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**Taras**(10) **Pub. No.: US 2011/0154837 A1**(43) **Pub. Date: Jun. 30, 2011**(54) **REFRIGERANT SYSTEM WITH ADAPTIVE  
HOT GAS REHEAT****Publication Classification**(76) Inventor: **Michael F. Taras, Fayetteville, NY  
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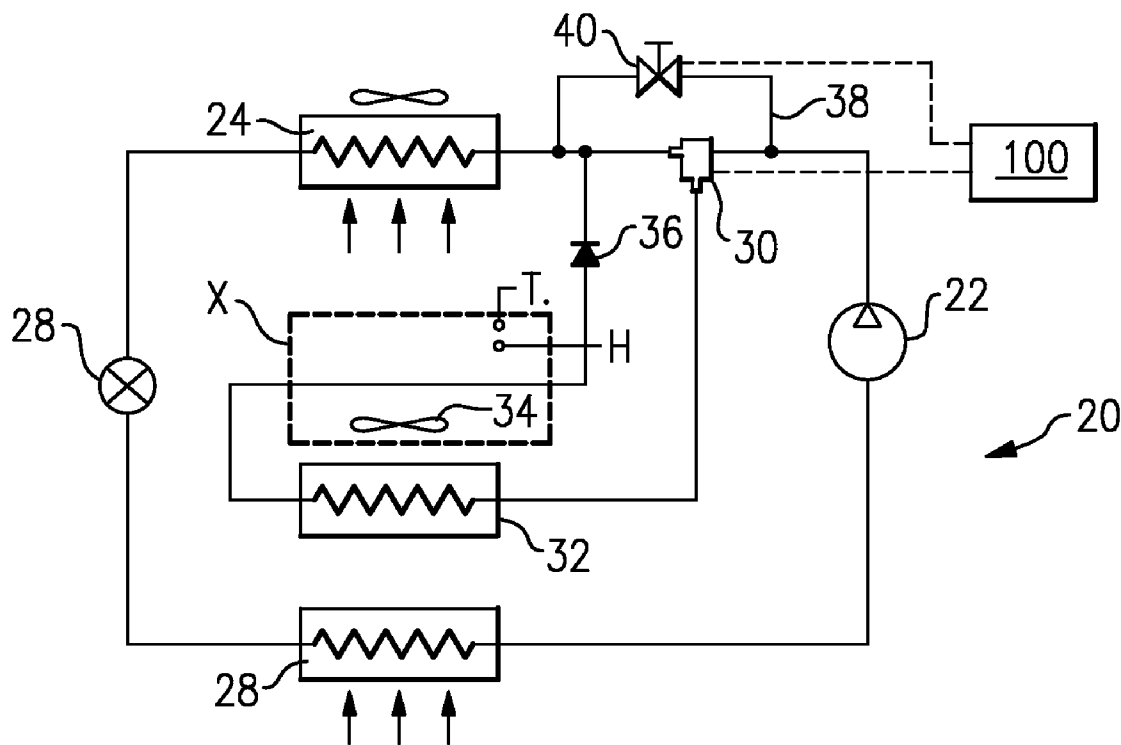
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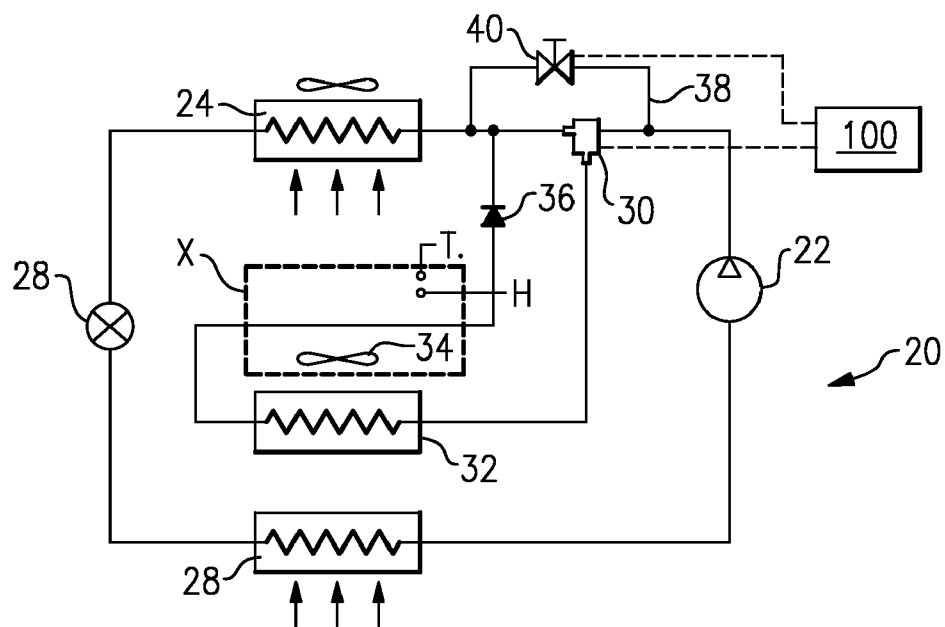
(2), (4) Date: **Feb. 22, 2011**(57) **ABSTRACT**

A refrigerant system incorporates a hot gas reheat circuit. The hot gas reheat circuit includes a reheat valve for selectively tapping at least a portion of refrigerant from a location downstream of a compressor and upstream of a condenser, and through a reheat heat exchanger. At least one refrigerant flow control device controls the amount of refrigerant passing through the reheat heat exchanger. A control for the refrigerant system is operable to receive inputs from an indoor environment, and to control the amount of refrigerant passing through the reheat heat exchanger to achieve desired temperature and humidity in the conditioned environment.

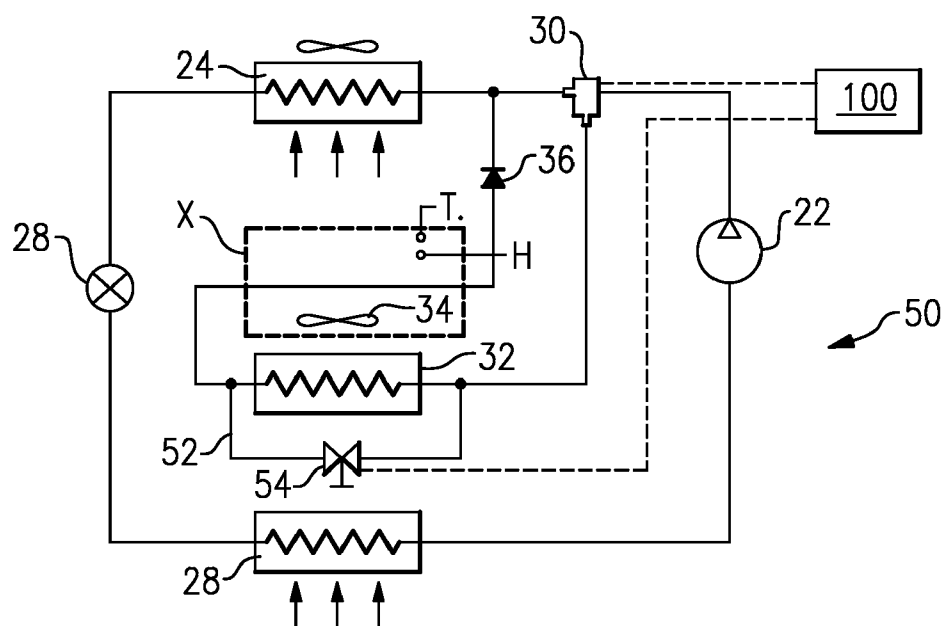
**Related U.S. Application Data**

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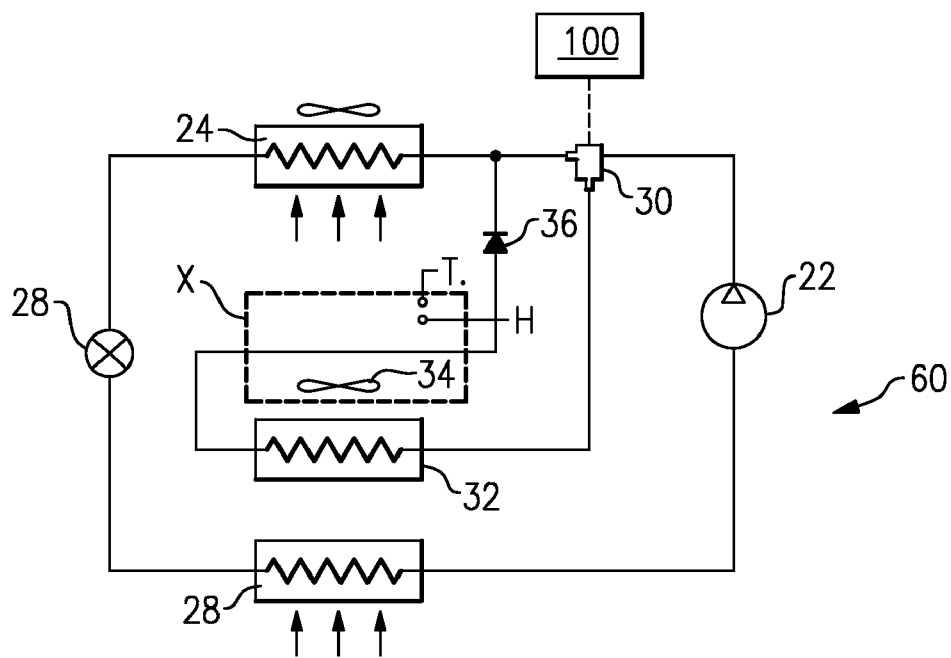




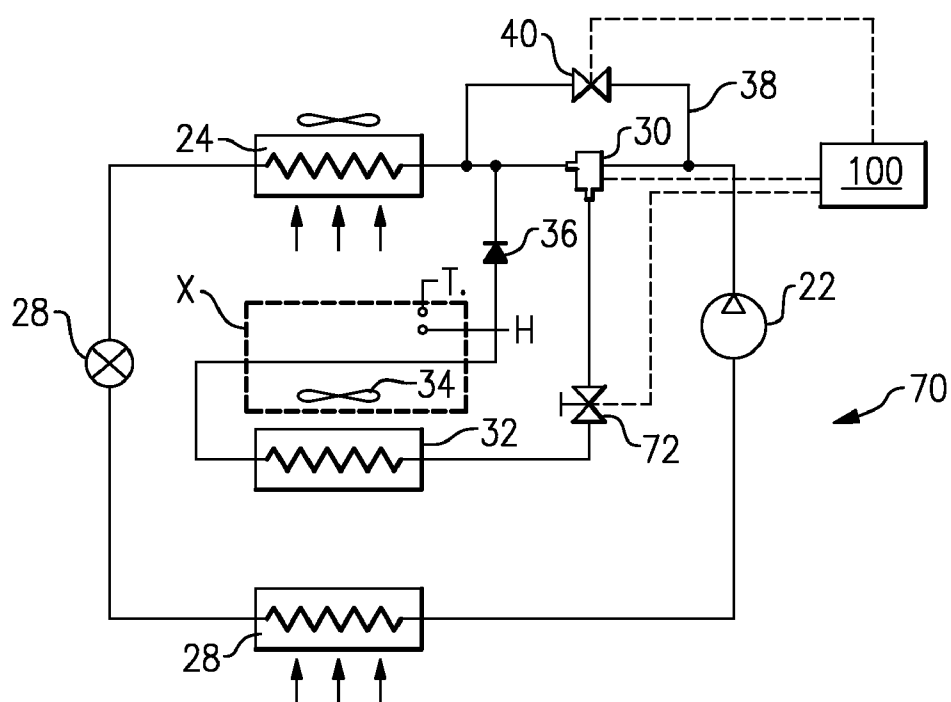
**FIG. 1**



**FIG.2**



**FIG. 3**



**FIG. 4**

## REFRIGERANT SYSTEM WITH ADAPTIVE 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 the evaporator operation such that it will initially cool the air 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 refrigerant system incorporating a reheat circuit provides the ability to remove additional moisture from the air stream, when dehumidification is desired and 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 passed through the reheat heat exchanger is tapped from a location intermediate the compressor and the condenser or a gas cooler (the outdoor heat exchanger will be referred to as a condenser throughout the text). In such systems, at times the refrigerant system may be called on to provide dehumidification without any cooling being provided for the air. Air conditioning systems are generally designed to provide cooling, or sensible capacity, as the primary function. They are not typically designed to provide latent capacity, and dehumidification is typically a by-product of the cooling process. Thus, when a system is called upon to provide only dehumidification, there are some challenges present for a refrigerant system designer.

**[0004]** Refrigerant systems having hot gas reheat circuits have been somewhat inflexible in providing strictly latent capacity, or dehumidification into an air stream supplied into a conditioned environment. The refrigerant systems have easily provided neutral air temperature only at a single design point, while providing sensible (cooling or heating) at all other off-design conditions. Thus, these refrigerant systems have been somewhat lacking design flexibility in satisfying comfort requirements in a climate-controlled environment and causing discomfort to an occupant of a conditioned space. Therefore, there is a need for adaptive reheat systems, and hot gas reheat systems in particular, which would meet both temperature and humidity demands at a variety of environmental conditions and internal/external thermal loads.

### SUMMARY OF THE INVENTION

**[0005]** A refrigerant system has a compressor for compressing and delivering refrigerant to a condenser. Refrigerant from the condenser passes through an expansion device, and then to an evaporator. A reheat circuit includes a reheat valve for selectively tapping at least a portion of refrigerant from a location downstream of the compressor and upstream of the condenser. The reheat refrigerant passes through a

reheat heat exchanger positioned to be in a path of air having passed over the evaporator, and to be delivered into an indoor environment to be conditioned. At least one refrigerant flow control device such as valve is included to control the amount of refrigerant passing through the reheat heat exchanger. A control for the refrigerant system is operable to receive inputs regarding conditions of the indoor environment, and to control the at least one valve to achieve a desired amount of dehumidification in the indoor environment.

**[0006]** 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

**[0007]** FIG. 1 shows a first circuit schematic.

**[0008]** FIG. 2 shows a second circuit schematic.

**[0009]** FIG. 3 shows a third circuit schematic.

**[0010]** FIG. 4 shows a fourth circuit schematic.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

**[0011]** FIG. 1 shows a typical refrigerant system **20** having a compressor **22** delivering a compressed refrigerant to an outdoor heat exchanger, or a condenser, **24**. Refrigerant from the condenser **24** passes through an expansion device **28**, and through an indoor heat exchanger, or evaporator, **26**. Refrigerant from the evaporator **26** returns to the compressor **22**. A hot gas reheat circuit is incorporated into the refrigerant system **20**, and includes a refrigerant flow control device such as three-way valve **30** for selectively diverting refrigerant through a reheat heat exchanger **32**. It has to be noted that the three-way valve may be replaced by a pair of conventional valves. A fan **34** pulls air over the evaporator **26**, and then over the reheat heat exchanger **32**, into an indoor environment to be conditioned **X**. An occupant of the indoor environment **X** may request temperature adjustment or/and dehumidification by a control such as thermostat **T** and humidistat **H**.

**[0012]** As typically incorporated in prior art systems, the three-way valve **30** is operable to either send the entire refrigerant flow through the reheat heat exchanger **32**, or bypass it. It is typically not able to modulate or vary the amount of refrigerant through the reheat circuit. Thus, such refrigerant systems have to run in a “digital” mode to satisfy thermal load demands in the conditioned space **X** and are inflexible in operation and control, as mentioned above.

**[0013]** In the refrigerant system **20**, a refrigerant bypass line **38** and an associated refrigerant flow control device such as valve **40**, selectively bypass at least some amount of refrigerant around the reheat circuit, in the reheat mode of operation. A control **100** for the refrigerant system can achieve precise dehumidification, or latent conditioning, of air delivered to the indoor environment **X**, with or without any appreciable temperature change, by controlling the exact amount of refrigerant which passes through the reheat heat exchanger **32**, in relation to the amount of refrigerant passing through the evaporator **26**. A worker of ordinary skill in the art would recognize how the controlled amount of refrigerant that passes through the reheat heat exchanger **32** would achieve this desired air conditioning (temperature and humidity). The air would be overcooled in the evaporator **26** to remove the desired amount of moisture from the air stream and obtain the required humidity level, and then would be heated back toward the target temperature by the refrigerant flowing

through the reheat heat exchanger 32. For instance, by controlling a precise amount of refrigerant passing through the reheat heat exchanger 32, the designer will be able to achieve the desired dehumidification with little or no temperature change. The valve 40 could be, for example, a simple on/off solenoid valve controlled by one of pulse width modulation techniques or a regulating valve with an adjustable opening controlled by a stepper motor.

[0014] A control 100 that operates the valves 30 and 40, and may be a general control for the refrigerant system 20. Control 100 takes in signals from thermostat T and humidistat H (or any equivalent devices) and controls the refrigerant system 20, at least in part based on these inputs. A worker ordinarily skilled in the art will be able to provide an appropriate design and control sequence based upon the disclosure of this invention.

[0015] FIG. 2 shows an alternative embodiment, wherein the refrigerant bypass line 52 includes a valve 54, and selectively bypasses just the reheat heat exchanger 32, rather than the entire reheat circuit. In this arrangement, in the reheat mode of operation, the entire refrigerant flow will pass through the reheat circuit, while at least a portion of the refrigerant flow could be selectively bypassed around the reheat heat exchanger 32. Again, the valve 54 may be an on/off valve or an adjustable regulating valve. As above, the amount of refrigerant passing through the reheat heat exchanger 32 would be varied to achieve precise control of the refrigerant system 50 to satisfy temperature and humidity requirements in the conditioned environment X.

[0016] FIG. 3 shows a refrigerant system 60 wherein the three-way valve 30 is actually a regulating valve. In other words, the conventional three-way valve of FIGS. 1 and 2 is combined with the valve 40 or 54 respectively. The amount of refrigerant diverted by the valve 30 into the reheat heat exchanger 32 can be precisely controlled by one of modulation or pulsation techniques (depending on the valve type). Again, the control of the amount of refrigerant passing through the reheat exchanger 32 will in turn result in precise control of the temperature and humidity in the indoor environment X.

[0017] FIG. 4 shows a refrigerant system 70, wherein a regulating (through pulsation or modulation) valve 72 is incorporated into the reheat circuit, for instance, on a refrigerant line downstream of the three-way valve 30 and leading to the reheat heat exchanger 32. Other locations with the reheat circuit are also feasible. The reheat circuit bypass line 38 and another regulating valve 40 positioned on the bypass line 38 are also included. This embodiment would allow even higher degree of operational flexibility for the refrigerant system 70 and precise control over temperature and humidity in the conditioned environment X. Furthermore, various combinations of the FIG. 1-4 embodiments are also feasible and within the scope of the invention.

[0018] 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.

What is claimed is:

1. A refrigerant system comprising:

a compressor for compressing and delivering refrigerant to a heat rejection heat exchanger, refrigerant from the heat

rejection heat exchanger passing through an expansion device, and then to a heat accepting heat exchanger;

a reheat circuit including a reheat valve for selectively tapping at least a portion of refrigerant from a location downstream of the compressor and upstream of the heat rejection heat exchanger, and through a reheat heat exchanger, the reheat heat exchanger being positioned to be in a path of air having passed over the heat accepting heat exchanger, and to be delivered into an indoor environment to be conditioned, a refrigerant flow control device to selectively control the amount of refrigerant passing through said reheat heat exchanger; and

a control for the refrigerant system, the control being operable to receive inputs from the conditioned environment, and to control said refrigerant flow control device to achieve desired temperature and humidity in the conditioned environment.

2. The refrigerant system as set forth in claim 1, wherein the refrigerant flow control device is a second valve that controls the amount of refrigerant passing through the reheat heat exchanger.

3. The refrigerant system as set forth in claim 2, wherein the second valve is provided within the reheat circuit downstream of said reheat valve.

4. The refrigerant system as set forth in claim 2, wherein the second valve is provided on a bypass line bypassing said reheat circuit.

5. The refrigerant system as set forth in claim 2, wherein the second valve is positioned on a bypass line bypassing said reheat heat exchanger.

6. The refrigerant system as set forth in claim 2, wherein the second valve is controlled by at least one of pulsation or modulation technique to achieve precise control over the amount of refrigerant passing through the reheat heat exchanger.

7. The refrigerant system as set forth in claim 2, wherein there are two of said second valves, with one valve positioned on a bypass line bypassing said reheat circuit, and another valve positioned within the reheat circuit downstream of said reheat valve.

8. The refrigerant system as set forth in claim 1, wherein said refrigerant flow control device is said reheat valve precisely controlling the amount of refrigerant passing through said reheat heat exchanger.

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

providing a reheat circuit of a refrigerant system including a reheat valve for selectively tapping at least a portion of refrigerant from a location downstream of a compressor and upstream of a heat rejection heat exchanger, and controlling the amount of refrigerant passing through said reheat heat exchanger based upon inputs from an indoor environment to be conditioned to provide precise control over temperature and humidity within the conditioned environment.

10. The method as set forth in claim 9, wherein a second valve controls the amount of refrigerant passing through the reheat heat exchanger.

11. The method as set forth in claim 10, wherein the second valve is provided within the reheat circuit downstream of said reheat valve.

**12.** The method as set forth in claim **10**, wherein the second valve provides bypass around said reheat circuit.

**13.** The method as set forth in claim **10**, wherein the second valve provides bypass around said reheat heat exchanger.

**14.** The method as set forth in claim **10**, wherein the second valve is controlled by at least one of pulsation or modulation

technique to achieve precise control over the amount of refrigerant passing through the reheat heat exchanger.

**15.** The method as set forth in claim **9**, wherein said reheat valve is a regulating valve that precisely controls the amount of refrigerant passing through said reheat heat exchanger.

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