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(54) **Ultra low temperature heat pump system with secondary refrigerant injection mechanism**

(57) An ultra low temperature heat pump system with secondary refrigerant injection mechanism is disclosed which comprising a compressor, a condenser, a reservoir tank, a thermal expansion valve, a vaporizer and a separator, sequentially connected to form a circulation loop, an air refill device I provided between the compressor

and the reservoir tank, which is constructed of an injection valve, an economizer, a first solenoid valve and a second solenoid valve. The two solenoid valves are arranged in parallel with the first solenoid valve connected directly to the compressor and the second solenoid valve connects sequentially to the injection valve and the economizer. The economizer is then connected to the compressor.

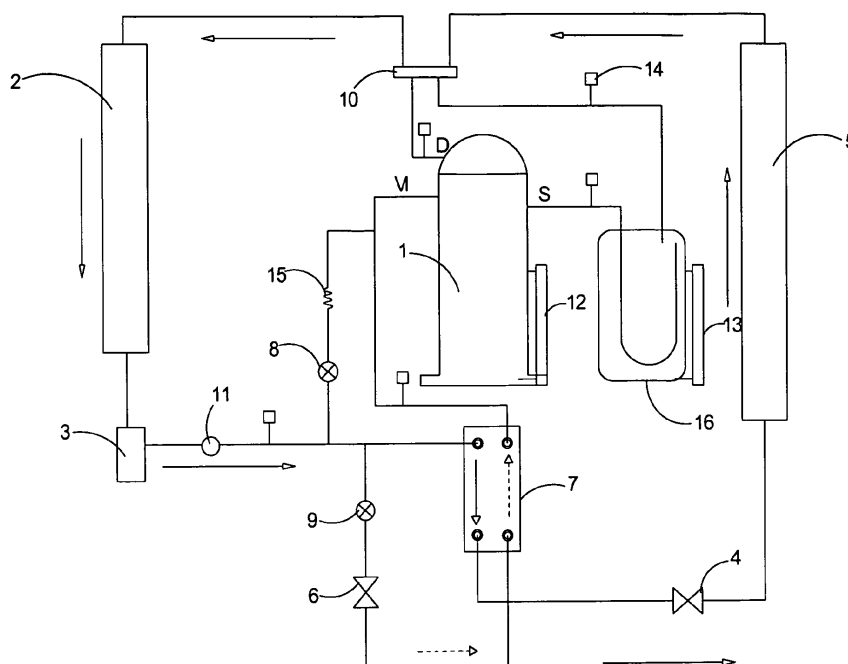


Fig 1

Description

Technical Field

[0001] The invention relates to air conditioning systems and particularly relates to an ultra low temperature heat pump system with secondary air injection mechanism.

Background technology

[0002] Today, the working temperature of conventional air source heat pumps is normally in the range of -7 to 43 degree Celsius. In the low temperature areas such as the northern part of this country however heat pumps of this kind can not working properly due to the low ambient temperature, therefore, there is a need for an improved heat pump with expanded working temperature range in the art.

Summary of the invention

[0003] An object of the invention is to provide an ultra low temperature heat pump system with secondary air injection mechanism, which is novel in structure and utility, utilizes air refilling technique whereby the range of the working temperature of the compressor is expanded and the stability as well as efficiency of the heat pump is improved.

[0004] According to one aspect of the invention, an ultra low temperature heat pump system with secondary air injection mechanism is provided which comprises a compressor, a condenser, a reservoir tank, a thermal expansion valve, a vaporizer and a separator connected sequentially to form a circulation loop. An air refill device is provided between the compressor and the reservoir tank which comprises an injection valve, an economizer, a first solenoid valve and a second solenoid valve; the two solenoid valves are arranged in parallel with the first solenoid valve connected to the compressor directly and the second solenoid valve connected to the injection valve and the economizer sequentially, the economizer is then connected to the compressor.

[0005] Preferably and additionally, the compressor is provided with an air refilling inlet to which the first solenoid valve and the economizer are connected.

[0006] Preferably and additionally, the economizer is a dual loop plate heat exchanger in which the respective ends of one loop is connected to the injection valve and the air refilling inlet, the respective ends of the other loop is connected to the reservoir tank and the thermal expansion valve.

[0007] The ultra low temperature heat pump system of the invention is advantageous in that by providing the air refilling device, the working temperature of the heat pump is greatly expanded, i.e., the compressor can work normally above an ambient temperature as low as -30 Celsius. Compared with the conventional heat pumps,

the heat pump in this invention has improved working stability and high efficiency and therefore can be used in the low temperature areas.

5 Description of the drawings

[0008] Figure 1 is a schematic illustration of the heat pump according to one embodiment of the invention.

10 Description of the preferred embodiments

[0009] The invention will now be described further in details with reference to the drawing as accompanied.

[0010] In one embodiment of the invention according to figure 1, an ultra low temperature heat pump system with secondary air injection mechanism is provided, the system comprises a compressor 1, a condenser 2, a reservoir tank 3, a thermal expansion valve 4, a vaporizer 5 and a separator 16, which are sequentially connected to form a circulation loop. An air refill device is provided between the compressor 1 and the reservoir tank 3, which is comprised of an injection valve 6, an economizer 7, a first solenoid valve 8 and a second solenoid valve 9; the two solenoid valves are arranged in parallel with the first solenoid valve 8 connected to the compressor 1 directly and the second solenoid valve 9 connected to the injection valve 6 and the economizer 7 sequentially, the economizer 7 is then connected to the compressor 1.

[0011] In this embodiment, the compressor 1 is provided thereon an air refilling inlet VI to which the first solenoid valve 8 and the economizer 7 are connected. The economizer 7 is preferably a dual loop plate heat exchanger in which the two ends of one loop is connected to the injection valve 6 and the air refilling inlet respectively and the two ends of the other loop is connected to the reservoir tank 3 and the thermal expansion valve 4 respectively. A four way valve 10 is provided through which the discharge port D of the compressor 1 is connected to the condenser 1, also by the four way valve, the vaporizer 5 is connected to and through the separator 16 to the suction port S of the compressor 1. The compressor 1 and the separator 16 are provided with respective sight glass 12, 13 for viewing the status of the working medium circulated therethrough. The heat pump is also provided with a plurality number of pressure monitoring port. Capillary tube 15 is provided between the first solenoid valve 8 and the compressor 1, i.e. if the primary injection realized by injection valve 6 is insufficient, the first solenoid valve 8 is activated and a secondary injection by the capillary tube is realized whereby the discharge temperature of the compressor is controllable and adjustable.

[0012] The ultra low temperature heat pump system with secondary air injection mechanism is operating in the following manner:

1) the coolant is compressed in the compressor 1 to the high temperature and high pressure state, which

is then transported through the discharge port D of the compressor 1 and through the four way valve into the condenser 2 for heat exchanging. During the heat exchange process it is transformed into liquid with moderate temperature and high pressure and is discharged by the condenser 2 to the reservoir tank 3.

2) the coolant flow from the reservoir tank 3 is transported through the sight glass 11, and then through the economizer 7 for heat exchange, to the thermal expansion valve 4 and then flow into and through the vaporizer 5 and the separator 16 back through the refilling inlet to the compressor 1.

(3) when the pressure in the compressor 1 is below the working pressure, the coolant remained can be throttled by the first solenoid valve 8; after passing through the second solenoid valve 9; the coolant is throttled and injected by the injection valve 6 into high temperature low pressure gaseous flow in which a small amount of liquid resides, the flow is then forced into the economizer 7 for heat exchanging by which the liquid portion is vaporized and forced into the refilling inlet of the compressor 1 for gas refilling.

[0013] Although the preferred embodiments of the invention are explained in detail, it is to be understood that other embodiments are contemplated. Accordingly, it is not intended that the invention is limited in the scope to the details of construction and arrangement of components. The invention is capable of other embodiments and of being practiced or carried out in various ways.

Claims

1. An ultra low temperature heat pump system with secondary air injection mechanism, comprising a compressor (1), a condenser (2), a reservoir tank (3), a thermal expansion valve (4), a vaporizer (5) and a separator (16) which are connected sequentially to form a circulation loop, **characterized in that** a air refill device is arranged between the compressor (1) and the reservoir tank (3) which comprising a injection valve (6), a economizer (7), a first solenoid valve (8) and a second solenoid valve (9) with the two solenoid valves arranged in parallel in which the first solenoid valve (8) is connected to the compressor (1) directly and the second solenoid valve (9) connected to the injection valve (6) and the economizer (7) sequentially, the economizer (7) is then connected to the compressor (1).
2. The ultra low temperature heat pump system with secondary air injection mechanism according to claim 1 **characterized in that** the compressor (1) is provided with an air refilling inlet to which the first solenoid valve (8) and the economizer (7) is con-

nected.

3. The ultra low temperature heat pump system with secondary air injection mechanism according to claim 2 **characterized in that** the economizer (7) is a dual loop plate heat exchanger with the respective ends of one loop connected to the injection valve (6) and the air refilling inlet, and the respective ends of the other loop connected to the reservoir tank (3) and the thermal expansion valve (4).
4. The ultra low temperature heat pump system with secondary air injection mechanism according to any of 1 to 3, **characterized in that** the outlet of the compressor (1) is connected to a four way valve through which the compressor (1) is connected to the condenser (2), and the vaporizer (5) is connected to the separator (16), the separator (16) is then connected to the air refilling inlet.

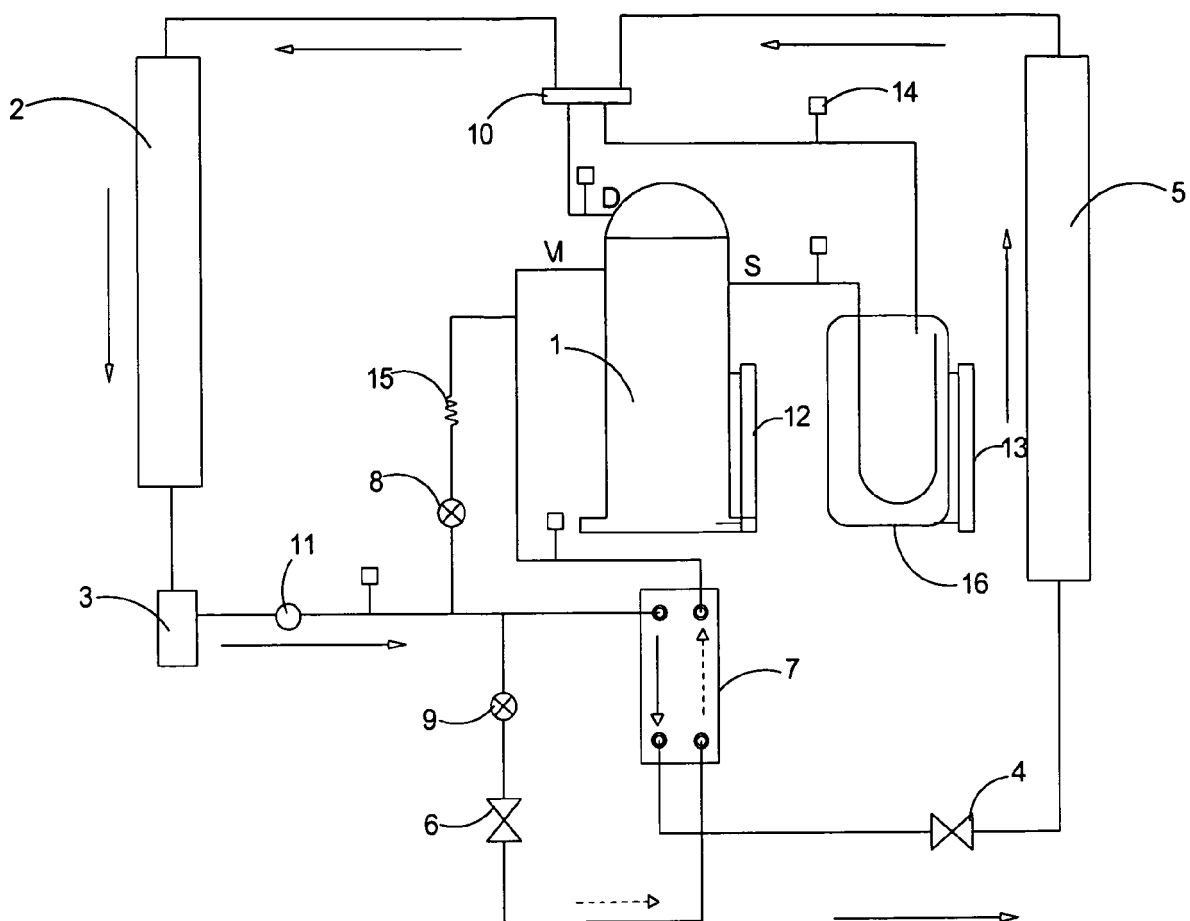


Fig 1