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(54) **VARIABLE CAPACITY CONDENSING UNIT**

(57) The present application provides a variable capacity condensing unit (150) for use with a refrigeration system (100). The variable capacity condensing unit may

include a gas cooler or a condenser (160), one or more fans (140; 180), and a number of fractional compressors (220).

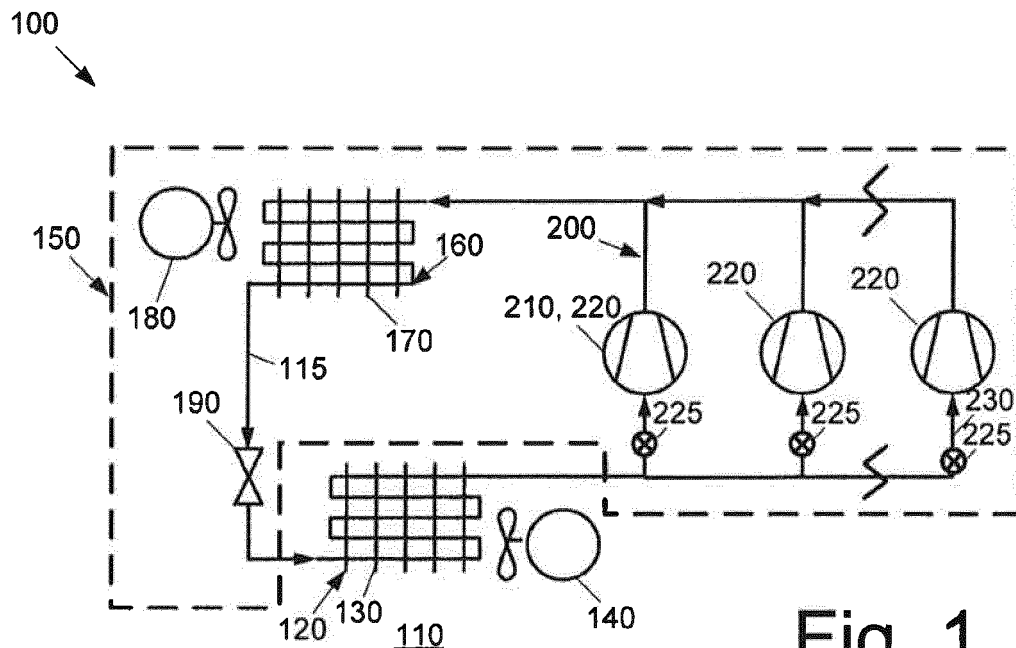


Fig. 1

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Description

[0001] The present application and the resultant patent relate generally to refrigeration systems and more particularly relate to refrigeration systems using variable capacity condensing units with a number of fractional compressors positioned in a parallel configuration or otherwise.

[0002] Modern air conditioning and refrigeration systems provide cooling, ventilation, and humidity control for all or part of a climate controlled area such as a refrigerator, a cooler, a building, and the like. Generally described, a conventional refrigeration cycle includes four basic stages to provide cooling. First, a vapor refrigerant is compressed within one or more compressors at high pressure and high temperature. Second, the compressed vapor is cooled within a condenser by heat exchange with ambient air drawn or blown across a condenser coil by a fan and the like. Third, the liquid refrigerant is passed through an expansion device that reduces both the pressure and the temperature of the liquid refrigerant. The liquid refrigerant is then pumped within the climate controlled area to one or more evaporators. The liquid refrigerant absorbs heat from the surroundings in an evaporator coil as the liquid refrigerant evaporates to a vapor. Finally, the vapor refrigerant returns to the compressor and the cycle repeats. Various alternatives on this basic refrigeration cycle are known and are also may be used herein.

[0003] The evaporator in a typical refrigeration system thus may be positioned inside the climate controlled area such that the evaporator transfers heat from the climate controlled area to the refrigerant. The remaining components may be positioned within a condensing unit that typically may be positioned outside of the climate controlled area. Specifically, the condensing unit may include one or more compressors, the condenser coil, and a fan assembly. The condensing unit thus dispenses the heat of the climate controlled area to the ambient or elsewhere.

[0004] Condensing units may require a wide variety of capacities depending upon the particular application and the cooling power required. Given such, manufacturers may stock a number of condensing units with differing capacities (BTU/hr). Despite providing such a large number of condensing units with differing capacities, gaps in the desired capacity may remain. As a result, oversized condensing units may be the only available option for a particular application. Moreover, the condensing units also must handle varying capacity demands based upon ambient conditions and other types of operational parameters.

[0005] There is thus a desire for an improved condensing unit. Such an improved condensing unit may provide a variable capacity for varying demand. Moreover, such an improved condensing unit may provide backup failure protection. The improved condensing unit thus may be operationally scalable.

[0006] The present application and the resultant patent thus provide a variable capacity condensing unit for use with a refrigeration system. The variable capacity condensing unit may include a gas cooler or a condenser, one or more fans, and a number of fractional compressors. The fractional compressors may be positioned in parallel, in series, or in a combined parallel and series configuration. The fractional compressors may have one (1) horsepower or less each.

[0007] The present application and the resultant patent further provide a method of operating a condensing unit in a refrigeration system. The method may include the steps of positioning a number of fractional compressors in a parallel configuration, flowing a refrigerant through the fractional compressors, and varying the number of the fractional compressors with the refrigerant flow during operation of the condensing unit based upon one or more operational parameters.

[0008] The present application and the resultant patent further provide a refrigeration system. The refrigeration system may include an evaporator and a variable capacity condensing unit. The variable capacity condensing unit may include a number of fractional compressors.

[0009] The plurality of fractional compressors may comprise a parallel configuration.

[0010] The plurality of fractional compressors may comprise a series configuration.

[0011] The plurality of fractional compressors may comprise a combined parallel configuration and series configuration.

[0012] The plurality of fractional compressors may comprise about one (1) horsepower or less.

[0013] These and other features and improvements of the present application and the resultant patent will become apparent to one of ordinary skill in the art upon review of the following detailed description when taken in conjunction with the several drawings and the appended claims, which illustrate embodiments of the invention by way of example only.

Fig. 1 is a schematic diagram of a refrigeration system with a variable capacity condensing unit as may be described herein.

Fig. 2 is a schematic diagram of a portion of an alternative embodiment of a refrigeration system with a variable capacity condensing unit as may be described herein.

Fig. 3 is a schematic diagram of a portion of an alternative embodiment of a refrigeration system with a variable capacity condensing unit as may be described herein.

[0014] Referring now to the drawings, in which like numerals refer to like elements throughout the several views, Fig. 1 shows an example of a refrigeration system 100 as may be described herein. The refrigeration system 100 may be used to cool any type of a climate controlled area or a refrigerated space 110. The refrigerated

space 110 may be a refrigerator, a cooler, a building, and the like. The refrigeration system 100 may be used with any type or size of refrigerated space 110. The overall refrigeration system 100 may have any suitable size, shape, configuration, or capacity. Any number of refrigeration systems 100 may be used herein. Heating application also may be used herein.

[0015] The refrigeration system 100 may include a flow of a refrigerant 115 therein. The refrigerant 115 may include conventional refrigerants such as hydro-fluorocarbons, carbon dioxide, and the like. Any type of refrigerant may be used herein. Multiple refrigeration cycles may use differing refrigerants in the same refrigeration system.

[0016] The refrigeration system 100 may include one or more evaporators 120. The evaporator 120 may include one or more evaporator coils 130 and one or more evaporator fans 140. The evaporator 120 may be positioned within or adjacent to the refrigerated space 110. The evaporator fans 140 pull in air from the refrigerated space 110 and over the evaporator coils 130 so as to exchange heat with the refrigerant 115. The evaporator 120 may be of conventional design and may have any suitable size, shape, configuration, or capacity.

[0017] The refrigeration system 100 also may include one or more condensing units 150. The condensing unit 150 may be positioned outside of the refrigerated space 110. Any number of condensing units 150 may be used herein in any suitable size, shape, configuration, or capacity. The condensing unit 150 may be in fluid communication with the evaporator 120 via the flow of refrigerant 115.

[0018] The condensing unit 150 may include a condenser or a gas cooler 160. The condenser or gas cooler 160 may include one or more condenser coils or gas cooler coils 170 and one or more condenser fans 180. The condenser fans 180 pull in ambient air over the condenser or the gas cooler coils 170 for heat exchange with the refrigerant 115. The condenser or gas cooler 160 may be of conventional design and may have any suitable size, shape, configuration, or capacity.

[0019] The condensing unit 150 also may include an expansion valve 190. The expansion valve 190 may be positioned within the condensing unit 150. Alternatively, the expansion valve 190 may be positioned about the evaporator 120 or elsewhere. The expansion valve 190 may reduce the pressure and temperature of the refrigerant 115. The expansion valve 190 may be of conventional design and may have any suitable size, shape, configuration, or capacity.

[0020] The condensing unit 150 also may include a compressor rack 200. The compressor rack 200 may include any number of compressors 210 therein. In this example, the compressors 210 may be a number of fractional compressors 220. The fractional compressors 220 each may have a power output of about one (1) horsepower or less. The fractional compressors 220 may be of conventional design. Any number of the fractional com-

pressors 220 may be used herein. The fractional compressors 220 may have any suitable size, shape, configuration, or capacity. The fractional compressors 220 each may have a compressor valve 225 upstream thereof. The compressor valve 225 may be an on-off valve or a variable flow valve so as to control the flow of the refrigerant 115 to each fractional compressor 220. Other components and other configurations may be used herein.

[0021] The fraction compressors 220 may be positioned in a parallel configuration 230. The number of the fraction compressors 220 in operation thus may vary based upon the operation of the compressor valves 225 and the like. The compressor rack 200 thus may have a number of operational fractional compressors 220 and a number of back-up or stand-by fractional compressors 220.

[0022] In use, the number of the fractional compressors 220 in operation may vary based upon the desired overall capacity of the condensing unit 150. Moreover, the number of fractional compressors 220 in operation at any given time may vary so as to provide variable capacity on demand. The number of fractional compressors 220 in operation may be optimized for ambient conditions, energy usage, or any type of operational parameter. Specifically, a control scheme may determine how many fractional compressors 220 may operate for a given condition and may dynamically control compressor operation for ambient conditions and energy usage. One or more of the fractional compressors 220 may operate with a variable frequency device so as to enable a more refined control of capacity and additional energy savings.

[0023] Operation of the fractional compressors 220 may be controlled so as to accommodate unloading, lead-lag control, and other types of operating conditions. Moreover, the use of a number of the fractional compressors 220 may provide back-up in case of the failure of one or more of the fractional compressors 220. Specifically, the replacement of a single compressor in the parallel configuration 230 would limit the overall loss of the flow of refrigerant 115. The fractional compressors 220 thus provide variable capacity as well as failure load operation. Further, the fractional compressors 220 may alternate in operation such that all of the fractional compressors 220 may have substantially similar usage so as to improve overall reliability.

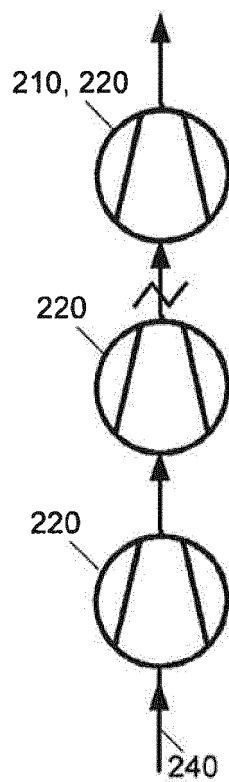
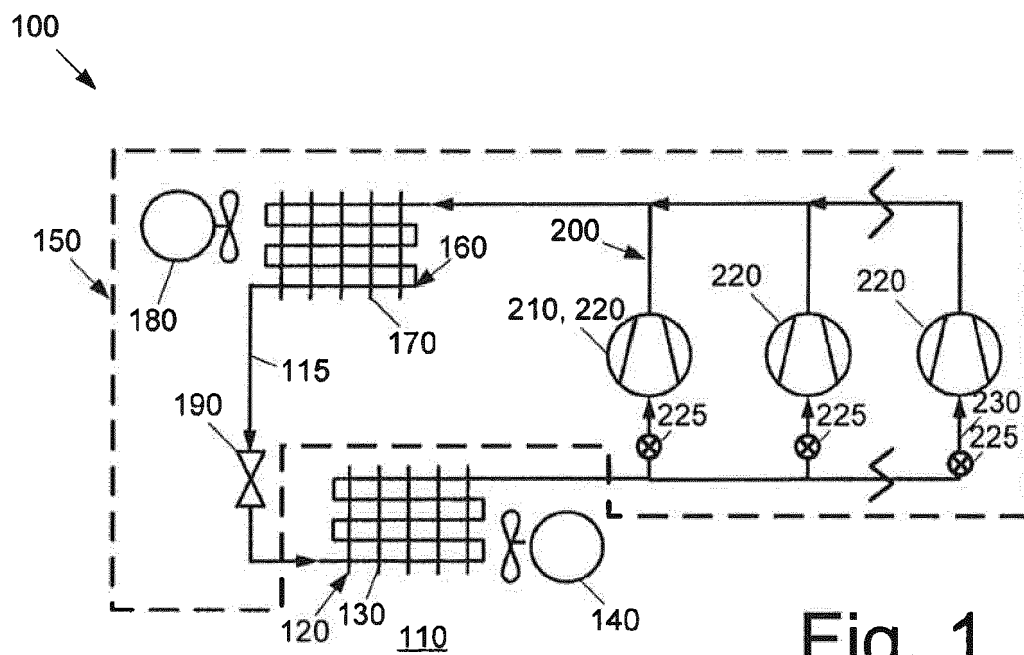
[0024] As is shown in Fig. 2, the fractional compressors 220 also may be positioned in a series configuration 240. The series configuration 240 thus may form a multiple stage compressor arrangement when a single stage compressor may be insufficient. The fractional compressors 220 also may be arranged in a booster orientation with, for example, a low temperature output feeding a medium temperature input. Moreover as is shown in Fig. 3, the fractional compressors 220 also may be positioned in a combined configuration 250 with a number of the fractional compressors 220 positioned in the parallel configuration 230 with other fractional compressors 220 ar-

ranged in the series configuration 240. Other components and other configurations may be used herein.

[0025] It should be apparent that the foregoing relates only to certain embodiments of the present application and the resultant patent. Numerous changes and modifications may be made herein by one of ordinary skill in the art without departing from the scope of the invention as defined by the following claims and the equivalents thereof.

Claims

1. A variable capacity condensing unit (150) for use with a refrigeration system (100), comprising:
 - a gas cooler or a condenser (160);
 - one or more fans (140; 180); and
 - a plurality of fractional compressors (220).
2. The variable capacity condensing unit (150) of claim 1, wherein the plurality of fractional compressors (220) comprises a parallel configuration (230).
3. The variable capacity condensing unit (150) of claim 1, wherein the plurality of fractional compressors (220) comprises a series configuration (240).
4. The variable capacity condensing unit (150) of claim 1, wherein the plurality of fractional compressors (220) comprises a combined parallel configuration and series configuration (250).
5. The variable capacity condensing unit (150) of any preceding claim, wherein the plurality of fractional compressors (220) comprises about one (1) horsepower or less.
6. The variable capacity condensing unit (150) of any preceding claim, wherein the plurality of fractional compressors (220) comprises a variable frequency.
7. The variable capacity condensing unit (150) of any preceding claim, wherein the plurality of fractional compressors (220) comprises a set of operational compressors and a set of backup compressors.
8. The variable capacity condensing unit (150) of any preceding claim, further comprising a compressor rack and wherein the plurality of fractional compressors (220) is positioned in the compressor rack.
9. The variable capacity condensing unit (150) of any preceding claim, wherein the plurality of fractional compressors (220) comprises an on/off compressor valve (225).
10. The variable capacity condensing unit (150) of any preceding claim, wherein the gas cooler (160) comprises a condenser or a gas cooler coil (170).
11. The variable capacity condensing unit (150) of any preceding claim, further comprising a carbon dioxide refrigerant or a hydro-fluorocarbon refrigerant.
12. The variable capacity condensing unit (150) of any preceding claim, wherein the variable capacity condensing unit is in communication with an expansion valve (190).
13. The variable capacity condensing unit (150) of any preceding claim, wherein the variable capacity condensing unit is in communication with one or more evaporators (120); and wherein the one or more evaporators preferably comprise an evaporator coil (130) and an evaporator fan (140).
14. A method of operating a condensing unit (150) in a refrigeration system (100), comprising:
 - positioning a plurality of fractional compressors (220) in a parallel configuration (230);
 - flowing a refrigerant through a number of the plurality of fractional compressors; and
 - varying the number of the plurality of fractional compressors with the flow of refrigerant (115) based upon one or more operational parameters.
15. A refrigeration system (100), comprising:
 - an evaporator (120); and
 - a variable capacity condensing unit (150) according to any preceding claim.



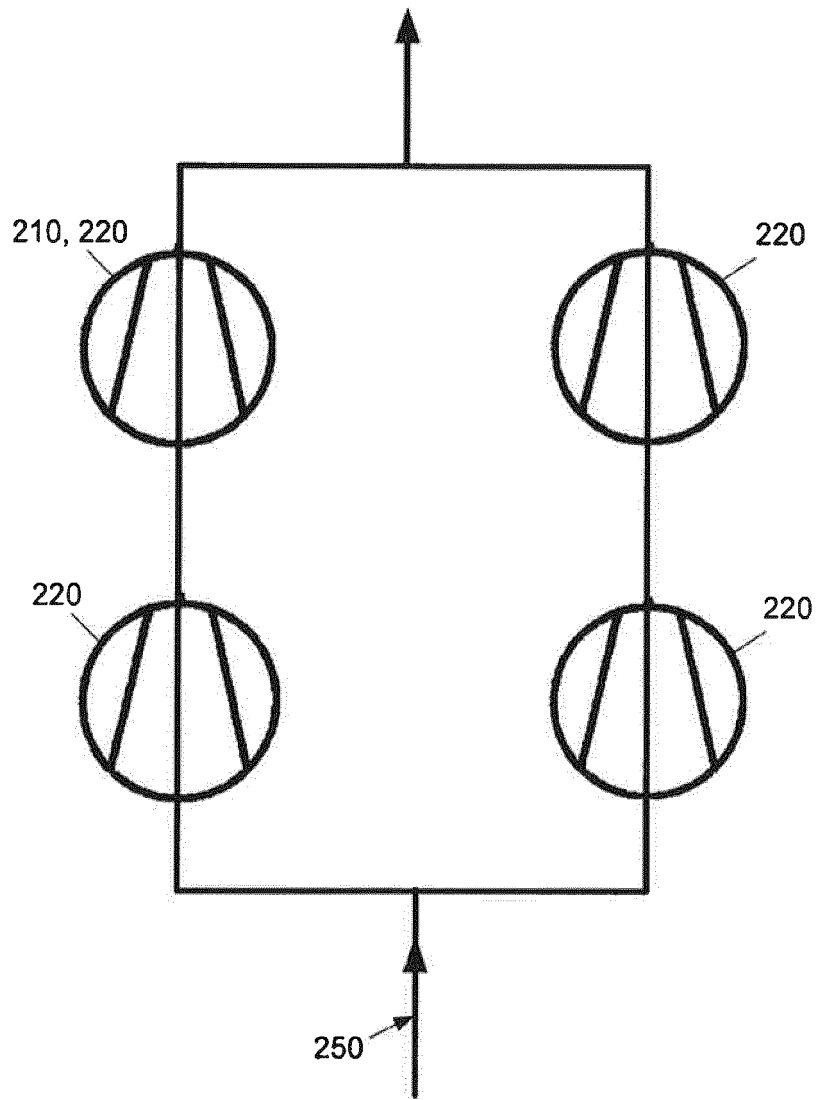


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 16 16 4205

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Place of search Munich		Date of completion of the search 11 August 2016	Examiner Ritter, Christoph
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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