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(54) **HVAC UNIT WITH EXPANSION DEVICE**

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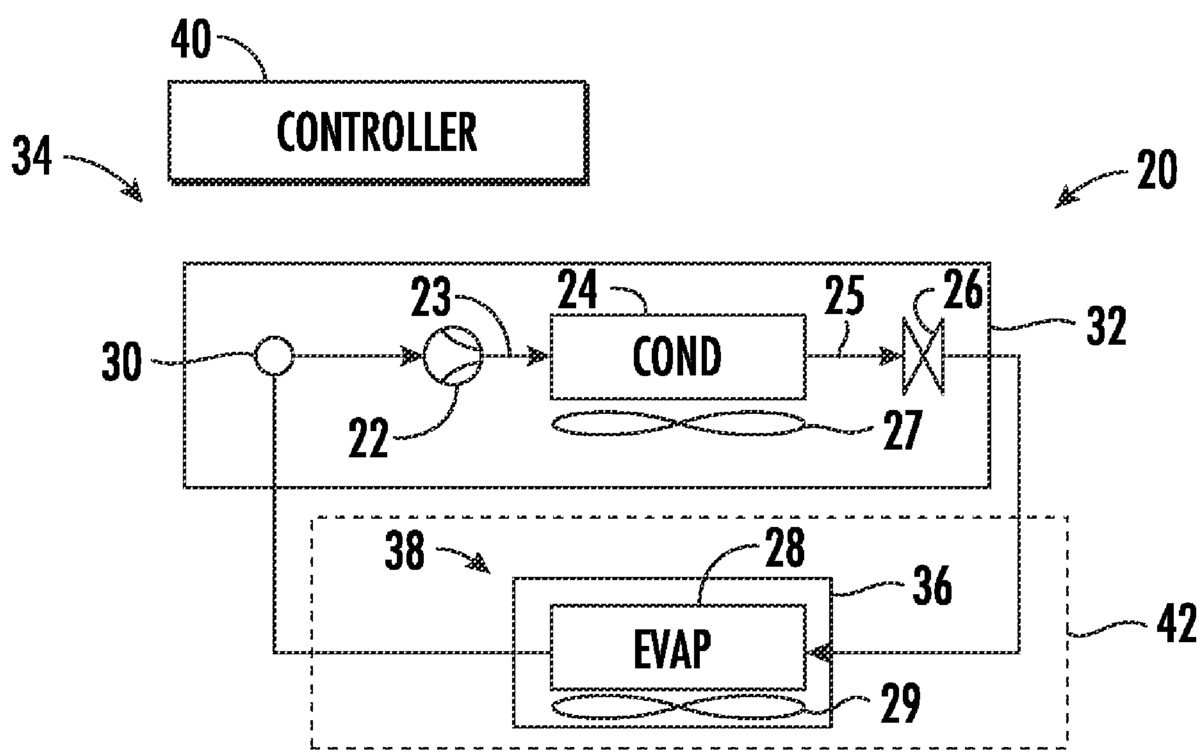
(57) **ABSTRACT**

An outdoor HVAC unit includes a housing. A compressor is located within the housing. A heat exchanger is located within the housing and is in fluid communication with the compressor. At least one expansion device is located within the housing and is in fluid communication with the heat exchanger.



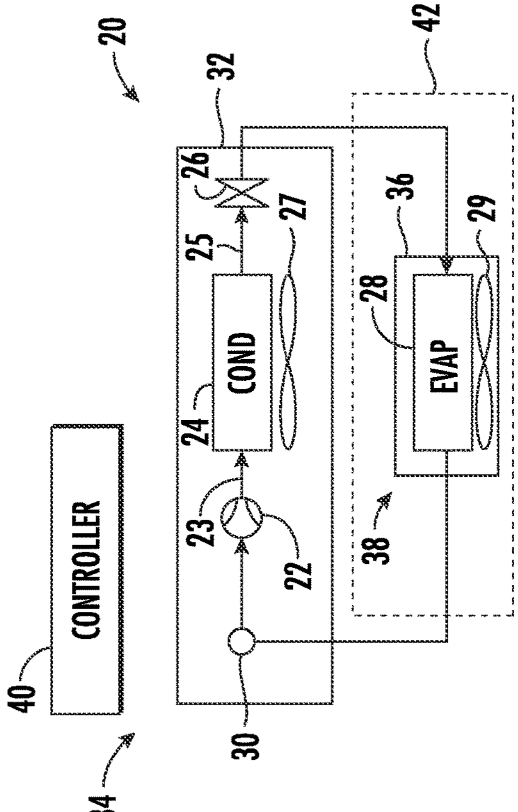


FIG. 1

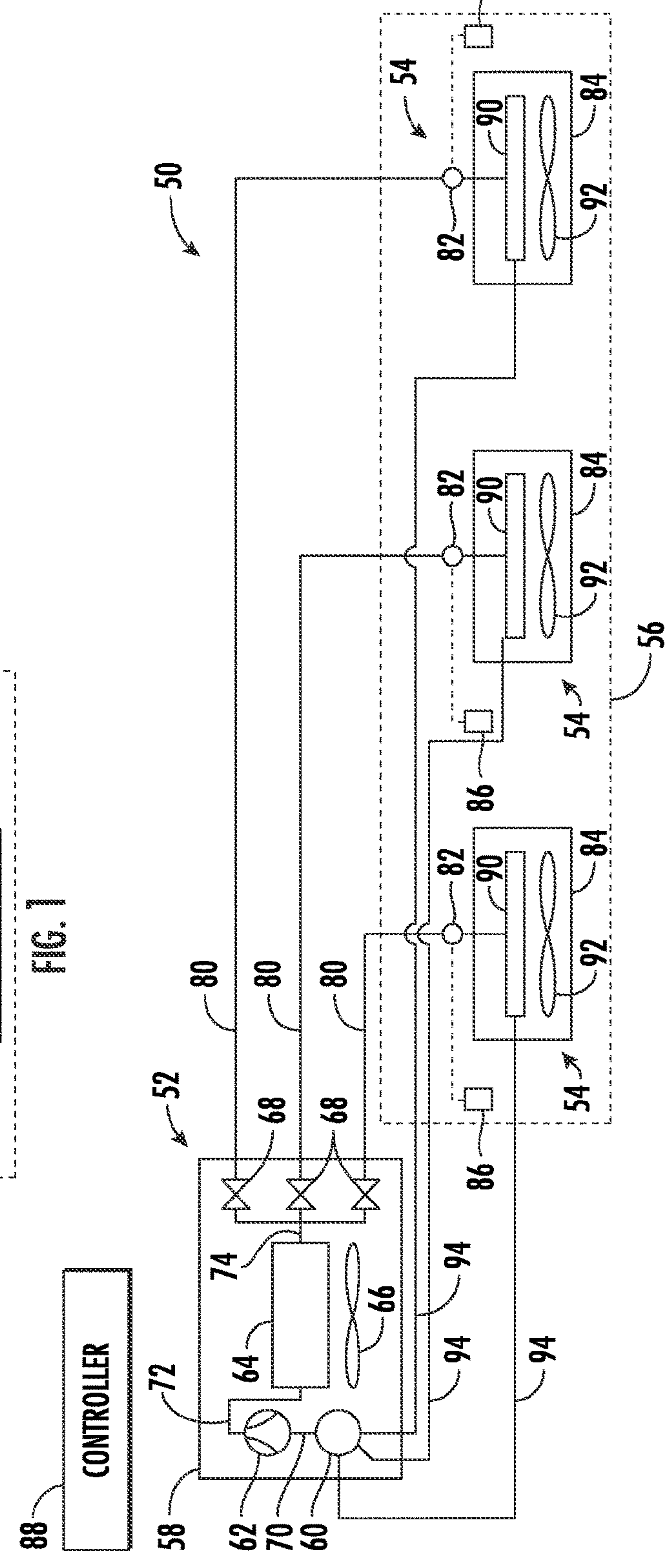


FIG. 2

HVAC UNIT WITH EXPANSION DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Application No. 62/899,798, which was filed on Sep. 13, 2019 and is incorporated herein by reference.

BACKGROUND

[0002] The present disclosure relates to refrigeration systems and, more particularly, to refrigeration systems with at least one indoor unit and at least one outdoor unit.

[0003] Buildings, such as university buildings, office buildings, residential buildings, commercial buildings, and the like, include climate systems which are operable to control the climate inside the building. A typical climate system includes an evaporator, a compressor, a condenser, and an expansion valve. These components utilize a refrigerant to maintain an indoor temperature of the buildings at a desired level.

SUMMARY

[0004] In one exemplary embodiment, an outdoor HVAC unit includes a housing. A compressor is located within the housing. A heat exchanger is located within the housing and is in fluid communication with the compressor. At least one expansion device is located within the housing and is in fluid communication with the heat exchanger.

[0005] In a further embodiment of any of the above, at least one isolation valve is in fluid communication with the compressor.

[0006] In a further embodiment of any of the above, the isolation value is fluidly upstream of the compressor. The at least one expansion device is fluidly downstream of the heat exchanger.

[0007] In a further embodiment of any of the above, the heat exchanger is a condenser.

[0008] In a further embodiment of any of the above, the at least one expansion device includes a plurality of expansion devices each in fluid communication with the heat exchanger.

[0009] In a further embodiment of any of the above, a plurality of liquid refrigerant lines are in fluid communication with the heat exchanger and a corresponding one of the plurality of expansion devices.

[0010] In a further embodiment of any of the above, the plurality of liquid lines are located within the housing.

[0011] In a further embodiment of any of the above, the outdoor unit operates with an A2L refrigerant.

[0012] In another exemplary embodiment, a refrigeration system includes an outdoor housing. A compressor is located within the outdoor housing. A first heat exchanger is located within the outdoor housing and is in fluid communication with the compressor. At least one expansion device is located within the outdoor housing and is in fluid communication with the heat exchanger. At least one second heat exchanger is located fluidly between the at least one expansion device and the compressor.

[0013] In a further embodiment of any of the above, the second heat exchanger is located within an indoor unit.

[0014] In a further embodiment of any of the above, at least one flow modulating valve is located fluidly between the at least one expansion device and the second heat exchanger.

[0015] In a further embodiment of any of the above, the first heat exchanger is a condenser. The second heat exchanger is an evaporator.

[0016] In a further embodiment of any of the above, a controller is configured to control the at least one modulating value, the at least one expansion device, and the compressor in response to a desired conditioning request.

[0017] In a further embodiment of any of the above, at least one isolation valve is located within the outdoor housing and fluidly between the at least one second heat exchanger and the compressor.

[0018] In a further embodiment of any of the above, a first fan is located adjacent the first heat exchanger and at least one second fan is located adjacent the at least one second heat exchanger.

[0019] In a further embodiment of any of the above, a plurality of liquid refrigerant lines are in fluid communication with the heat exchanger and a corresponding one of the at least one expansion devices.

[0020] In a further embodiment of any of the above, the refrigeration system operates with an A2L refrigerant.

[0021] In another exemplary embodiment, a method of operating a refrigeration system includes the step of fluidly isolating a first heat exchanger located within a housing of an outdoor unit from an indoor unit with at least one expansion device located within the outdoor unit. A second heat exchanger is fluidly isolated in the indoor unit from a compressor with at least on isolation valve located within the outdoor unit.

[0022] In a further embodiment of any of the above, at least one liquid refrigerant line extends from the first heat exchanger to the at least one expansion device. The at least one liquid refrigerant line is located within the housing of the outdoor unit.

[0023] In a further embodiment of any of the above, the refrigeration system operates with an A2L refrigerant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. **1** illustrates an example refrigeration system.

[0025] FIG. **2** illustrates an example multi-zone refrigeration system.

DETAILED DESCRIPTION

[0026] A refrigeration system **20** is illustrated in FIG. **1** and includes a compressor **22** delivering refrigerant into a discharge line **23** leading to a heat exchanger **24**, such as a condenser for subcritical applications and a gas cooler for trans-critical applications. The heat is transferred in the heat exchanger **24** from the refrigerant to a secondary loop fluid, such as ambient air, with a fan **27**. The high pressure, but cooled, refrigerant passes into a liquid refrigerant line **25** downstream of the heat exchanger **24** and through an expansion device **26**, where the refrigerant is expanded to a lower pressure and temperature. Downstream of the expansion device **26**, the refrigerant flows through an evaporator **28** and then through an isolation valve **30** before returning back to the compressor **22**. A fan **29** draws air to be conditioned through the evaporator **28**.

[0027] In the illustrated example, the compressor **22**, condenser **24**, expansion device **26**, and isolation valve **30** are located within a housing **32** to form an outdoor unit **34**. The expansion device **26** could include one of a TXV, a piston valve, or an EXV. Similarly, the evaporator **28** and the fan **29** are located in a housing **36** that forms an indoor unit **38**. Furthermore, the system **20** is configured to operate with an A2L refrigerant.

[0028] The configuration of FIG. **1** can be used in a number of applications, such as in residential systems. When used with a residential system, the evaporator **28** is located inside a residence and the fan **29** draws air through the evaporator **28**. Additionally, the fan **29** may be associated with a separate heating system for the residence. A controller **40** is either in direct electrical communication or wireless communication with the compressor **22**, the fans **27**, **29**, the expansion device **26**, and the isolation valve **30** to control or monitor operation of these elements. The controller **40** includes a microprocessor in communication with memory which stores programs to direct operation of the refrigeration system **20**.

[0029] In the event of a refrigerant leak within the refrigeration system **20**, the controller **40** can isolate refrigerant in the outdoor unit **34** from the indoor unit **38** by signaling the compressor **22** to stop along with signaling the isolation valve **30** and the expansion device **26** to move into a fully closed position that prevents the passage of refrigerant. One feature of this isolation approach with the outdoor unit **34** is that a greater percentage of refrigerant of the entire system **20** is captured in the outdoor unit **34**. In particular, a greater percentage is captured because the liquid refrigerant line **25** does not extend downstream of the outdoor unit **34** since the expansion device **26** is located within the housing **32**. This is due to the amount of refrigerant located in the liquid refrigerant line **25** being much greater per unit length than the amount of refrigerant in the refrigerant line connecting the expansion device **26** with the evaporator **28**.

[0030] FIG. **2** illustrates example variable refrigerant flow ("VRF") system **50**. In the illustrated example, the VRF system **50** includes a single outdoor unit **52** and multiple indoor units **54**. The outdoor unit **52** is located on an exterior of a building **56** while the indoor units **54** are located on an interior of the building **56**. Although the VRF system **50** only includes a single outdoor unit **52** in the illustrated example, the VRF system **50** could include multiple outdoor units **52** arranged in series depending on the heating and/or cooling needs of the building **56**. Additionally, the VRF system **50** is configured to operate with an A2L refrigerant.

[0031] In the illustrated example, the outdoor unit **52** includes a housing **58** enclosing an isolation valve **60**, a compressor **62**, a first heat exchanger **64**, a fan **66**, and multiple expansion devices **68**. The compressor **62** is in fluid communication with a suction line **70** that connects the compressor **62** with an outlet of the isolation valve **60**. Additionally, the compressor **62** is in fluid communication with a discharge line **72** that connects the compressor **62** with the first heat exchanger **64**. A liquid refrigerant line **74** connects an output of the first heat exchanger **64** with each of the three expansion devices **68**, such that the liquid refrigerant line **74** includes a branching portion between the first heat exchanger **64** and each of the expansion devices **68**.

[0032] In the illustrated example, the expansion devices **68** could include one of a TXV, a piston valve, or an EXV. An output of each of the expansion devices **68** is in fluid communication with an input line **80** that connects each of the expansion devices **68** with one of the indoor units **54**. One feature of having the liquid refrigerant line **74** located within the housing **58** is that the overall system refrigerant charge is reduced due to the reduction in length of the liquid refrigerant line **74**. This is due to the amount of refrigerant located in the liquid refrigerant line **74** being much greater per unit length than the amount of refrigerant in a corresponding one of the input lines **80**.

[0033] Each of the input lines **80** are in communication with a flow modulating valve **82** associated with each of the indoor units **54**. Although the flow modulating valves **82** are shown on an exterior of the indoor units **54**, the flow modulating valves **82** could be located within a housing **84** of the indoor units **54**. The flow modulating valves **82** are in electrical communication with individual temperature controls **86** to control a conditioned temperature of a region within the building **56**. To change the temperature in the corresponding region of the building **56**, the indoor units **54** each include a second heat exchanger **90** and a second fan **92** to move air within the building **56** over the second heat exchanger **90**.

[0034] Return lines **94** fluidly connect the second heat exchangers **90** in the indoor units **54** with the isolation valve **60** in the outdoor unit **52**. Although the isolation valve **60** is shown receiving each of the three return lines **94** in the illustrated example, an additional valve could be utilized to collect each of the return lines **94** into a single return line which would be in fluid communication with an input on the isolation valve **60**.

[0035] During operation of the VRF system **50**, the individual temperature controls **86** are used to control a temperature within the regions of the building **56**. To change the temperature, the individual temperature controls **86** can communicate with the individual flow modulating valves **82** for each of the associated indoor units **54**. Alternatively, the individual temperature controls **86** can communication with the rest of the VRF system **50** through a main controller **88**. The main controller **88** controls and monitors operation of the isolation valve **60**, the compressor **62**, the fans **66** and **92**, the expansion devices **68**, and/or the flow modulating valves **82**. The controller **88** includes a microprocessor in communication with memory which stores programs to direct operation of the VRF system **50**.

[0036] Furthermore, in the event of a refrigerant leak within the VRF system **50**, the main controller **88** can isolate refrigerant in the outdoor unit **52** from the rest of the indoor units **54** by signaling the compressor **62** to stop along with signaling the isolation valve **60** and each of the expansion devices **68** to move into a fully closed position that prevents the passage of refrigerant. One feature of this isolation approach with the outdoor unit **52** is that a greater percentage of refrigerant of the entire VRF system **50** is able to be captured in the outdoor unit **52**. In particular, a greater percentage is captured because the liquid refrigerant lines **74** do not extend downstream of the outdoor unit **52** since the expansion devices **68** are located within the housing **58**.

[0037] Although the different non-limiting examples are illustrated as having specific components, the examples of this disclosure are not limited to those particular combinations. It is possible to use some of the components or features from any of the non-limiting examples in combination with features or components from any of the other non-limiting examples.

[0038] It should be understood that like reference numerals identify corresponding or similar elements throughout the several drawings. It should also be understood that although a particular component arrangement is disclosed and illustrated in these exemplary embodiments, other arrangements could also benefit from the teachings of this disclosure.

[0039] The foregoing description shall be interpreted as illustrative and not in any limiting sense. A worker of ordinary skill in the art would understand that certain modifications could come within the scope of this disclosure. For these reasons, the following claim should be studied to determine the true scope and content of this disclosure.

What is claimed is:

1. An outdoor HVAC unit comprising:

a housing;

a compressor located within the housing;

a heat exchanger located within the housing and in fluid communication with the compressor; and

at least one expansion device located within the housing and in fluid communication with the heat exchanger.

2. The unit of claim **1**, further comprising at least one isolation valve in fluid communication with the compressor.

3. The unit of claim **2**, wherein the isolation value is fluidly upstream of the compressor and the at least one expansion device is fluidly downstream of the heat exchanger.

4. The unit of claim **3**, wherein the heat exchanger is a condenser.

5. The unit of claim **1**, wherein the at least one expansion device includes a plurality of expansion devices each in fluid communication with the heat exchanger.

6. The unit of claim **5**, further comprising a plurality of liquid refrigerant lines in fluid communication with the heat exchanger and a corresponding one of the plurality of expansion devices.

7. The unit of claim **6**, wherein the plurality of liquid lines are located within the housing.

8. The unit of claim **1**, wherein the outdoor unit operates with an A2L refrigerant.

9. A refrigeration system comprising:

an outdoor housing;

a compressor located within the outdoor housing;

a first heat exchanger located within the outdoor housing and in fluid communication with the compressor;

at least one expansion device located within the outdoor housing and in fluid communication with the heat exchanger; and

at least one second heat exchanger located fluidly between the at least one expansion device and the compressor.

10. The system of claim **9**, wherein the second heat exchanger is located within an indoor unit.

11. The system of claim **10**, further comprising at least one flow modulating valve located fluidly between the at least one expansion device and the second heat exchanger.

12. The system of claim **11**, wherein the first heat exchanger is a condenser and the second heat exchanger is an evaporator.

13. The system of claim **12**, further comprising a controller configured to control the at least one modulating value, the at least one expansion device, and the compressor in response to a desired conditioning request.

14. The system of claim **12**, further comprising at least one isolation valve located within the outdoor housing and fluidly between the at least one second heat exchanger and the compressor.

15. The system of claim **12**, further comprising a first fan located adjacent the first heat exchanger and at least one second fan located adjacent the at least one second heat exchanger.

16. The system of claim **12**, further comprising a plurality of liquid refrigerant lines in fluid communication with the heat exchanger and a corresponding one of the at least one expansion devices.

17. The system of claim **9**, wherein the refrigeration system operates with an A2L refrigerant.

18. A method of operating a refrigeration system comprising the steps of:

fluidly isolating a first heat exchanger located within a housing of an outdoor unit from an indoor unit with at least one expansion device located within the outdoor unit; and

fluidly isolating a second heat exchanger in the indoor unit from a compressor with at least on isolation valve located within the outdoor unit.

19. The method of claim **18**, wherein at least one liquid refrigerant line extends from the first heat exchanger to the at least one expansion device and the at least one liquid refrigerant line is located within the housing of the outdoor unit.

20. The method of claim **18**, wherein the refrigeration system operates with an A2L refrigerant.

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