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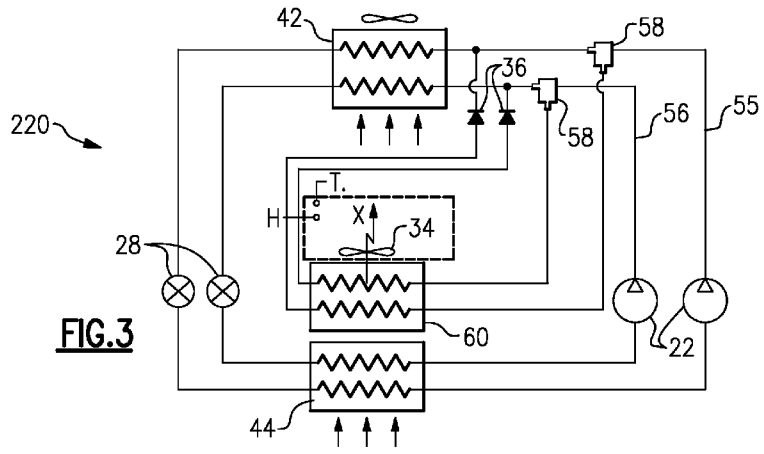


FIG.3

(57) **Abstract**: A refrigerant system has a compressor for compressing and delivering refrigerant to a heat rejecting heat exchanger. Refrigerant from the heat rejecting heat exchanger passes through an expansion device, and then to an evaporator. A reheat circuit includes a reheat valve for selectively tapping refrigerant from a location downstream of the compressor and upstream of the condenser. The reheat refrigerant passes through a reheat heat exchanger, the reheat heat exchanger being positioned to be in a path of air having passed over the evaporator, and delivered into an indoor environment to be conditioned. A control for the refrigerant system is operable to receive inputs from the indoor environment to be conditioned, and to control the several components in the refrigerant system, the control being operable to determine a request for dehumidification provided without any request for significant change in the temperature of the air being delivered into the indoor environment to be conditioned, but said control starting operation of the refrigerant system by enabling cooling mode of operation initially and at least for a short period of time.

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# START-UP FOR REFRIGERANT SYSTEM WITH HOT GAS REHEAT

## BACKGROUND OF THE INVENTION

**[0001]** Refrigerant systems are known and utilized to condition a secondary fluid, such as air to be delivered into a climate-controlled environment. Typically, a compressor compresses a refrigerant and delivers that refrigerant to an outdoor heat exchanger, known as a condenser for subcritical applications and as a gas cooler for transcritical applications. From the outdoor heat exchanger, the refrigerant passes through an expansion device, and then to an indoor heat exchanger, known as an evaporator.

**[0002]** An optional refrigerant system feature is a reheat circuit. In a reheat circuit, a refrigerant is passed through a heat exchanger located downstream in the path of air having passed over an evaporator. A control for the refrigerant system may then control its operation such that the air is initially cooled below a temperature that is desired by an occupant of the environment to be conditioned. This allows the removal of extra moisture from the air. The air then passes downstream over the reheat heat exchanger, and is warmed back to the desired temperature. The reheat circuit provides the ability to provide dehumidification when no or little cooling is required.

**[0003]** One known reheat option is a "hot gas" reheat system. In a hot gas reheat system, the refrigerant flowing through the reheat heat exchanger is tapped from a location intermediate the compressor and the condenser (or gas cooler). In such systems, at times the refrigerant system may need to provide dehumidification without any cooling of the conditioned air stream. Air conditioning systems are generally designed to provide cooling, or sensible capacity, as the primary function. Latent capacity, or dehumidification, usually becomes a by-product of the cooling process. Thus, when a refrigerant system is required to provide only dehumidification, there are some challenges. In particular, the condenser coil may store a higher refrigerant charge amount in a dehumidification mode of operation. Therefore, it will take the refrigerant system a longer period of time to arrive at a steady state operating condition. Further, condensate accumulated on the external surfaces of the evaporator may re-evaporate and be re-introduced into the conditioned space at start-up, thus actually further humidifying air provided to a conditioned environment that the occupant would like to have dehumidified.

[0004] Therefore, it is desired to improve start-up operation of the hot gas reheat system.

## SUMMARY OF THE INVENTION

[0005] In a disclosed embodiment of this invention, a refrigerant system includes a compressor delivering refrigerant to a heat rejecting heat exchanger such as condenser. Refrigerant from the condenser passes through an expansion device and to a heat accepting heat exchanger such as evaporator. A hot gas reheat circuit is incorporated into the refrigerant system to tap refrigerant intermediate the compressor and the condenser. The reheat circuit taps the refrigerant through a reheat heat exchanger which is positioned to be in the path of airflow having passed over the evaporator, and then into an indoor environment to be conditioned.

[0006] In one disclosed embodiment, during start-up, the refrigerant system control operates the refrigerant system in a cooling mode, for a short period of time, even if only a call for dehumidification is present, thus quickly reaching stable operating conditions.

[0007] In another disclosed embodiment, in a multi-circuit refrigerant system, the refrigerant system control controls operation of an adjustable hot gas reheat circuit in both part-load and full-load modes to provide desired temperature and humidity in a conditioned environment. This arrangement allows reducing refrigerant system complexity and charge amount, thus improving refrigerant system reliability.

[0008] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 shows a first schematic.

[0010] Figure 2 shows a second schematic.

[0011] Figure 3 shows a third schematic.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] A refrigerant system 20 is illustrated in Figure 1 having a compressor 22 compressing a refrigerant and delivering it to a heat rejecting heat exchanger (e.g. condenser)

24. From the condenser 24, the refrigerant passes through an expansion device 28, and to a heat accepting heat exchanger, or evaporator 26. A three-way valve 30 selectively taps refrigerant through a reheat heat exchanger 32, and returns it through an optional check valve 36 to a main refrigerant circuit to a refrigerant line leading to the condenser 24. The refrigerant passing through the reheat heat exchanger 32 is controlled by the three-way valve 30 such that the reheat function can be selectively enabled or disabled. This refrigerant passing through the reheat heat exchanger 32 is a hot gas refrigerant vapor. An air-moving device such as fan 34 pulls air over the evaporator 26, and the reheat heat exchanger 32, and then into an indoor environment X to be conditioned. It has to be pointed out that the three-way valve 30 can be substituted by a pair of conventional valves performing the same function.

**[0013]** As mentioned above, at times, the environment to be conditioned X may require only dehumidification such as by initiating dehumidification request through a humidistat H or other similar device. Under such conditions, the temperature within the environment to be conditioned X is within a temperature set point range of a thermostat T or other temperature control. Thus, the refrigerant system 20 would start up to provide dehumidification without any cooling of the air to satisfy the requirements of thermostat T and humidistat H. Challenges such as mentioned above will then surface.

**[0014]** In accordance to the present invention, the refrigerant system control starts operation of the refrigerant system 20 in the cooling mode initially and for at least a short period of time, even under the circumstances when only dehumidification in the conditioned space X is required. In this manner, the refrigerant will be redistributed throughout the refrigerant system 20 and a stable, steady state operating condition can be quickly reached. The cooling mode need only be operated for a short period of time, e.g., on the order of 30 seconds to 5 minutes.

**[0015]** Figure 2 shows a second schematic wherein there are multiple refrigerant circuits 40 and 41 of a multi-circuit refrigerant system 120. The three-way valve 30 and reheat heat exchanger 32 are provided only on the refrigerant circuit 41, which includes a hot gas reheat circuit. A bypass line 48 is provided with a refrigerant flow control device such as valve 50 to selectively bypass the reheat circuit. A further optional refrigerant flow control device such as valve 46 can be placed within the reheat circuit, for instance, on the refrigerant

line between the three-way valve 30 and reheat heat exchanger 32. Only one of the valves 50 and 46 may need to be used in any particular instant of time. Further, each of the valves 46 and 50 may be an ON/OFF or regulating device. In this manner, the amount of refrigerant passing through the reheat heat exchanger can be selectively controlled, allowing a wide range of temperature and humidity levels in a conditioned environment X during part-load and full-load operation. Having the ability to control the amount of refrigerant passing through the reheat circuit provides for precise control over temperature and humidity in the conditioned environment X at a wide spectrum of ambient conditions and thermal load demands. As before, the control for the refrigerant system 120 executes start up in a cooling mode of operation initially and at least for a short period of time.

**[0016]** Figure 3 shows yet another multi-circuit refrigerant system 220 wherein multiple refrigerant circuits 55 and 56 are provided, and with each refrigerant circuit having its own reheat valve 58, passing refrigerant through a reheat heat exchanger 60. In all other aspects, the refrigerant system 220 is similar to the Figure 2 embodiment.

**[0017]** It has to be pointed out that the multi-circuit refrigerant systems of Figure 2 and Figure 3 embodiments may have refrigerant circuits of different sizes and capacities.

**[0018]** In each of the several embodiments of the invention, if a request is made to provide dehumidification without significant cooling for the environment to be conditioned X that would require the system to operate in the reheat mode and activate the reheat function, the refrigerant system will start and operate initially and at least for a short period of time in the cooling mode. In this manner, the refrigerant will be quickly re-distributed throughout the refrigerant system allowing for stable operation and avoiding excessive re-evaporation of the condensate accumulated on external evaporator surfaces that otherwise could result in unduly high levels of humidity of the air being delivered into the environment to be conditioned.

**[0019]** Although an embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

## CLAIMS

What is claimed is:

1. A refrigerant system comprising:

a compressor for compressing and delivering refrigerant to a heat rejecting heat exchanger, refrigerant from the heat rejecting heat exchanger passing through an expansion device, and then to an evaporator;

a reheat circuit including a reheat valve for selectively tapping refrigerant from a location downstream of the compressor and upstream of the heat rejecting heat exchanger, and the tapped refrigerant passing through a reheat heat exchanger, the reheat heat exchanger being positioned to be in a path of air having passed over the evaporator, and to be delivered into an indoor environment to be conditioned; and

a control for the refrigerant system, the control being operable to receive inputs from the indoor environment to be conditioned, and to control the refrigerant system, the control being operable to determine a request for dehumidification provided without any request for significant change in temperature of the air being delivered into the indoor environment to be conditioned, and said control starting operation of the reheat mode of operation by initiating cooling mode of operation at least for a short period of time in response to such a request.

2. The refrigerant system as set forth in claim 1, wherein there is a single refrigerant circuit.

3. The refrigerant system as set forth in claim 1, wherein there are at least two refrigerant circuits incorporated into the refrigerant system.

4. The refrigerant system as set forth in claim 3, wherein at least one of the refrigerant circuits is not provided with a reheat circuit.

5. The refrigerant system as set forth in claim 3, wherein at least one refrigerant flow control device is provided to control the amount of refrigerant passing through the reheat heat exchanger.

6. The refrigerant system as set forth in claim 1, wherein the short period of time is greater than thirty seconds, and less than five minutes.

7. The refrigerant system as set forth in claim 3, wherein the at least two refrigerant circuits have different capacities.

8. A method of operating a refrigerant system including the steps of:

receiving a request for dehumidification without any request for significant change in the temperature of the air being delivered into the indoor environment to be conditioned, and starting operation of a refrigerant system by enabling the reheat mode of operation by initiating cooling mode of operation at least for a short period of time in response to such a request.

9. The method as set forth in claim 8, including the step of controlling the amount of refrigerant passing through a reheat heat exchanger.

10. The method as set forth in claim 8, wherein the short period of time is greater than thirty seconds, and less than five minutes.

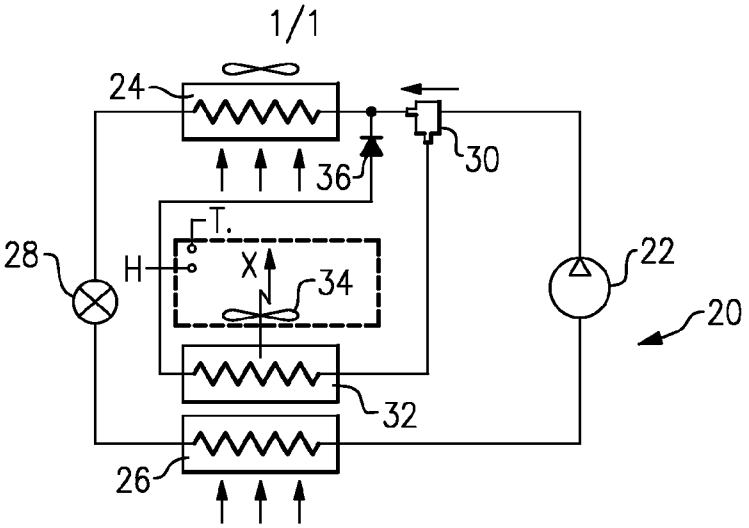


FIG.1

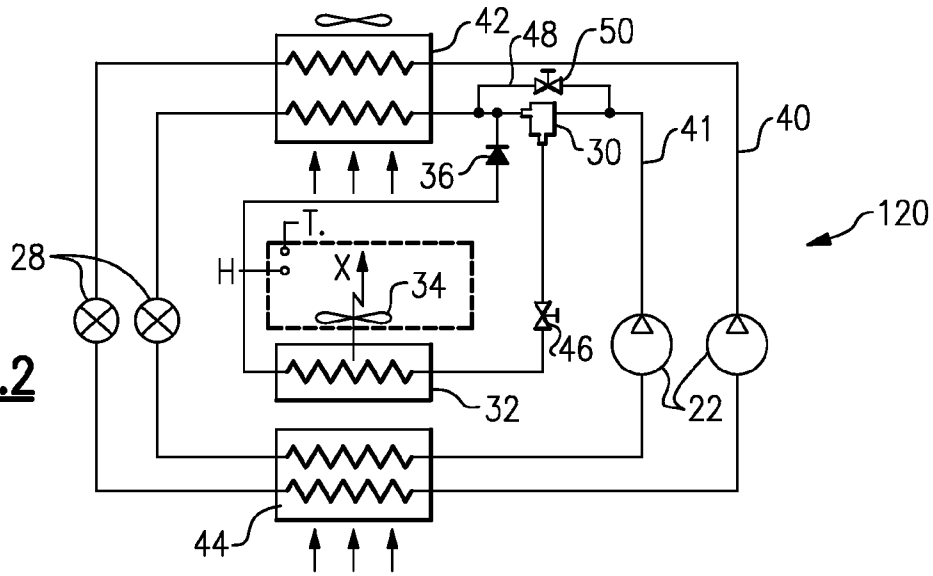


FIG.2

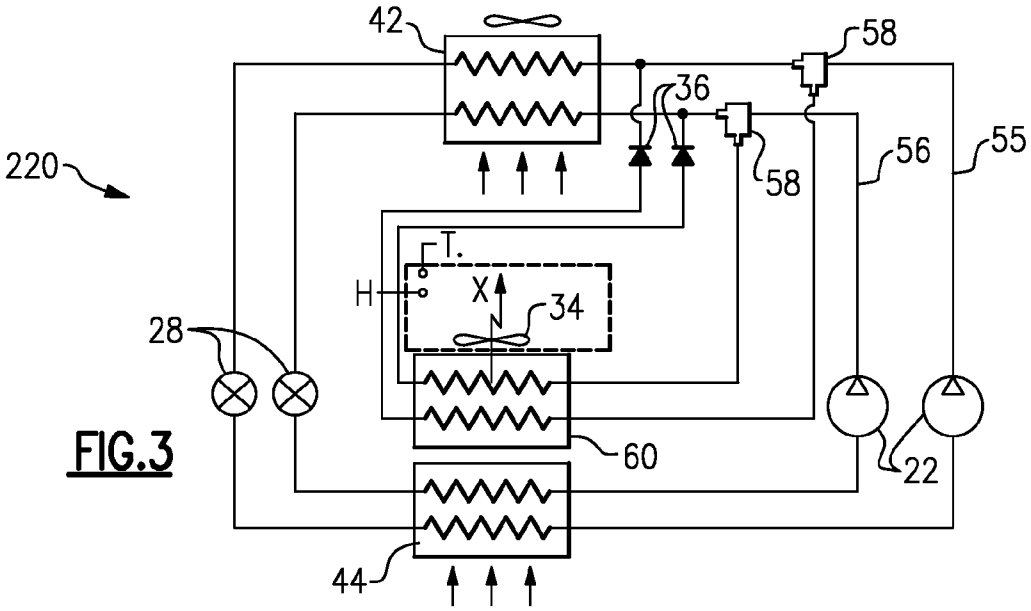


FIG.3