may include an orbiting scroll 92 and a non-orbiting scroll 94. The orbiting scroll 92 may include an end plate 96 having a spiral wrap 98 extending therefrom. A cylindrical hub 102 may project downwardly from the end plate 96 and may include a drive bushing 104 disposed
30 therein. The crank pin 88 may drivingly engage the drive bushing 104. The Oldham coupling 106 may be engaged with the orbiting and non-orbiting scrolls 92, 94 to prevent relative rotation therebetween.

[0075] The non-orbiting scroll 94 may include an end plate 108 and a spiral wrap 110 projecting downwardly from the end plate 108. The spiral wrap 110 may meshingly engage the spiral wrap 98 of the orbiting scroll 92, thereby creating a series of moving fluid pockets. The fluid pockets defined by the spiral wraps 98, 110 may decrease in volume as they move from a radially outer position (at a low pressure) to a radially intermediate position (at an intermediate pressure) to a radially inner position (at a high pressure) throughout a compression cycle of the compression mechanism 42. The end plate 108 may include a discharge passage 112 in communication with one of the fluid pockets at the radially inner position and allows compressed working fluid (at the high pressure) to flow into the discharge chamber 62.

[0076] The high-side compressor 14 is depicted in the figures as a scroll compressor, however, in some embodiments, the high-side compressor 14 could be any other type of compressor, such as a rotary, reciprocating piston, screw, or centrifugal compressor, for example. The high-side compressor 14 may include a hermetic shell assembly 136, a first and second bearing assemblies 138, 139, a motor assembly 140, a compression mechanism 142, a discharge fitting 146, and a suction inlet fitting 150. The shell assembly 136 may define a high-pressure discharge chamber 162 and may include a cylindrical shell 154, an end cap 156 at an upper end thereof, and a base 160 at a lower end thereof.

[0077] The discharge fitting 146 may be attached to the end cap 156 and may provide fluid communication between the discharge chamber 162 and the second discharge line 28. The suction inlet fitting 150 may be attached to shell assembly 136 and may fluidly couple the second suction line 24 with a suction conduit 153. The suction conduit 153 may extend through a portion of the discharge chamber 162 and provide fluid communication between the second suction line 24 and a check valve 151 at or proximate an inlet of the compression mechanism 142, while fluidly isolating the low-pressure fluid from the second suction line 24 from the high-pressure fluid in the discharge chamber 162.

[0078] The base 160 of the shell assembly 136 may at least partially define a lubricant sump 170. A second lubricant fitting 172 may engage the shell assembly 136 and may provide fluid communication between the lubricant sump 170 and the lubricant conduit 74 extending between the low-side and high-side

compressors 12, 14. The second lubricant fitting 72, 172 may be disposed at any suitable location at, above or below a predetermined oil level in the sump 170. As shown in Figure 1, the lubricant conduit 74 may include a valve 75 disposed between the first and second lubricant fittings 72, 172. The lubricant conduit 74 and valve 75 may allow for regulation of amounts of lubricant contained in the lubricant sumps 70, 170 of the low-side and high-side compressors 12, 14, respectively. In some embodiments, the valve 75 may be an electromechanical valve (e.g., a solenoid-actuated valve) controlled by a control module that may open and close the valve in response to oil levels (determined by fluid-level sensors) in the sumps 70, 170 and/or pressure differences therebetween. In some embodiments, the valve 75 may be actuated by the pressure differentials.

[0079] The motor assembly 140 may be disposed entirely within the discharge chamber 162 and may include a motor stator 182, a rotor 184, and a drive shaft 186. The motor stator 182 may be press fit into the shell 154. The rotor 184 may be press fit on the drive shaft 186 and may transmit rotational power to the drive shaft 186. The drive shaft 186 may be rotatably supported by the first and second bearing assemblies 138, 139. The drive shaft 186 may include an eccentric crank pin 188 and a lubricant passageway 190. Lubricant may be transmitted through the lubricant passageway 190 from the lubricant sump 170 to various compressor components such as the Oldham coupling 206, the compression mechanism 142, the first bearing assembly 138 and/or the second bearing assembly 139, for example.

[0080] The compression mechanism 142 may be disposed entirely within the discharge chamber 162 and may include an orbiting scroll 192 and a non-orbiting scroll 194. The orbiting scroll 192 may include an end plate 196 having a spiral wrap 198 extending therefrom. A cylindrical hub 202 may project downwardly from the end plate 196 and may include a drive bushing 204 disposed therein. The crank pin 188 may drivingly engage the drive bushing 204. The Oldham coupling 206 may be engaged with the orbiting and non-orbiting scrolls 192, 194 to prevent relative rotation therebetween.

[0081] The non-orbiting scroll 194 may include an end plate 208 and a spiral wrap 210 projecting downwardly from the end plate 208. The spiral wrap 210 may meshingly engage the spiral wrap 98 of the orbiting scroll 92, thereby

creating a series of moving fluid pockets. The fluid pockets defined by the spiral wraps 198, 210 may decrease in volume as they move from a radially outer position (at a low pressure) to a radially intermediate position (at an intermediate pressure) to a radially inner position (at a high pressure) throughout a compression cycle of the compression mechanism 142. The end plate 208 may include a discharge passage 212 in communication with one of the fluid pockets at the radially inner position and allows compressed working fluid (at the high pressure) to flow into the discharge chamber 162. A discharge valve 148 may provide selective fluid communication between the discharge passage 212 and the discharge chamber 162.

[0082] It will be appreciated that either or both of the low-side and high-side compressors 12, 14 may include some form of capacity modulation, such as mechanical modulation and/or vapor injection, for example, to vary the output of one or both of the low-side and high-side compressors 12, 14. In some embodiments, the system 10 may include more than one low-side compressor 12 and/or more than one high-side compressor 14. One or more of the compressors 12, 14 may have different capacities than one or more of the other compressors 12, 14. One or more of the compressors 12, 14 may include a fixed-speed or variable-speed motor.

[0083] As shown in Figure 2, the main suction line 32 and the first suction line 22 may form a generally straight and/or a generally unrestricted flow path. By contrast, the second suction line 24 may be angled relative to the main suction line 32 so that fluid flowing from the main suction line 32 will make a turn that is greater than ninety degrees to enter the second suction line 24. In this manner, if and when a mixture of liquid and vapor working fluid flows through the main suction line 32 toward the low-side and high-side compressors 12, 14, all or a substantial portion of the liquid working fluid may bypass the second suction line 24 and flow through to the first suction line 22, and vapor working fluid may flow into the second suction line 24. This is because the liquid working fluid will have a higher inertia than the vapor working fluid, which hinders the ability of the liquid working fluid from making the greater-than-ninety-degree turn into the second suction line 24. The lighter vapor working fluid may not be hindered by the greater-than-ninety-degree turn as much as the liquid working fluid may be. In

this manner, vapor working fluid may be supplied to the suction fitting 150 and suction conduit 153 of the high-side compressor 14, while more of the liquid working fluid may be supplied to the suction fitting 50 and suction chamber 63 of the low-side compressor 12. Therefore, liquid working fluid received into the suction chamber 63 of the low-side compressor 12 may cool the motor assembly 40 and/or other components of the low-side compressor 12 before being drawn into the compression mechanism 42. Some or all of the liquid working fluid received in the suction chamber 63 may evaporate (change phase to vapor working fluid) as it cools the motor assembly 40 prior to entering the compression mechanism 42. The structure of the main suction line 32 and the first and second suction lines 22, 24 described above may reduce or prevent liquid working fluid from entering the high-side compressor 14, which may reduce or prevent liquid working fluid from washing away lubricant from moving parts of the compression mechanism 142.

[0084] It will be appreciated that, in some embodiments, the angle between the main suction line 32 and the second suction line 24 may be greater or less than the angle shown in Figure 2. For example, in some embodiments, the angle may be about ninety degrees or less than ninety degrees.

[0085] As shown in Figure 1, the second suction line 24 may include a check valve 34 disposed between the main suction line 32 and the suction fitting 150 of the high-side compressor 14. The check valve 34 may allow fluid flow toward the suction fitting 150 and restrict or prevent fluid from flowing from the suction fitting 150 to the main suction line 32 or the first suction line 22. In some embodiments, the second suction line 24 may not include the check valve 34.

[0086] With reference to Figure 3, another system 310 is provided that may include a low-side compressor 312, a high-side compressor 314, a first heat exchanger 316, an expansion device 318, and a second heat exchanger 320. The low-side and high-side compressor 312, 314 may be arranged in a parallel compression arrangement. The structure and function of the compressors 312, 314, heat exchangers 316, 320 and expansion device 318 may be generally similar to that of the compressors 12, 14, heat exchangers 16, 20 and expansion device 18 described above, apart from any exceptions noted below and/or shown in the figures. Therefore, similar features will not be described again in detail.

[0087] Like the system 10, the system 310 may include a main discharge line 330 and a main suction line 332. The main suction line 332 of the system 310 may be fluidly connected to first and second suction fittings 334, 336 of the low-side compressor 312. In some embodiments, both the first and second suction fittings 334, 336 may provide low-pressure (suction pressure) working fluid to a suction chamber 363 of the low-side compressor 312. In some embodiments, the first and second suction fittings 334, 336 could be combined to form a single fitting. In some embodiments, the first suction fitting 334 may be coupled with a suction conduit (not shown) connected directly to an inlet of a compression mechanism 342 of the low-side compressor 312 that substantially fluidly isolates some or all of the fluid therein from the suction chamber 363 (e.g., similar to the configurations disclosed in Assignee's commonly owned U.S. Provisional Application No. 61/761,378, the disclosure of which is incorporated by reference herein).

[0088] The low-side compressor 312 may include a discharge fitting 346 and an outlet fitting 347. Similar to the discharge fitting 46, the discharge fitting 346 may be in fluid communication with the discharge chamber 362 and may receive compressed working fluid discharged from the compression mechanism 342. A portion of the suction-pressure working fluid in the suction chamber 363 may exit the low-side compressor 312 through the outlet fitting 347. The discharge chamber 362 and the suction chamber 363 may be separated by a partition 358.

[0089] The high-side compressor 314 may include a suction fitting 450, first and second discharge fittings 446, 447, and an inlet 449. Suction-pressure working fluid from the outlet 347 of the low-side compressor 312 may be received by the suction fitting 450. The suction fitting 450 may be coupled to a compression mechanism 442 of the high-side compressor 314 via a suction conduit 453. Like the suction conduit 153, the suction conduit 453 may maintain the suction-pressure working fluid therein substantially fluidly isolated from the discharge-pressure working fluid in the discharge chamber 462.

[0090] The first and second discharge fittings 446, 447 and the inlet 449 may be in fluid communication with the discharge chamber 462 of the high-side compressor 314. Discharge-pressure working fluid from the discharge fitting 346

of the low-side compressor 312 may be received into the discharge chamber 462 of the high-side compressor 314 through the inlet 449. Discharge-pressure working fluid may exit the discharge chamber 462 of the high-side compressor 314 through the first and second discharge fittings 446, 447 and flow into the main discharge line 330. In some embodiments, the first and second discharge fittings 446, 447 may be combined to form a single discharge fitting supplying fluid to the main discharge line 330.

[0091] A lubricant conduit 374 may be in fluid communication with lubricant sumps of the low-side and high-side compressors 312, 314. A valve 375 may control flow through the lubricant conduit 374 to regulate lubricant levels in the lubricant sumps of the low-side and high-side compressors 312, 314.

[0092] With continued reference to Figure 3, operation of the system 310 will be described in detail. Suction-pressure working fluid from the second heat exchanger 320 may flow into the main suction line 332. From the main suction line 332, the suction-pressure working fluid may flow into the suction chamber 363 of the low-side compressor 312 through the first and second suction fittings 334, 336. A first portion of the working fluid in the suction chamber 363 may be drawn into and compressed in the compression mechanism 342. This working fluid may be discharged from the compression mechanism 342 into the discharge chamber 362. From the discharge chamber 362, discharge-pressure working fluid may exit the low-side compressor 312 through the discharge fitting 346 and flow into the discharge chamber 462 of the high-side compressor 314 through the inlet 449. In this manner, the discharge chamber 462 of the high-side compressor 314 may act as an oil separator and/or muffler for the low-side compressor 312 during operation of the high-side compressor 314 and/or while the high-side compressor 314 is not operating (i.e., shutdown). While the high-side compressor 314 is not operating and the low-side compressor 312 is operating, at least one check valve (not shown) disposed between the outlet 347 of the low-side compressor 312 and the outlet of compression mechanism 442 of the high-side compressor 314 may restrict or prevent a reverse flow condition through the system 310. For example, this check valve may be internal or external to the high-side compressor 314 and may be similar to the discharge valve 148 of the high-side compressor 14 in Figure 1.

[0093] A second portion of the working fluid in the suction chamber 363 may exit the low-side compressor 312 through the outlet 347 and may flow into the suction fitting 450 for subsequent compression in the compression mechanism 442 of the high-side compressor 314. Accordingly, the suction chamber 363 of the low-side compressor 312 may act as a suction-line-liquid-accumulator for the high-side compressor 314 during operation of the low-side compressor 312 and/or while the low-side compressor 312 is not operating (while the low-side compressor 312 is shutdown, a majority or all of the working fluid may enter the suction chamber 363 through the second inlet 336). Working fluid is compressed in the compression mechanism 442 of the high-side compressor 314 and is discharged from the compression mechanism 442 into the discharge chamber 462. From the discharge chamber 462, the discharge-pressure working fluid exits the high-side compressor 314 through the one or both of the first and second discharge fittings 446, 447 and may flow into the main discharge line 330. As described above, working fluid may flow from the main discharge line 330 to the first heat exchanger 316, then to the expansion device 318 and back to the second heat exchanger 320.

[0094] With reference to Figure 4, another system 510 is provided that may include a low-side compressor 512, a high-side compressor 514, a first heat exchanger 516, an expansion device 518, and a second heat exchanger 520. The structure and function of the compressors 512, 514, heat exchangers 516, 520 and expansion device 518 may be generally similar to that of the compressors 12, 14, heat exchangers 16, 20 and expansion device 18 described above, apart from any exceptions noted below and/or shown in the figures. Therefore, similar features will not be described again in detail.

[0095] The system 510 may operate in a first mode in which the high-side and low-side compressors 514, 512 operate as first and second compressor stages (i.e., a series compression arrangement in which the low-side compressor 512 may further compress working fluid that has been compressed by the high-side compressor 514). The system 510 may also operate in second mode in which the high-side compressor 514 may be shut down or deactivated, in which case working fluid may bypass the high-side compressor 514, as will be described in more detail below.

[0096] The high-side compressor 514 may include a compression mechanism 642 disposed in a discharge chamber 662 and a suction conduit 653 coupling the suction fitting 650 with the compression mechanism 642. The compression mechanism 642 may compress working fluid received from the suction conduit 653 and discharge the compressed working fluid into the discharge chamber 662. From the discharge chamber 662, the compressed working fluid may exit the high-side compressor 514 through a discharge fitting 646.

[0097] The low-side compressor 512 may include a compression mechanism 542 that may be entirely or at least partially disposed in a suction chamber 563. The compression mechanism 542 may draw in working fluid from the suction chamber 563, compress the working fluid, and discharge the working fluid into a discharge chamber 562. The suction chamber 563 and the discharge chamber 562 may be separated by a partition 558. From the discharge chamber 562, the working fluid may exit the low-side compressor 512 through a discharge fitting 546. A lubricant conduit 574 may be disposed between first and second lubricant fittings 572, 672 and may provide fluid communication between oil sumps 570, 670 of the low-side and high-side compressors 512, 514, respectively. The first and second lubricant fittings 572, 672 may be disposed at, above or below a predetermined lubricant level in sumps 570, 670

[0098] The system 510 may include a main suction line 532, a main discharge line 530, a suction bypass line 531, and an inter-stage line 533. The main suction line 532 may be in fluid communication with the suction bypass line 531 and the suction fitting 650 of the high-side compressor 514. The suction bypass line 531 may include a first end 501 fluidly coupled to the main suction line 532 and a second end 502 fluidly coupled to the inter-stage line 533. A check valve 503 may be disposed between the first and second ends 501, 502 and may allow fluid-flow from the first end 501 to the second end 502 when a fluid pressure in the first end 501 is greater than a fluid pressure in the second end 502 (e.g., when the high-side compressor 514 is deactivated and the low-side compressor 512 is operating). The check valve 503 may restrict or prevent fluid-flow from the second end 502 to the first end 501. The inter-stage line 533 may fluidly couple the discharge fitting 646 of the high-side compressor 514 with the suction fitting

550 of the low-side compressor 512. The main discharge line 530 may receive working fluid from the discharge fitting 546 of the low-side compressor 512.

[0099] With continued reference to Figure 4, operation of the system 510 will be described in detail. As described above, the system 510 may be operable in a first mode in which both compressors 512, 514 are operating and the low-side compressor 512 further compresses working fluid that has been compressed by the high-side compressor 514 and a second mode in which the high-side compressor 514 is shut down and the low-side compressor 512 is operating.

[00100] When the system 510 is operating in the first mode, working fluid at a first, low pressure may flow from the main suction line 532 into the suction fitting 650 of the high-side compressor 514. From the suction fitting 650, the working fluid is drawn into the compression mechanism 642 and compressed to a second pressure that is higher than the first pressure. The working fluid at the second pressure may be discharged to the discharge chamber 662 before flowing out of the high-side compressor 514 through the discharge fitting 646 and into the inter-stage line 533. From the inter-stage line 533, the working fluid at the second pressure may flow into the suction chamber 563 of the low-side compressor 512 through the suction fitting 550. From the suction chamber 563, the working fluid at the second pressure may be drawn into the compression mechanism 542 of the low-side compressor 512 and further compressed to a third pressure that is higher than the second pressure. The working fluid at the third pressure may be discharged from the compression mechanism 542 into the discharge chamber 562 before flowing out of the low-side compressor 512 through the discharge fitting 546 and into the main discharge line 530.

[00101] In the first mode, a fluid pressure within the discharge chamber 662 of the high-side compressor 514 may be substantially equal to the fluid pressure within the suction chamber 563 of the low-side compressor 512. Therefore, pressure on both sides of the lubricant conduit 574 may be substantially equal. This pressure equality may promote equalization of the oil levels in the lubricant sumps 670, 570 of the high-side and low-side compressors 514, 512.

[00102] When the system 510 is operating in the second mode, working fluid at the first pressure may flow from the main suction line 532 into the first end 501 of the suction bypass line 531. Because the high-side compressor 514 may be deactivated in the second mode and the low-side compressor 512 may be operating in the second mode, the working fluid from the main suction line 532 may be drawn through the suction bypass line 531 by the compression mechanism 542, and therefore, little or no working fluid may enter the suction fitting 650. From the first end 501 of the suction bypass line 531, the working fluid at the first pressure may flow through the check valve 503 and into the inter-stage line 533 and subsequently into the suction chamber 563 of the low-side compressor 512 through the suction fitting 550. From the suction chamber 563, the working fluid may be drawn into the compression mechanism 542 and compressed therein from the first pressure to a pressure that is higher than the first pressure and lower than the third pressure. From the compression mechanism 542, the working fluid may be discharged into the discharge chamber 562 and may flow out of the low-side compressor 512 through the discharge fitting 546 into the main discharge line 530.

[00103] With reference to Figure 5, another system 710 is provided that may include a low-side compressor 712, a high-side compressor 714, a first heat exchanger 716, an expansion device 718, and a second heat exchanger 720. The structure and function of the compressors 712, 714, heat exchangers 716, 720 and expansion device 718 may be generally similar to that of the compressors 12, 14, heat exchangers 16, 20 and expansion device 18 described above, apart from any exceptions noted below and/or shown in the figures. Therefore, similar features will not be described again in detail.

[00104] The system 710 may operate in a first mode in which the low-side and high-side compressors 712, 714 operate as first and second compressor stages (i.e., the high-side compressor 714 may further compress working fluid that has been compressed by the low-side compressor 712). The system 710 may also operate in second mode in which the low-side compressor 712 may be shut down or deactivated, in which case working fluid may bypass the low-side compressor 712, as will be described in more detail below.

[00105] The high-side compressor 714 may include a compression mechanism 842 disposed in a discharge chamber 862 and a suction conduit 853 coupling the suction fitting 850 with the compression mechanism 842. The compression mechanism 842 may compress working fluid received from the suction conduit 853 and discharge the compressed working fluid into the discharge chamber 862. From the discharge chamber 862, the compressed working fluid may exit the high-side compressor 714 through a discharge fitting 846.

[00106] The low-side compressor 712 may include a compression mechanism 742 that may be entirely or at least partially disposed in a suction chamber 763. The compression mechanism 742 may draw in working fluid from the suction chamber 763, compress the working fluid, and discharge the working fluid into a discharge chamber 762. The suction chamber 763 and the discharge chamber 762 may be separated by a partition 758. From the discharge chamber 762, the working fluid may exit the low-side compressor 712 through a discharge fitting 746. A lubricant conduit 774 may provide fluid communication between oil sumps 770, 870 of the low-side and high-side compressors 712, 714, respectively.

[00107] The system 710 may include a main suction line 732, a main discharge line 730, a suction bypass line 731, and an inter-stage line 733. The main suction line 732 may be in fluid communication with the suction bypass line 731 and the suction fitting 750 of the low-side compressor 712. The suction bypass line 731 may include a first end 701 fluidly coupled to the main suction line 732 and a second end 702 fluidly coupled to the inter-stage line 733. A check valve 703 may be disposed between the first and second ends 701, 702 and may allow fluid-flow from the first end 701 to the second end 702 when a fluid pressure in the first end 701 is greater than a fluid pressure in the second end 702 (e.g., when the low-side compressor 712 is deactivated and the high-side compressor 714 is operating). The check valve 703 may restrict or prevent fluid-flow from the second end 702 to the first end 701. The inter-stage line 733 may fluidly couple the discharge fitting 746 of the low-side compressor 712 with the suction fitting 850 of the high-side compressor 714. The main discharge line 730 may receive working fluid from the discharge fitting 846 of the high-side compressor 714.

[00108] With continued reference to Figure 5, operation of the system 710 will be described in detail. As described above, the system 710 may be operable in a first mode in which both compressors 712, 714 are operating and the high-side compressor 714 further compresses working fluid that has been compressed by the low-side compressor 712 and a second mode in which the low-side compressor 712 is shut down and the high-side compressor 714 is operating.

[00109] When the system 710 is operating in the first mode, working fluid at a first, low pressure may flow from the main suction line 732 into the suction fitting 750 of the low-side compressor 712. From the suction fitting 750, the working fluid flows in the suction chamber 763 and is drawn into the compression mechanism 742 and compressed to a second pressure that is higher than the first pressure. The working fluid at the second pressure may be discharged to the discharge chamber 762 before flowing out of the low-side compressor 712 through the discharge fitting 746 and into the inter-stage line 733. From the inter-stage line 733, the working fluid at the second pressure may flow into the high-side compressor 714 through the suction fitting 850. From the suction fitting 850, the working fluid at the second pressure may be drawn through the suction conduit 853 into the compression mechanism 842 of the high-side compressor 714 and further compressed to a third pressure that is higher than the second pressure. The working fluid at the third pressure may be discharged from the compression mechanism 842 into the discharge chamber 862 before flowing out of the high-side compressor 714 through the discharge fitting 846 and into the main discharge line 730.

[00110] In the first mode, a fluid pressure within the discharge chamber 862 of the high-side compressor 714 may be higher than the fluid pressure within the suction chamber 763 of the low-side compressor 712. Therefore, the pressure differential across the lubricant conduit 774 may promote lubricant flow from the lubricant sump 870 of the high-side compressor 714 to the lubricant sump 770 of the low-side compressor 712. Therefore, lubricant that is transferred from the low-side compressor 712 to the high-side compressor 714 with the discharged working fluid through the inter-stage line 733 may be returned to the low-side compressor 712 through the lubricant conduit 774. In some embodiments, a

control valve 775 may communicate with fluid level sensors (not shown) within the low-side and high-side compressor 712, 714 and may control fluid flow through the lubricant conduit 774 to maintain a generally equal or predetermined oil level in the low-side and high-side compressors 712, 714.

5 **[00111]** When the system 710 is operating in the second mode, working fluid at the first pressure may flow from the main suction line 732 into the first end 701 of the suction bypass line 731. From the first end 701 of the suction bypass line 731, the working fluid at the first pressure may flow through the check valve 703 and into the inter-stage line 733 and subsequently into the suction fitting 850
10 of the high-side compressor 714. From the suction fitting 850, the working fluid may be drawn into the compression mechanism 842 and compressed therein from the first pressure to a pressure that is higher than the first pressure and lower than the third pressure. From the compression mechanism 842, the working fluid may be discharged into the discharge chamber 862 and may flow out of the high-side
15 compressor 714 through the discharge fitting 846 into the main discharge line 730.

[00112] With reference to Figure 6, another system 910 is provided that may include a compressor 912, a first heat exchanger 916, an expansion device 918, a second heat exchanger 920, a discharge line 930 and a suction line 932. The structure and function of heat exchangers 916, 920 and expansion device
20 918 may be generally similar to that of the heat exchangers 16, 20, expansion device 18, discharge line 30 and suction line 32 described above, apart from any exceptions noted below and/or shown in the figures. Therefore, similar features will not be described again in detail.

[00113] The compressor 912 may include a hermetic shell assembly 936,
25 first and second bearing assemblies 938, 939, a motor assembly 940, a first compression mechanism 942, a second compression mechanism 944, a discharge fitting 946, and a suction inlet fitting 950. The shell assembly 936 may form a compressor housing and may include a cylindrical shell 954, a first end 956, a transversely extending partition 958, and a second end 960. The shell 954
30 may define a lubricant sump 970. The first end 956, the shell 954 and the partition 958 may define a first chamber 961. The second end 960 and the partition 958 may define a second chamber 962. The partition 958 may separate the second chamber 962 from the first chamber 961. The first chamber 961 may

contain compressed working fluid received from the first compression mechanism 942. The second chamber 962 may contain further compressed working fluid received from the second compression mechanism 944.

5 **[00114]** The motor assembly 940 may be received within the shell assembly 936 and may include a stator 982, a rotor 984, and a drive shaft 986 fixed to the rotor 984. The drive shaft 986 may be rotatably supported by the first and second bearing assemblies 938, 939 and may drive both of the first and second compression mechanisms 942, 944. Each end of the drive shaft 986 may include a crank pin 988 drivingly engaging a respective one of the first and second
10 compression mechanisms 942, 944.

[00115] The first compression mechanism 942 may be generally similar to the compression mechanism 142 described above and may include an orbiting scroll 1092 and a non-orbiting scroll 1094. The non-orbiting scroll 1094 may include a suction inlet 1051 that is coupled to the suction fitting 950 by a suction
15 conduit 953. As described above, working fluid flowing through the suction fitting 950 and suction conduit 953 may be substantially fluidly isolated from the first chamber 961. The non-orbiting scroll 1094 may include a discharge passage 1012 in communication with the first chamber 961.

[00116] The second compression mechanism 944 may be generally
20 similar to the compression mechanism 42 described above and may include an orbiting scroll 992 and a non-orbiting scroll 994. The non-orbiting scroll 994 may include a discharge passage 996. Working fluid may be discharged from the second compression mechanism 944 through the discharge passage 996 and may flow into the second chamber 962 through an opening 998 in the partition
25 958.

[00117] With continued reference to Figure 6, operation of the compressor 912 will be described in detail. Working fluid at a first, low pressure may flow from the suction line 932 to the suction fitting 950. From the suction fitting 950, the working fluid may flow through the suction conduit 953 and into the
30 first compression mechanism 942. The first compression mechanism 942 may compress the working fluid to a second pressure that is higher than the first pressure and discharge the working fluid into the first chamber 961.

[00118] Working fluid at the second pressure in the first chamber 961 may be drawn in the second compression mechanism 944 and may be compressed therein to a third pressure that is higher than the second pressure. The working fluid at the third pressure may be discharged from the second compression mechanism 944 to the second chamber 962 and may exit the compressor 912 through the discharge fitting 946.

[00119] It will be appreciated that any of the systems 10, 310, 510, 710, 910 could be reversible heat pump systems. It will be appreciated that one or both of the compressors and/or compression mechanisms of the systems 10, 310, 510, 710, 910 may be modulated, may include vapor injection, a variable-speed motor and/or interstage vapor injection, for example, and/or additional or alternative components or features for varying their capacities. In some configurations having a compressor with a variable speed motor, the inverter may power both of the low-side and high-side compressors or only one of the low-side and high-side compressors. Additionally or alternatively, within a given system 10, 310, 510, 810, the low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714 may have different capacities or displacements than each other. Similarly, the compression mechanisms 942, 944 may have different capacities or displacements than each other within the system 910. In some configurations of the systems described above, only one of the compressors of the system may operate during the cooling mode and only the other of the compressors may operate during the heating mode (i.e., one of the compressors is dedicated to operation in the cooling mode and the other compressor is dedicated to operation in the heating mode).

[00120] As shown in Figure 7, in some configurations, the systems 10, 310, 510, 710 may include a control module 800 that may operate one of the low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714 and prevent operation of another of the low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714 when the system 10, 310, 510, 710 is operating in a heating mode. In some embodiments, the control module 800 may be operable to operate the other of said low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714 and prevent operation of the one of said low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714 when the system 10, 310, 510,

710 is operating in a cooling mode. While not specifically shown in Figure 7, the system 10, 310, 510, 710 may include bypass conduits and control valves to route working fluid around a non-operating one of the low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714. Furthermore, a switching device (e.g., a four-way valve; not shown) may be provided to change the direction of fluid flow through the system 10, 310, 510, 710 depending on whether the system 10, 310, 510, 710 is operating in a cooling mode, a heating mode or a defrost mode.

[00121] As shown in Figure 7, in some configurations, the system 10, 310, 510, 710 may include an outdoor unit 802 including an outdoor heat exchanger 804 and one of the low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714; and an indoor unit 806 including an indoor heat exchanger 808 and the other of the low-side and high-side compressors 12, 14, 312, 314, 512, 514, 712, 714.

[00122] With reference to Figure 8, a heat pump system 1110 is provided that may include a high-side compressor 1112, a low-side compressor 1114, an outdoor heat exchanger 1116, a first expansion device 1124, a first check valve 1122, a second check valve 1120, a second expansion device 1118, an indoor heat exchanger 1126, a high-side bypass conduit 1128 and a low-side bypass conduit 1130. The high-side bypass conduit 1128 may include a first control valve 1132 selectively restricting and allowing fluid flow therethrough. The low-side bypass conduit 1130 may include a second control valve 1134 selectively restricting and allowing fluid flow therethrough. The high-side compressor 1112 may include a suction inlet 1136 and a discharge outlet 1138. The low-side compressor 1114 may include a suction inlet 1140 and a discharge outlet 1142. A suction conduit 1144 may extend between the suction inlets 1136, 1140 of the high-side and low-side compressors 1112, 1114.

[00123] The heat pump system 1110 may be operable in a heating mode and in a cooling mode. When the heat pump system 1110 is operating in the cooling mode, a control module 1146 may shut down the high-side compressor 1112, open the first control valve 1132, close the second control valve 1134, and operate the low-side compressor 1114 to circulate working fluid through the heat pump system 1110. In this manner, during operation of the heat pump system

1110 in the cooling mode, the low-side compressor 1114 may compress working fluid drawn into the low-side compressor 1114 from the suction conduit 1144 and discharge compressed working fluid through the discharge outlet 1142. From the discharge outlet 1142, the working fluid may flow through the outdoor heat
5 exchanger 1116, where heat from the working fluid may be rejected. From the outdoor heat exchanger 1116, the working fluid may flow through the first check valve 1122 and the first expansion device 1124. From the first expansion device 1124, the working fluid may flow to the indoor heat exchanger 1126, where the working fluid may absorb heat from indoor air or another fluid. From the indoor
10 heat exchanger 1126, the working fluid may flow into the high-side bypass conduit 1128, through the first control valve 1132 and back into the suction conduit 1144.

[00124] When the heat pump system 1110 is operating in the heating mode, the control module 1146 may shut down the low-side compressor 1114, close the first control valve 1132, open the second control valve 1134, and
15 operate the high-side compressor 1112 to circulate working fluid through the heat pump system 1110. In this manner, during operation of the heat pump system 1110 in the heating mode, the high-side compressor 1112 may compress working fluid drawn into the high-side compressor 1112 from the suction conduit 1144 and discharge compressed working fluid through the discharge outlet 1138. From the
20 discharge outlet 1138, the working fluid may flow through the indoor heat exchanger 1126, where heat from the working fluid may be rejected. From the indoor heat exchanger 1126, the working fluid may flow through the second check valve 1120 and the second expansion device 1118. From the second expansion device 1118, the working fluid may flow to the outdoor heat exchanger 1116,
25 where the working fluid may absorb heat from outdoor ambient air, another fluid or another heat sink (e.g., ground). From the outdoor heat exchanger 1116, the working fluid may flow into the low-side bypass conduit 1130, through the second control valve 1134 and back into the suction conduit 1144.

[00125] In some embodiments, the low-side compressor 1114 may be
30 operable as a suction accumulator during the heating mode, and the high-side compressor 1112 may be operable as a suction accumulator during the cooling mode. In such embodiments, the heat pump system 1110 may include first and second accumulation conduits 1150, 1152 in fluid communication with the interior

of the high-side and low-side compressors 1112, 1114, respectively. The first and second accumulation conduits 1150, 1152 may include first and second accumulation control valves 1154, 1156, respectively, that are in electrical communication with the control module 1146. When the heat pump system 1110 is operating in the heating mode, the control module 1146 may close the first accumulation control valve 1154 and open the second accumulation control valve 1156. With the second accumulation control valve 1156 open, suction-pressure working fluid from the outdoor heat exchanger 1116 is allowed to enter a suction chamber (e.g., like suction chamber 63 described above) of the low-side compressor 1114 so that a desired amount of working fluid can accumulate therein. When the heat pump system 1110 is operating in the cooling mode, the control module 1146 may close the second accumulation control valve 1156 and open the first accumulation control valve 1154. With the first accumulation control valve 1154 open, suction-pressure working fluid from the suction conduit 1144 is allowed to enter a chamber (e.g., like chamber 162 described above) of the high-side compressor 1112 so that a desired amount of working fluid can accumulate therein.

[00126] In some embodiments, a lubricant communication conduit 1160 may provide fluid communication between lubricant sumps (not shown) of the high-side and low-side compressors 1112, 1114. A control valve 1162 may be disposed along the lubricant communication conduit 1160. The control module 1146 may open and close the control valve 1162 to selectively allow and restrict communication of lubricant between the high-side and low-side compressors 1112, 1114 (e.g., based on information from a liquid-level sensor (not shown) in the low-side compressor 1114).

[00127] With reference to Figure 9, another heat pump system 1210 is provided that may include a heat pump system 1210 is provided that may include a high-side compressor 1212, a low-side compressor 1214, an outdoor heat exchanger 1216, a first expansion device 1224, a first check valve 1222, a second check valve 1220, a second expansion device 1218, an indoor heat exchanger 1226, a high-side bypass conduit 1228 and a low-side bypass conduit 1230. The high-side bypass conduit 1228 may include a first control valve 1232 selectively restricting and allowing fluid flow therethrough. The low-side bypass conduit 1230

may include a second control valve 1234 selectively restricting and allowing fluid flow therethrough. The high-side compressor 1212 may include a suction inlet 1236 and a discharge outlet 1238. The low-side compressor 1214 may include a suction inlet 1240 and a discharge outlet 1242. A suction conduit 1244 may extend between the suction inlets 1236, 1240 of the high-side and low-side compressors 1212, 1214. A discharge conduit 1246 may extend between the discharge outlets 1238, 1242 of the high-side and low-side compressors 1212, 1214.

[00128] A first three-way valve 1248 may interconnect the discharge conduit 1246, the discharge outlet 1238 of the high-side compressor 1212 and a conduit 1250 extending between the indoor heat exchanger 1226 and the high-side compressor 1212. The first three-way valve 1248 may be movable between first and second positions. In the first position, the first three-way valve 1248 allows fluid communication between the discharge outlet 1238 of the high-side compressor 1212 and the discharge conduit 1246 and prevents the conduit 1250 from fluidly communicating with the discharge conduit 1246 and the discharge outlet 1238. In the second position, the first three-way valve 1248 allows fluid to flow from the discharge outlet 1238 of the high-side compressor 1212 to the conduit 1250 and allows fluid to flow from the discharge conduit 1246 to the conduit 1250. In some embodiments, the first three-way valve 1248 may be movable to a third position in which all of the discharge outlet 1238, the discharge conduit 1246 and the conduit 1250 are prevented from communicating with each other.

[00129] A second three-way valve 1252 may be disposed between the discharge conduit 1246, the discharge outlet 1242 of the low-side compressor 1214 and a conduit 1254 extending between the outdoor heat exchanger 1216 and the low-side compressor 1214. The second three-way valve 1252 may be movable between first and second positions. In the first position, the second three-way valve 1252 allows fluid communication between the discharge outlet 1242 of the low-side compressor 1214 and the discharge conduit 1246 and prevents the conduit 1254 from fluidly communicating with the discharge conduit 1246 and the discharge outlet 1242. In the second position, the second three-way valve 1252 allows fluid to flow from the discharge outlet 1242 of the low-side

compressor 1214 to the conduit 1254 and allows fluid to flow from the discharge conduit 1246 to the conduit 1254. In some embodiments, the second three-way valve 1252 may be movable to a third position in which all of the discharge outlet 1242, the discharge conduit 1246 and the conduit 1254 are prevented from communicating with each other.

[00130] The heat pump system 1210 may be operable in a first heating mode (in which the high-side compressor 1212 is operating and the low-side compressor 1214 is shutdown), a second heating mode (in which high-side and low-side compressors 1212, 1214 are operating), a first cooling mode (in which the low-side compressor 1214 is operating and the high-side compressor 1212 is shutdown), and a second cooling mode (in which high-side and low-side compressors 1212, 1214 are operating). To operate the heat pump system 1210 in the first heating mode, a control module 1256 may shutdown the low-side compressor 1214, move the second three-way valve 1252 to the third position, open the second control valve 1234, close the first control valve 1232, move the first three-way valve 1248 to the second position, and operate the high-side compressor 1212. In the first heating mode, the high-side compressor 1212 may compress working fluid drawn into the high-side compressor 1212 from the suction conduit 1244 and discharge compressed working fluid through the discharge outlet 1238. From the discharge outlet 1238, the working fluid may flow through the conduit 1250 and into the indoor heat exchanger 1226, where heat from the working fluid may be rejected. From the indoor heat exchanger 1226, the working fluid may flow through the second expansion device 1218 and the second check valve 1220. From the second expansion device 1218, the working fluid may flow to the outdoor heat exchanger 1216, where the working fluid may absorb heat from outdoor ambient air, another fluid or another heat sink (e.g., ground). From the outdoor heat exchanger 1216, the working fluid may flow into the low-side bypass conduit 1230, through the second control valve 1234 and back into the suction conduit 1244.

[00131] Operation of the heat pump system 1210 in the second heating mode may be substantially the same as operation in the first heating mode, except in the second heating mode, the control module 1256 moves the second three-way valve 1252 to the first position and operates the low-side compressor

1214. In this manner, a portion of the working fluid from the suction conduit 1244 is also drawn into the low-side compressor 1214, and compressed working fluid is discharged from the low-side compressor 1214 and flows through the discharge conduit 1246 to the conduit 1250 and subsequently to the indoor heat exchanger 1226.

[00132] To operate the heat pump system 1210 in the first cooling mode, the control module 1256 may shutdown the high-side compressor 1212, move the first three-way valve 1248 to the third position, open the first control valve 1232, close the second control valve 1234, move the second three-way valve 1252 to the second position, and operate the low-side compressor 1214. In the first cooling mode, the low-side compressor 1214 may compress working fluid drawn into the low-side compressor 1214 from the suction conduit 1244 and discharge compressed working fluid through the discharge outlet 1242. From the discharge outlet 1242, the working fluid may flow through the conduit 1254 and into the outdoor heat exchanger 1216, where heat from the working fluid may be rejected. From the outdoor heat exchanger 1216, the working fluid may flow through the first expansion device 1224 and the first check valve 1222. From the first expansion device 1224, the working fluid may flow to the indoor heat exchanger 1226, where the working fluid may absorb heat from indoor air or another fluid. From the indoor heat exchanger 1226, the working fluid may flow into the high-side bypass conduit 1228, through the first control valve 1232 and back into the suction conduit 1244.

[00133] Operation of the heat pump system 1210 in the second cooling mode may be substantially the same as operation in the first cooling mode, except in the second cooling mode, the control module 1256 moves the first three-way valve 1248 to the first position and operates the high-side compressor 1212. In this manner, a portion of the working fluid from the suction conduit 1244 is also drawn into the high-side compressor 1212, and compressed working fluid is discharged from the high-side compressor 1212 and flows through the discharge conduit 1246 to the conduit 1254 and subsequently to the outdoor heat exchanger 1216.

[00134] It will be appreciated that the first and second three-way valves 1248, 1252 can be replaced with three two-way valves (not shown). That is, a first

one of the two-way valves can be disposed along conduit 1250 between the high-side bypass conduit 1228 and the discharge conduit 1246. A second one of the two-way valves can be disposed along the discharge conduit 1246. A third one of the two-way valves can be disposed along conduit 1254 between the discharge
5 conduit 1246 and the low-side bypass conduit 1230.

[00135] With reference to Figure 10, another system 1310 is provided that may be similar or identical to any of the configurations of the system 1210 described above, apart from any exceptions noted below. The system 1310 may include a high-side compressor 1312, a low-side compressor 1314, an outdoor
10 heat exchanger 1316, a first expansion device 1324, a first check valve 1322, a second check valve 1320, a second expansion device 1318, an indoor heat exchanger 1326, a first supply conduit 1328, a second supply conduit 1330, a low-side suction conduit 1332, a high-side suction conduit 1334, and a discharge conduit 1336. The high-side compressor 1312 may include a suction inlet 1338
15 and a discharge outlet 1340. The low-side compressor 1314 may include a suction inlet 1342, a discharge outlet 1344 and a low-pressure outlet 1346. The low-pressure outlet 1346 may be in communication with the suction inlet 1338 of the high-side compressor 1312 via the high-side suction conduit 1334. A lubricant communication conduit 1348 may interconnect oil sumps (not shown) of the high-
20 side and low-side compressors 1312, 1314. A lubrication control valve 1350 may be disposed along the lubricant communication conduit 1348 and may control lubricant flow therethrough.

[00136] The first supply conduit 1328 may include a first control valve 1352. The second supply conduit 1330 may include a second control valve 1354.
25 A third control valve 1356 may be disposed downstream of the discharge outlet 1340 of the high-side compressor 1312 between the first supply conduit 1328 and the discharge conduit 1336. A fourth control valve 1358 may be disposed along the discharge conduit 1336. A fifth control valve 1360 may be disposed downstream of the discharge outlet 1344 of the low-side compressor 1314
30 between the second supply conduit 1330 and the discharge conduit 1336. A control module 1362 may be in communication with the valves 1350, 1352, 1354, 1356, 1358, 1360. The control module 1362 may also control operation of the compressors 1312, 1314.

[00137] The system 1310 may be a heat pump system operable in a heating mode and in a cooling mode. In some embodiments, the system 1310 may be operable in a first heating mode (in which both compressors 1312, 1314 are operating), a second heating mode (in which the low-side compressor 1314 is shut down and the high-side compressor 1312 is operating), a first cooling mode (in which both compressors 1312, 1314 are operating), and a second cooling mode (in which the low-side compressor 1314 is operating and the high-side compressor 1312 is shutdown). As will be described in more detail below, an interior volume 1364 of the low-side compressor 1314 may function as a suction accumulator in one or all of the first and second heating and cooling modes.

[00138] To operate the system 1310 in the first heating mode in which both compressors 1312, 1314 are operating, the control module 1362 may close the first control valve 1352, open the second control valve 1354, open the third control valve 1356, open the fourth control valve 1358 and close the fifth control valve 1360. Suction-pressure working fluid may be drawn into the interior volume 1364 of the low-side compressor 1314 through the low-side suction conduit 1332 and the suction inlet 1342 of the low-side compressor 1314. A portion of the working fluid drawn into the interior volume 1364 may be compressed by the low-side compressor 1314 and discharged through the discharge outlet 1344. Another portion of the working fluid drawn into the interior volume 1364 may be drawn into the suction inlet 1338 of the high-side compressor 1312 through the low-pressure outlet 1346 of the low-side compressor 1314 and the high-side suction conduit 1334 and may be subsequently compressed by the high-side compressor 1312 and discharged therefrom through the discharge outlet 1340. Still another portion of the working fluid drawn into the interior volume 1364 may accumulate in the interior volume 1364. Working fluid from the discharge outlet 1344 of the low-side compressor 1314 may flow through the discharge conduit 1336 and merge with working fluid exiting the high-side compressor 1312 through the discharge outlet 1340. Thereafter, the working fluid discharged from the compressors 1312, 1314 may flow through the third control valve 1356 and flow through the indoor heat exchanger 1326, the second check valve 1320, the second expansion valve 1318, and through the outdoor heat exchanger 1316. From the outdoor heat exchanger 1316, the working fluid may flow into the second

supply conduit 1330 and through the low-side suction conduit 1332 and back into the interior volume 1364 of the low-side compressor 1314.

[00139] To operate the system 1310 in the second heating mode, in which the low-side compressor 1314 is shut down and only the high-side
5 compressor 1312 is operating, the control module 1362 may close the first control valve 1352, open the second control valve 1354, open the third control valve 1356, close the fourth control valve 1358 and close the fifth control valve 1360. The flow of working fluid throughout the system 1310 in the second heating mode may be similar or identical to that of the first heating mode, except working fluid is
10 not compressed by the low-side compressor 1314 and discharged through the discharge outlet 1344 and the discharge conduit 1336.

[00140] To operate the system 1310 in the first cooling mode, in which both compressors 1312, 1314 are operating, the control module 1362 may open the first control valve 1352, close the second control valve 1354, close the third
15 control valve 1356, open the fourth control valve 1358 and open the fifth control valve 1360. As described above, suction-pressure working fluid may be drawn into the interior volume 1364 of the low-side compressor 1314 through the low-side suction conduit 1332 and the suction inlet 1342 of the low-side compressor 1314. A portion of the working fluid drawn into the interior volume 1364 may be
20 compressed by the low-side compressor 1314 and discharged through the discharge outlet 1344. Another portion of the working fluid drawn into the interior volume 1364 may be drawn into the suction inlet 1338 of the high-side compressor 1312 through the low-pressure outlet 1346 of the low-side compressor 1314 and the high-side suction conduit 1334 and may be
25 subsequently compressed by the high-side compressor 1312 and discharged therefrom through the discharge outlet 1340. Still another portion of the working fluid drawn into the interior volume 1364 may accumulate in the interior volume 1364. Working fluid from the discharge outlet 1340 of the high-side compressor 1312 may flow through the discharge conduit 1336 and merge with working fluid
30 exiting the low-side compressor 1314 through the discharge outlet 1344. Thereafter, the working fluid discharged from the compressors 1312, 1314 may flow through the fifth control valve 1360 and flow through the outdoor heat exchanger 1316, the first check valve 1322, the first expansion valve 1324 and

through the indoor heat exchanger 1326. From the indoor heat exchanger 1326, the working fluid may flow into the first supply conduit 1328 and through the low-side suction conduit 1332 and back into the interior volume 1364 of the low-side compressor 1314.

5 **[00141]** To operate the system 1310 in the second cooling mode, in which the low-side compressor 1314 is operating and the high-side compressor 1312 is shutdown, the control module 1362 may open the first control valve 1352, close the second control valve 1354, close the third control valve 1356, close the fourth control valve 1358 and open the fifth control valve 1360. The flow of
10 working fluid throughout the system 1310 in the second cooling mode may be similar or identical to that of the first cooling mode, except working fluid is not compressed by the high-side compressor 1312 and discharged through the discharge outlet 1340 and the discharge conduit 1336.

[00142] The foregoing description of the embodiments has been provided
15 for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways.
20 Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

CLAIMS

What is claimed is:

1. A heat pump system operable to circulate fluid between first and second heat exchangers in a first direction in a heating mode and in a second direction in a cooling mode, the heat pump system including a suction conduit, a low-side compressor and a high-side compressor, said low-side and high-side compressors both being in fluid communication with said suction conduit.
2. The heat pump system of Claim 1, further comprising:
an oil conduit fluidly connecting oil sumps of said low-side and high-side compressors; and
a control module controlling a valve disposed in said oil conduit.
3. The heat pump system of Claim 1, further comprising a control module operating one of said low-side and high-side compressors when the heat pump system is operating in said heating mode and preventing operation of another of said low-side and high-side compressors when the heat pump system is operating in said heating mode.
4. The heat pump system of Claim 3, wherein said control module is operable to operate said other of said low-side and high-side compressors when the heat pump system is operating in said cooling mode and prevent operation of said one of said low-side and high-side compressors when the heat pump system is operating in said cooling mode.
5. The heat pump system of Claim 1, further comprising:
an outdoor unit including an outdoor heat exchanger and one of said low-side and high-side compressors; and
an indoor unit including an indoor heat exchanger and another of said low-side and high-side compressors.

6. The heat pump system of Claim 1, wherein said heating mode includes a first heating mode in which both of said high-side and low-side compressors are operating and a second heating mode in which said high-side compressor is operating and said low-side compressor is shut down.

5

7. The heat pump system of Claim 6, wherein said cooling mode includes a first cooling mode in which both of said high-side and low-side compressors are operating and a second cooling mode in which said low-side compressor is operating and said high-side compressor is shut down.

10

8. The heat pump system of Claim 1, wherein an interior volume of one of said high-side and low-side compressors is operable as a suction accumulator accumulating working fluid therein during said heating mode.

15

9. The heat pump system of Claim 8, wherein said interior volume of said one of said high-side and low-side compressors is operable as a suction accumulator accumulating working fluid therein during said cooling mode.

20

10. The heat pump system of Claim 8, wherein an interior volume of another of said high-side and low-side compressors is operable as a suction accumulator accumulating working fluid therein during said cooling mode.

25

11. A heat pump system operable in a first heating mode and in a first cooling mode, the heat pump system comprising:

a high-side compressor including a first suction inlet and a first suction outlet;

a low-side compressor including a second suction inlet and a second suction outlet; and

30

a discharge conduit receiving compressed working fluid from said low-side compressor in said first heating mode and receiving compressed working fluid from said high-side compressor in said first cooling mode.

12. The heat pump system of Claim 11, wherein fluid communication between said low-side compressor and said discharge conduit is restricted in said first cooling mode, and fluid communication between said high-side compressor and said discharge conduit is restricted in said first heating mode.

5

13. The heat pump system of Claim 11, wherein fluid communication between said high-side compressor and said discharge conduit is restricted in a second cooling mode, and fluid communication between said low-side compressor and said discharge conduit is restricted in a second heating mode.

10

14. The heat pump system of Claim 13, wherein fluid communication between said low-side compressor and said discharge conduit is restricted in said second cooling mode, and fluid communication between said high-side compressor and said discharge conduit is restricted in said second heating mode.

15

15. The heat pump system of Claim 14, wherein both of said low-side and high-side compressors operate during said first heating mode and during said first cooling mode, and wherein only one of said high-side and low-side compressors operates during said second heating mode and said second cooling mode.

20

16. The heat pump system of Claim 15, wherein said high-side compressor operates during said second heating mode and said low-side compressor is shut down during said second heating mode.

25

17. The heat pump system of Claim 16, wherein said low-side compressor operates during said second cooling mode and said high-side compressor is shut down during said second cooling mode.

30

18. The heat pump system of Claim 11, wherein said second suction inlet of said low-side compressor receives working fluid at a suction pressure, and wherein said low-side compressor includes an outlet through which working fluid at said suction pressure exits said low-side compressor.

19. The heat pump system of Claim 11, further comprising a suction conduit in fluid communication with said first and second suction inlets in said first heating mode and in said first cooling mode.

5

20. The heat pump system of Claim 19, further comprising a high-side bypass conduit having a first control valve and a low-side bypass conduit having a second control valve, wherein working fluid flows through said low-side bypass conduit in said first heating mode and is restricted from flowing through said low-side bypass conduit in said first cooling mode, and wherein working fluid flows
10 through said high-side bypass conduit in said first cooling mode and is restricted from flowing through said high-side bypass conduit in said first heating mode.

21. The heat pump system of Claim 20, wherein both of said low-side
15 and high-side compressors operate during said first heating mode and during said first cooling mode, wherein only one of said high-side and low-side compressors operates during a second heating mode and a second cooling mode, and wherein working fluid flows through said low-side bypass conduit in said second heating mode and is restricted from flowing through said low-side bypass conduit in said
20 second cooling mode, and wherein working fluid flows through said high-side bypass conduit in said second cooling mode and is restricted from flowing through said high-side bypass conduit in said second heating mode.

22. A system operable to circulate fluid between first and second heat
25 exchangers and including a suction line, a low-side compressor, a high-side compressor and a discharge line, said low-side and high-side compressors both being in fluid communication with said suction and discharge lines.

23. The system of Claim 22, wherein said suction line is fluidly coupled
30 to a low-side suction inlet and a high-side suction inlet.

24. The system of Claim 23, wherein a shell of said low-side compressor is disposed between said suction line and said high-side suction inlet, such that

fluid passes through a suction chamber defined by said shell after exiting said suction line and before entering said high-side compressor.

25. The system of Claim 23, wherein a discharge outlet of said high-side
5 compressor feeds compressed fluid to said low-side suction inlet.

26. The system of Claim 23, wherein said high-side suction inlet receives fluid discharged by said low-side compressor.

10 27. The system of Claim 26, further comprising a bypass conduit directly coupling said suction line with said high-side suction inlet.

28. The system of Claim 22, wherein said high-side compressor includes a shell having first and second inlets, said first inlet receiving fluid from
15 said low-side compressor at a first pressure, said second inlet receiving fluid discharged from said low-side compressor at a second pressure that is higher than said first pressure.

29. The system of Claim 28, wherein said high-side compressor
20 includes a compression mechanism defining at least one compression pocket that receives fluid from said first inlet and is fluidly isolated from fluid received by said high-side compressor from said second inlet.

30. The system of Claim 22, wherein a discharge chamber of said high-
25 side compressor and a suction chamber of said low-side compressor are at substantially equal pressures when said high-side and low-side compressors are operating at approximately one-hundred percent capacity.

31. The system of Claim 22, further comprising an oil conduit fluidly
30 connecting oil sumps of said low-side and high-side compressors.

32. A compressor comprising:
a shell defining a first chamber containing fluid at a first fluid-pressure;

a first compression mechanism including first orbiting and first non-orbiting scrolls disposed in said first chamber and discharging compressed fluid into said first chamber at said first fluid-pressure;

5 a second compression mechanism including second orbiting and second non-orbiting scrolls disposed in said first chamber and defining a suction inlet and a discharge outlet, said suction inlet receiving fluid at said first fluid-pressure from said first chamber, said discharge outlet discharging fluid at a second fluid-pressure out of said shell.

10 33. The compressor of Claim 32, wherein said shell defines a second chamber at said second fluid-pressure.

34. The compressor of Claim 33, wherein said second chamber includes a discharge muffler.

15 35. The compressor of Claim 32, further comprising a driveshaft disposed in said first chamber and drivingly engaging said first and second orbiting scrolls.

20 36. The compressor of Claim 32, further comprising a motor disposed within said shell and driving both of said first and second orbiting scrolls.

25 37. The compressor of Claim 32, further comprising a suction conduit extending through said shell and engaging a suction inlet of said first compression mechanism and transferring fluid at a third fluid-pressure to said first compression mechanism, wherein said third fluid-pressure is less than said first and second fluid-pressures.

30 38. The compressor of Claim 32, wherein said shell defines a single lubricant sump supplying lubricant to both of said first and second compression mechanisms.

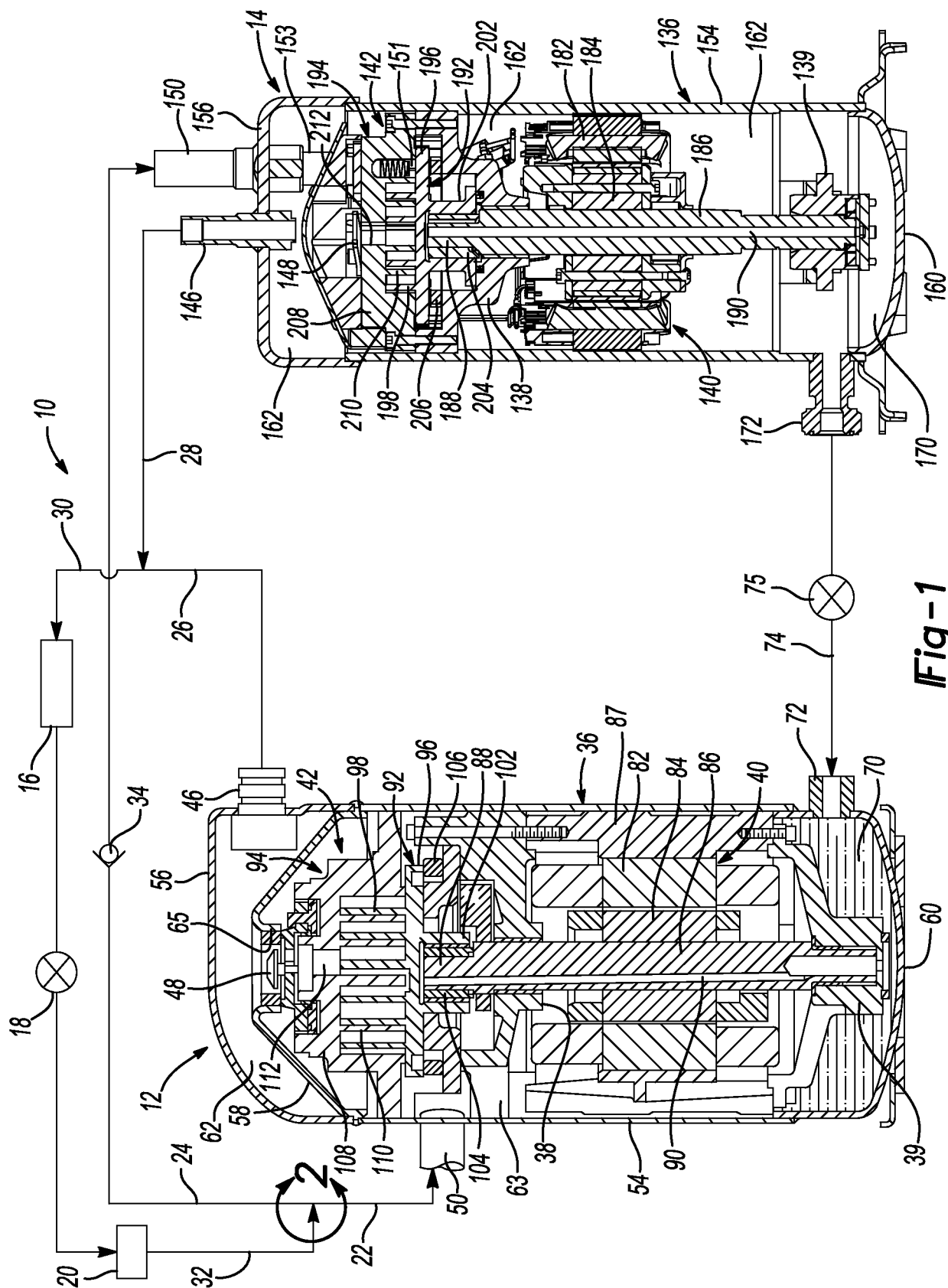


Fig-1

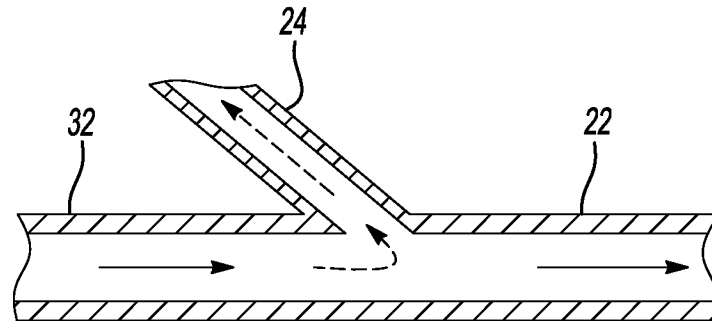


Fig-2

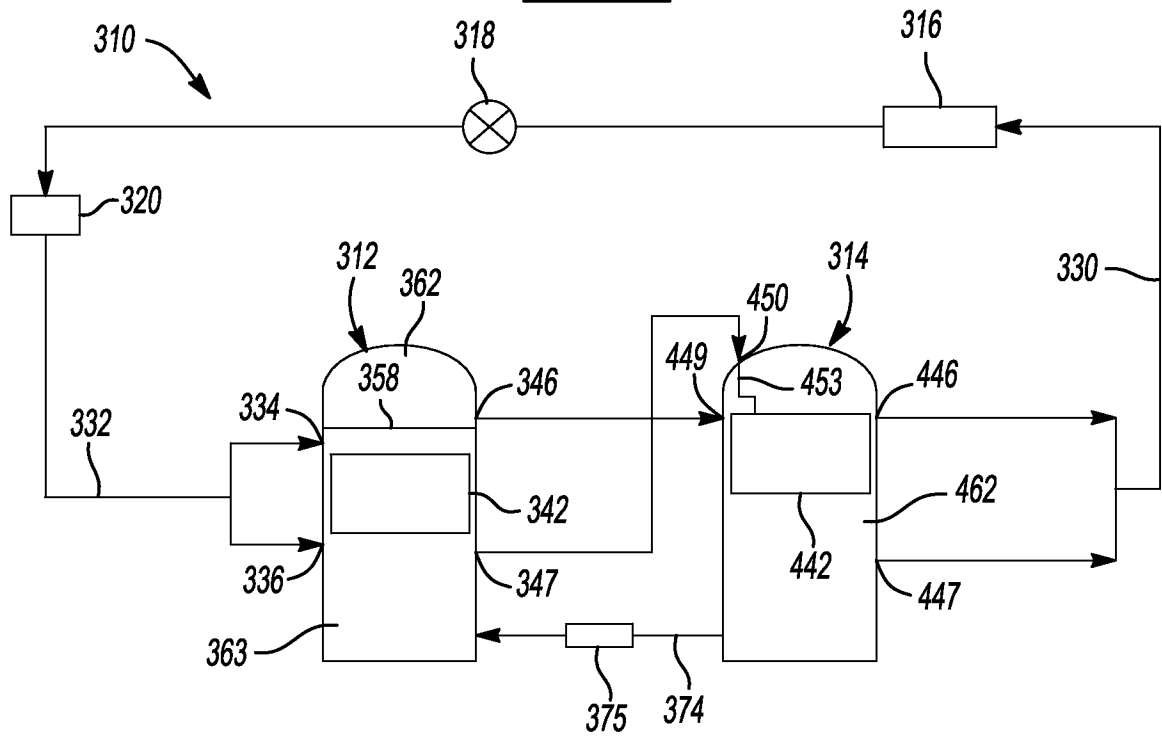


Fig-3

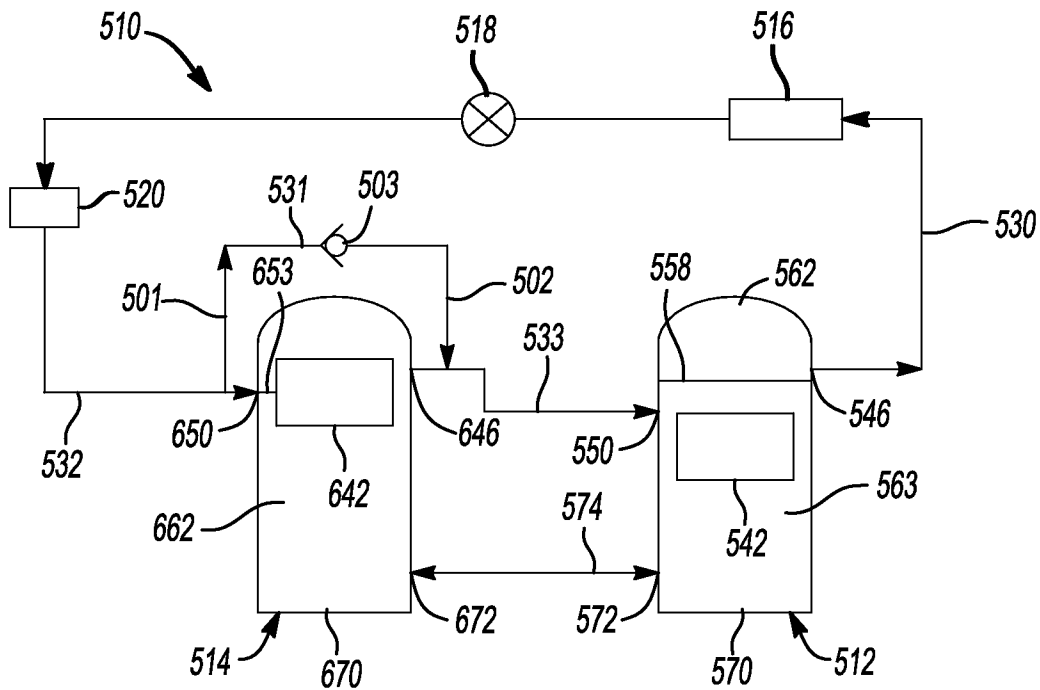


Fig-4

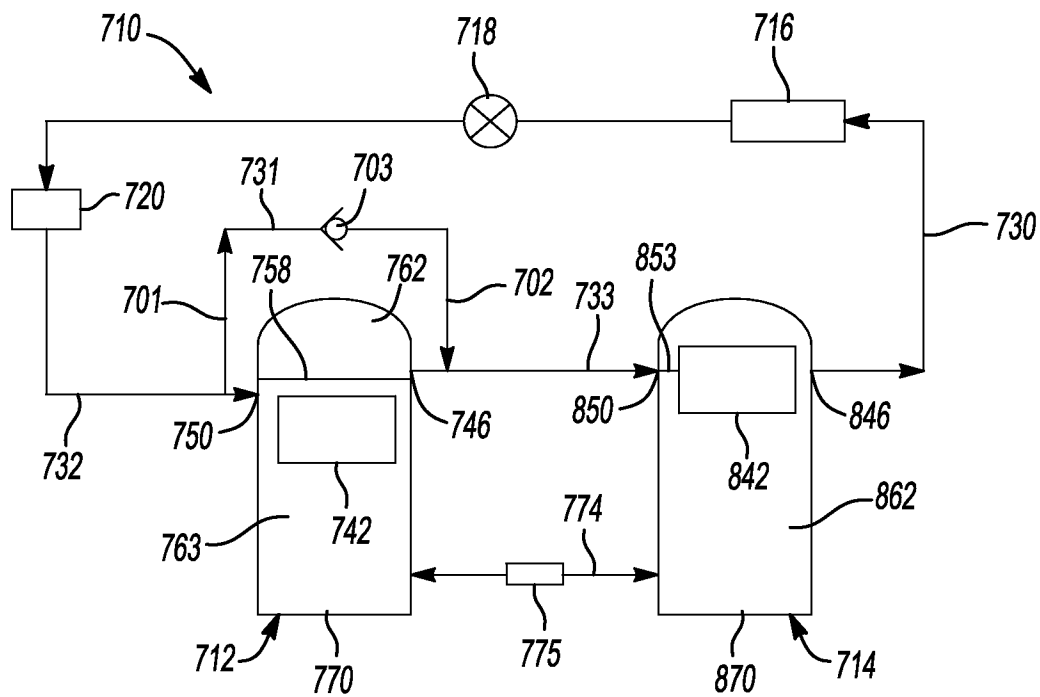


Fig-5

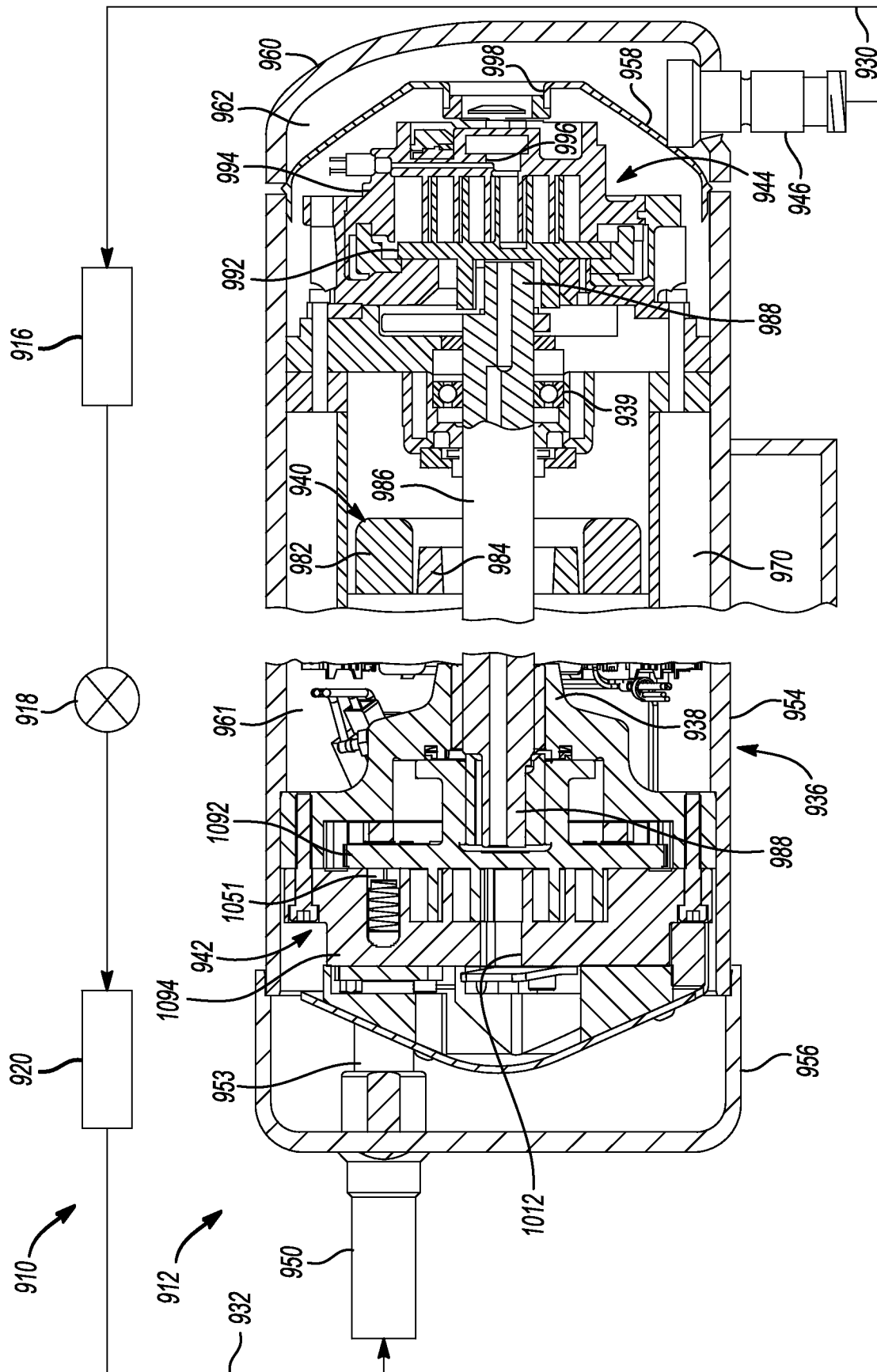


Fig-6

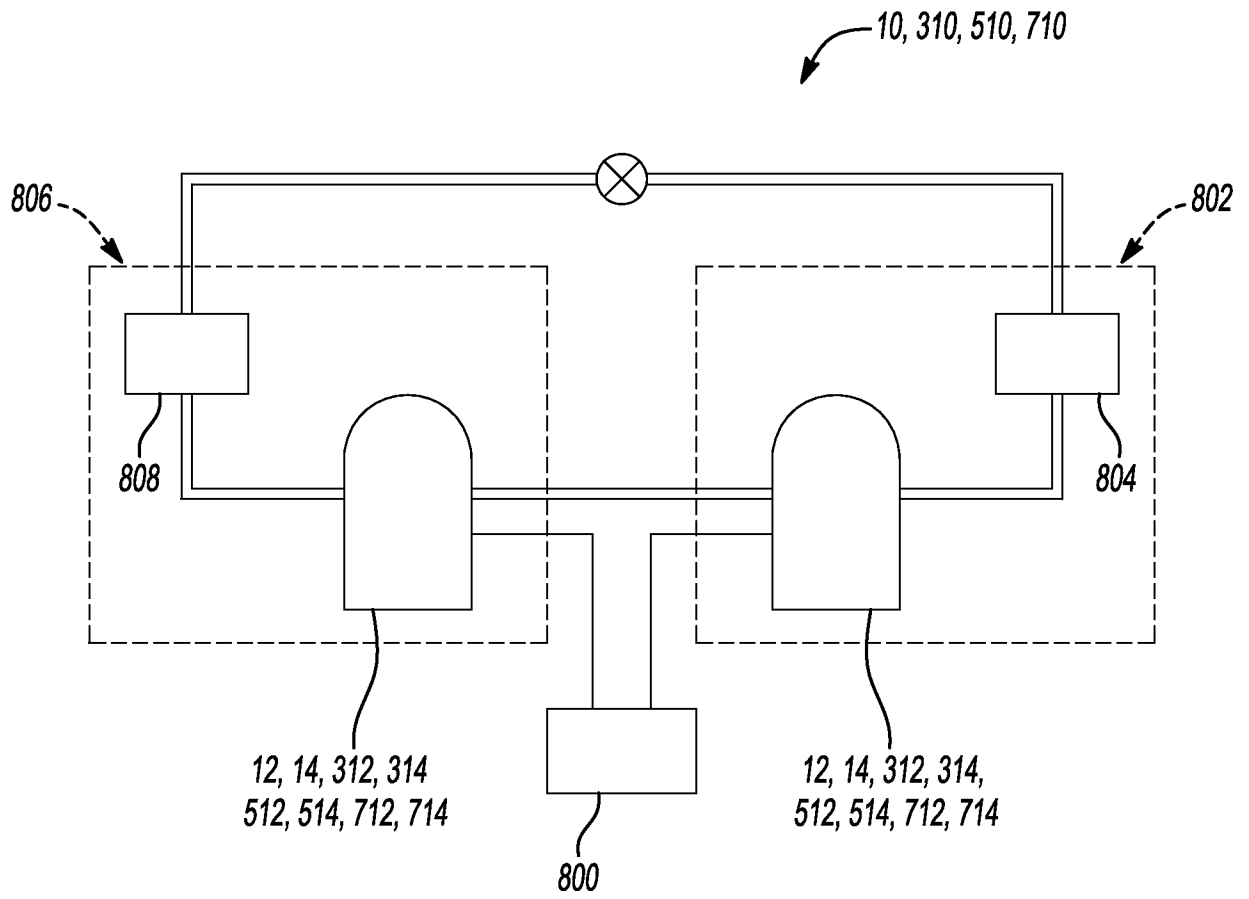
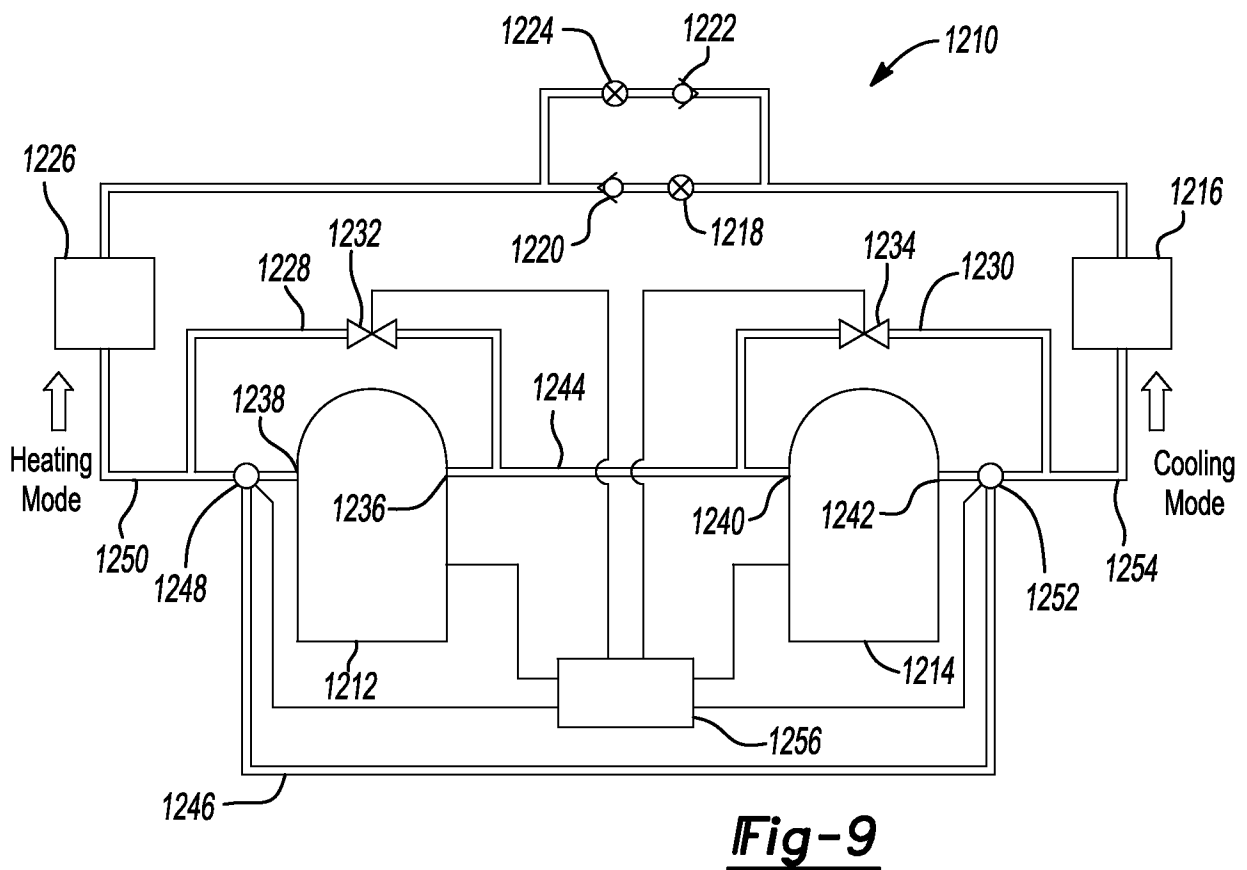
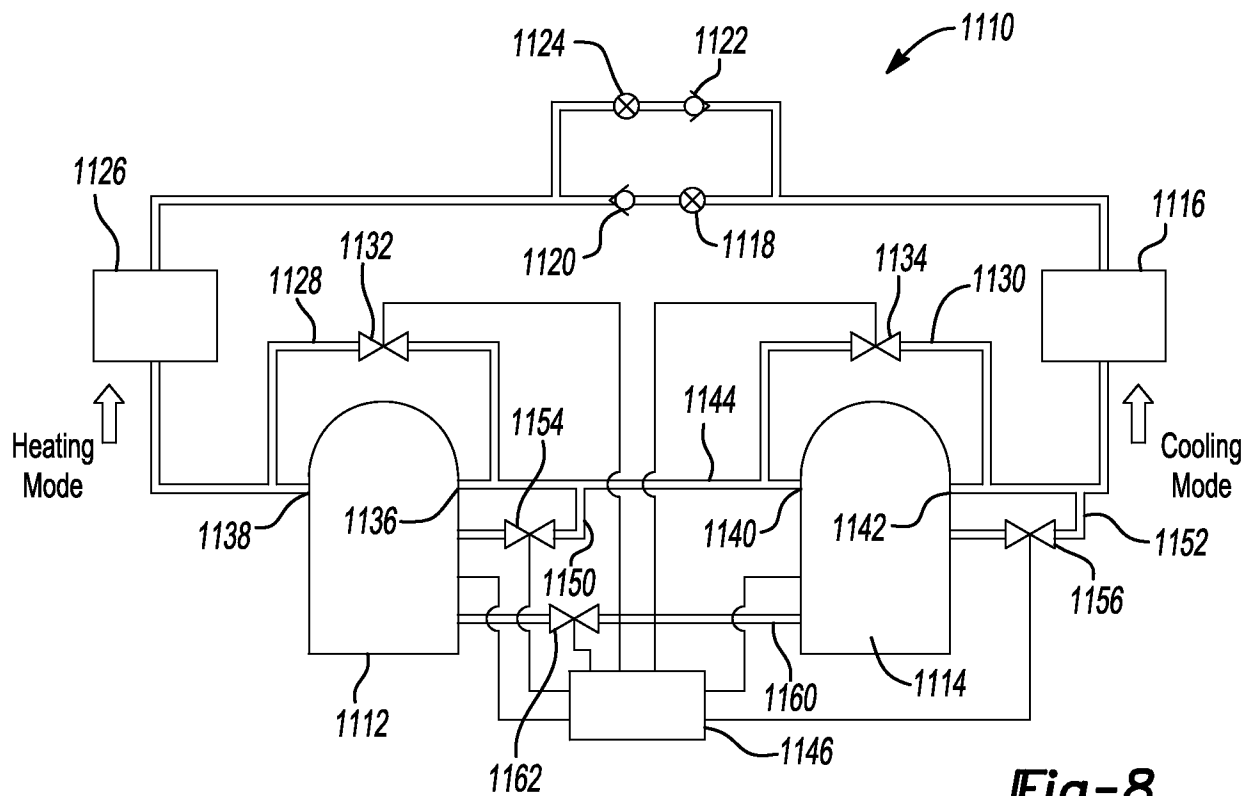


Fig-7



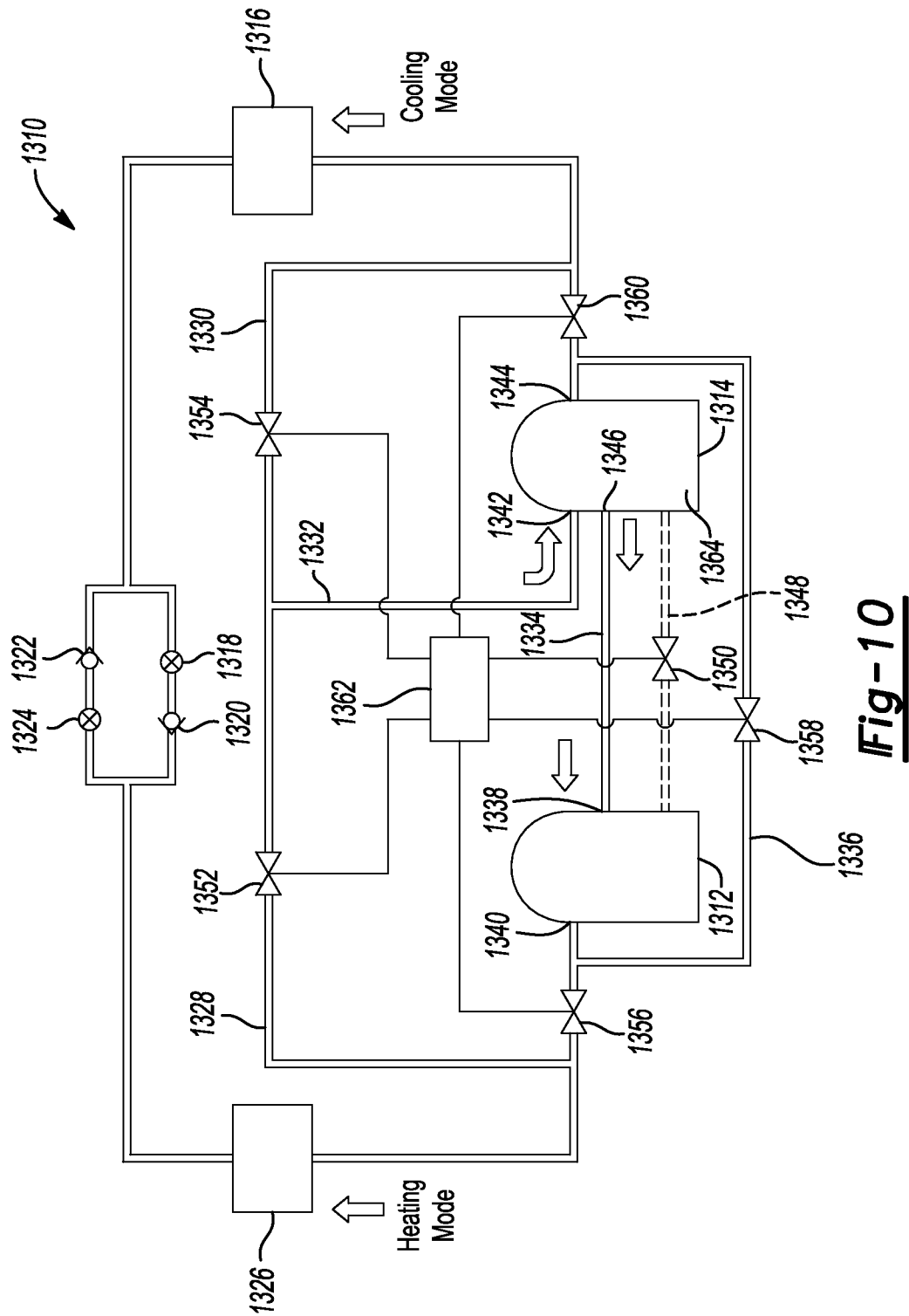


Fig-10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/018371**A. CLASSIFICATION OF SUBJECT MATTER****F25B 30/02(2006.01)i, F04C 18/02(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25B 30/02; F04B 39/02; F04C 23/00; F04C 18/02; F25D ; F25B 43/02; F25B 7/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: heat pump, compressor, scroll, and heat exchanger

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	WO 2005-050107 A2 (CARRIER CORPORATION) 02 June 2005 See abstract; paragraphs [0012]-[0020]; and figure 2.	1, 3-19, 22-23, 30 2, 24, 26, 31 20-21, 25, 27-29 , 32-38
Y	US 2009-0007588 A1 (SHAW, DAVID) 08 January 2009 See paragraphs [0033]-[0034], [0040]; and figures 3-6.	2, 31
Y	US 4,910,972 A (JASTER, HEINZ) 27 March 1990 See column 2, lines 36-66; and figure 1.	24, 26
Y	EP 2497954 A2 (MITSUBISHI HEAVY INDUSTRIES) 12 September 2012 See paragraphs [0016]-[0028]; and figure 1.	32-38
Y	JP 11-141483 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 25 May 1999 See paragraphs [0128]-[0143]; and figures 1-2.	32-38



Further documents are listed in the continuation of Box C.



See patent family annex.

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

09 July 2014 (09.07.2014)

Date of mailing of the international search report

09 July 2014 (09.07.2014)

Name and mailing address of the ISA/KR

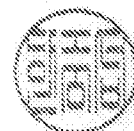
International Application Division
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