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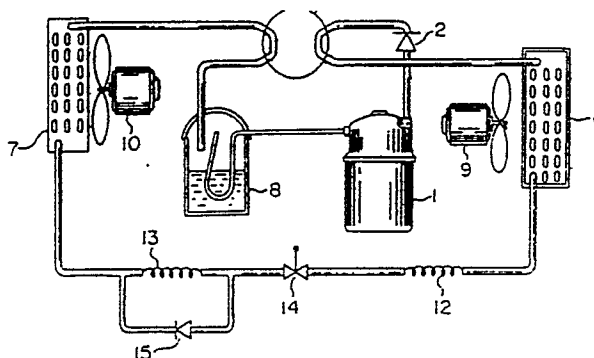
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54 **Refrigeration cycle apparatus.**

57 Refrigeration cycle apparatus comprising: a compressor (1), a condenser (4), an expansion means (12,13) and an evaporator (7) connected in series with each other; means for repeatedly starting and stopping said compressor (1); and means (2,14) for isolating refrigerant on a high pressure side of said compressor (1) from said refrigerant on a low pressure side of said compressor (1) when compressor (1) is stopped characterised in that said expansion means comprises at least two capillary tube portions (12,13) and in that valve means (15) is connected across one portion (13) whereby the effective length of said expansion means may be changed.



REFRIGERATION CYCLE APPARATUS

The present invention relates to refrigerant cycle apparatus comprising: a compressor, a condenser, an expansion means and an evaporator connected in series with each other; means for repeatedly starting and stopping said compressor; and means for isolating refrigerant on a high pressure side of said compressor from said refrigerant on a low pressure side of said compressor when said compressor is stopped

Such apparatus is known from US-A-3093976.

One conventional refrigeration cycle apparatus includes a compressor, a condenser, an expansion device such as a capillary tube or an expansion valve, and an evaporator with these components sequentially coupled in series with each other. When the compressor is stopped, the pressure of the refrigerant on a high pressure side is balanced with the pressure of the refrigerant on the low pressure side. As the compressor is started, the difference between the pressures of the high pressure side and the low pressure side is gradually increased until the apparatus is brought to an ordinary operating state. When the compressor is accordingly repeatedly started and stopped, the high pressure side refrigerant is balanced with the low pressure side refrigerant each time the apparatus is stopped. During these times, the refrigerant liquid stored on the low pressure side in an evaporator is drawn into the compressor. The presence of the liquid refrigerant in the condenser increases the load on the compressor at the time of restarting the compressor. This lowers the coefficient of performance (hereinafter abbreviated as "COP") of the apparatus as compared with that during continuous operation.

This problem is mitigated by the apparatus described in US-A-3093976, but when the refrigeration cycle apparatus is used in an air temperature conditioning system capable of operating in both cooling and heating modes the refrigerant flow must be reversible. Conventional apparatus of this type is relatively expensive to manufacture and is relatively large.

An object of the invention is to simplify the construction of such apparatus thus enabling less expensive manufacture and reduction in size.

Another object of the invention is to enable the expansion coefficient of the apparatus to be varied between the heating and cooling modes in a simple manner.

According to the invention, the apparatus defined in the first paragraph of this specification is characterised in that said expansion means comprises at least two capillary tube portions and in that valve means is connected across one portion whereby the effective length of said expansion means may be changed.

The foregoing objects and other objects as well as the characteristic features of the invention will become more apparent and more readily understandable by the following description and the appended claims when read in conjunction with the accompanying drawings, the sole Figure of which is a schematic structural view showing a preferred embodiment of refrigeration cycle apparatus of the invention.

Reference is now made to the drawing showing a preferred embodiment of the refrigeration cycle apparatus, constructed according to the invention. Reference numeral 1 designates generally a compressor. A refrigerant gas compressed at high temperature and high pressure by the compressor 1 is fed through a check valve 2 and a four-way valve 3 into a condenser 4. The refrigerant dissipates heat in the condenser 4 and is condensed to a high temperature and high pressure liquid. The refrigerant liquid, increased in temperature and pressure by the condenser 4, is passed through a capillary tube 12 where the refrigerant becomes a low temperature, low pressure liquid and a switching element 14 which acts as a valve and from there is introduced into an evaporator 7. The low temperature and low pressure refrigerant liquid in the evaporator 7 absorbs heat and thus evaporates to a gas. This refrigerant gas is again fed through the four-way valve 3 into an accumulator 8 which isolates the refrigerant liquid which cannot be evaporated in the evaporator 7 and is retained in the liquid state and which returns only the refrigerant gas again to the compressor 1. While the compressor 1 is operating, the apparatus repeats the refrigeration cycle.

Reference numeral 9 illustrates a fan for the condenser 4 and 10 a fan for the evaporator 7. The four-way valve 3 is a change-over or switching valve which operates so that the condenser 4 can be used as an evaporator and the evaporator 7 used as a condenser.

When this refrigeration cycle apparatus is used in a room air temperature conditioning system, the evaporator 7 is used as an indoor side heat exchanger, and the condenser 4 is used as an outdoor side heat exchanger. In the illustrated cooling mode, the apparatus is operated in a refrigeration

cycle which in the heating mode is switched by the four-way valve 3 so that the indoor side heat exchanger 7 is used as a condenser and the outdoor side heat exchanger 4 is used as an evaporator.

The air temperature conditioning system operates to detect the temperature in the room by a temperature detector or thermostat (not shown) and to start or stop the compressor 1 so as to maintain the room temperature at a set temperature by operating or stopping the refrigeration cycle apparatus.

The switching element 14, which isolates the compressor 1, is constructed so as to open when the compressor 1 is started and to close when the compressor 1 is stopped. The element 14 and the check valve 2 function to isolate high pressure side refrigerant and low pressure side refrigerant when the compressor 1 is stopped.

In this refrigeration cycle apparatus used in an air temperature conditioning system as described above, when the compressor 1 is repeatedly started and stopped to maintain the room temperature at a set value, the element 14 is simultaneously opened and closed. Since the element 14 is closed when the compressor 1 is stopped, the high temperature and high pressure refrigerant liquid in the condenser 4 does not flow into the capillary tubes 12, 13 and accordingly does not flow into the evaporator 7. On the other hand, since the check valve 2 is provided at the exhaust side of the compressor 1, the refrigerant gas in the condenser 4 and the condensed refrigerant liquid cannot return to the compressor 1.

When the compressor 1 is restarted, the high pressure side refrigerant in the refrigeration cycle is isolated from the low pressure side refrigerant. Since the element 14 is then opened, a desired pressure difference between the high and low pressure side refrigerant can be attained in short time and the apparatus can reach ordinary operating state in short time.

The conventional refrigerant cycle not incorporating such an isolating device requires about five minutes to reach the ordinary operation state after restarting. On the other hand, the refrigeration cycle apparatus of the invention requires only about one minute and twenty seconds to make the transition.

It is noted that the aforesaid switching element 14 may be a solenoid valve 5 or another type of switching valve and may be any type which closes when the compressor 1 is stopped and opens when the compressor 1 is started.

There is also provided a further capillary tube 13 in parallel with a check valve 15 which is constructed to pass the refrigerant in the illustrated cooling mode and to block the refrigerant in the non-illustrated heating mode with the valve 3

switched to its other position. The check valve 15 is provided to effectively alter the length of the total capillary tube 12, 13 since the apparatus will operate more efficiently if the expansion coefficient of the refrigerant is varied between the cooling mode and the heating mode in such a manner that the capillary tube is effectively increased in length in the heating mode.

With two capillary tubes 12 and 13 used instead of an expansion valve, the apparatus can be inexpensively constructed, even if the check valve 15 is added.

The switching element 14 is constructed to compare the pressure P_2 , determined by the output side refrigerant gas temperature of the evaporator 7 as detected by a heat sensitive tube provided between the outlet of the evaporator 7 and the inlet of the compressor 1, with the pressure P_1 of the refrigerant exhausted from the capillary tube 12, and to open when $P_2 > P_1$ and to close when $P_2 < P_1$, in the same manner as described above.

Claims

1. Refrigeration cycle apparatus comprising: a compressor (1), an condenser (4), an expansion means (12,13) and an evaporator (7) connected in series with each other; means for repeatedly starting and stopping said compressor (1); and means (2,14) for isolating refrigerant on a high pressure side of said compressor (1) from said refrigerant on a low pressure side of said compressor (1) when said compressor (1) is stopped, characterised in that said expansion means comprises at least two capillary tube portions (12,13) and in that valve means (15) is connected across one portion (13) whereby the effective length of said expansion means may be changed.

2. Apparatus according to claim 1 wherein said valve means comprises a check valve (15).

3. Apparatus according to claim 1 or 2 wherein said effective length is increased in a heating mode.

4. Apparatus according to any one of the preceding claims wherein said isolating means comprises a switching element (14) provided between said capillary tube portions (12,13) and arranged to close fully when said compressor (1) is stopped and to open fully when said compressor (1) is started.

