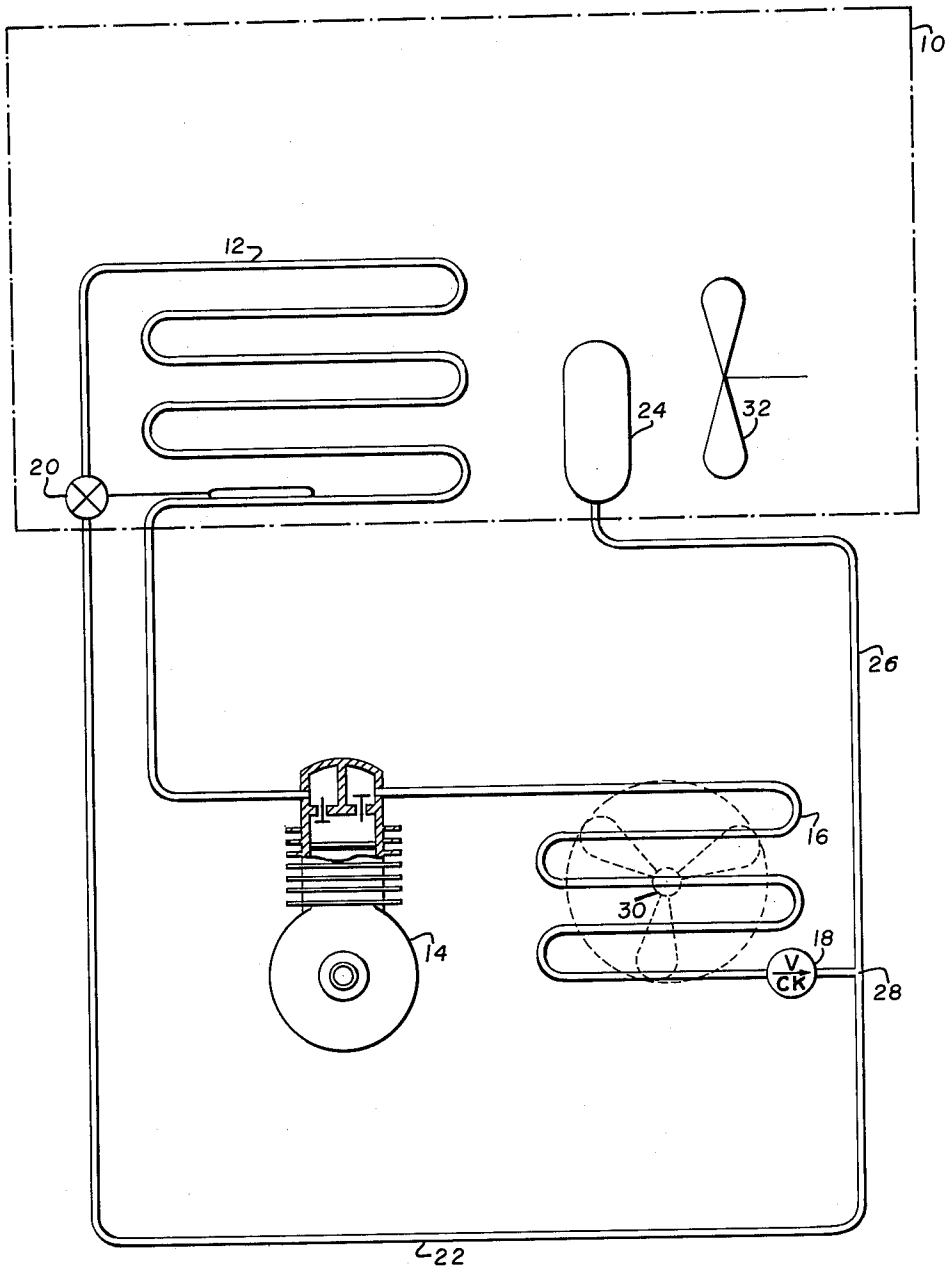
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CONTROL MEANS INCLUDING AN ACCUMULATOR FOR REFRIGERATION APPARATUS

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CONTROL MEANS INCLUDING AN ACCUMULATOR FOR REFRIGERATION APPARATUS

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This invention relates to control means for refrigerant circuits. More specifically our invention relates to an improvement in refrigeration systems employing an accumulator disposed in heat exchange relation with the conditioned space and being connected to the liquid leg of a refrigerant circuit.

The instant invention involves improvements in refrigeration apparatus for conditioning a space comprising a refrigerant evaporator disposed in heat exchange relation with the conditioned space; a refrigerant compressor; an air cooled refrigerant condenser; refrigerant throttling means; a refrigerant circuit connecting the evaporator, compressor, condenser and throttling means in series in a closed circuit; and an accumulator disposed in heat exchange relation with the conditioned space and connected to the liquid leg of the refrigerant circuit for controlling pressure therein. As used within this specification and the claims appended hereto, the term "accumulator" is intended to mean a chamber outside the refrigerant circuit but connected thereto and is to be distinguished from the ordinary refrigerant receiver which forms a portion of the refrigerant circuit through which all the refrigerant must pass as it flows from condenser to the throttling means. Our invention resides specifically in the addition of a check valve in the refrigerant circuit in a manner to permit refrigerant to flow alternately to and from the accumulator without permitting a reversal of refrigerant flow in the refrigerant circuit. This novel arrangement produces advantages which are outlined as the objects of this invention.

A prime object of this invention is to provide a pressure control means for a refrigerant system which is low in cost, efficient, reliable, and extremely versatile.

A further object of the instant invention is to provide means to prevent short cycling by the provision of means to continue refrigerant flow through the evaporator for a limited time after termination of the compressor especially when the pressure in the condenser is low.

Another object of our invention is to provide a refrigerant system which provides a low compressor starting torque requirement and power consumption during periods of low condenser pressure without unduly reducing the pressure at the throttling means.

A further object of this invention is to provide a refrigerant system having a pressure control comprised of an accumulator which is merely disposed in the conditioned space for withdrawing heat therefrom and in which the accumulator, which is consequently relatively slow in response, need only control pressure at the throttling means without regard to condenser pressure.

Other objects and advantages will become more apparent as this specification proceeds to describe the invention with reference to the accompanying drawing in which the sole figure thereof schematically illustrates our invention.

Referring now to the drawing it will be seen that a space **10** is provided with a refrigerant evaporator **12** disposed in heat exchange relation therewith for cooling the atmosphere therein.

Evaporator **12** is connected respectively in series with a compressor **14**, an air cooled condenser **16**, a check valve **18** and a temperature responsive variable orifice expansion valve **20** in a closed refrigerant circuit **22**. Compressor **14** is of the typical type having intake and discharge valves which are operated by the flow of refrigerant into and out of the compression chamber. This arrangement permits refrigerant gas to flow through the compressor during off periods when and if the pressure on the discharge side falls below the pressure on the suction side. Expansion valve **20** may be arranged to be responsive to the temperature at the outlet of the evaporator.

Disposed in heat exchange relation with the conditioned space is an accumulator **24** separate from but connected to the aforedescribed refrigerant circuit as by conduit **26** at a point **28** thereof downstream of check valve **18** and upstream of expansion valve **20**.

A fan **30** may be provided to circulate cooling air over condenser **16**. A second fan **32** may be provided to circulate air in the conditioned space over and in heat exchange relation with accumulator **24**.

Operation

During operation, refrigerant gas from the evaporator is compressed in compressor **14** and discharged to condenser **16** where the latent heat is removed and the gas condensed to a liquid. This liquid refrigerant condensate passes freely through check valve **18** to expansion valve **20** from whence it passes into the evaporator for vaporization in the usual manner. Under equilibrium conditions there is no net translation of refrigerant liquid to or from the accumulator. However, in some systems not employing check valve **18**, there may be a tendency for the liquid level in the condenser and accumulator to hunt, even under equilibrium conditions. This is undesirable as the system may be subjected to cyclic variations in discharge pressure. The addition of check valve **18** substantially eliminates hunting under equilibrium conditions and no refrigerant passes into or out of the accumulator.

Should the cooling medium for condenser **16** suddenly become excessively cold the pressure in the condenser will suddenly drop. Assuming the absence of valve **18**, liquid refrigerant in accumulator **24** would tend to flow into the refrigerant circuit to the condenser. However, after only a small quantity of liquid refrigerant has egressed the accumulator, the pressure in the accumulator would be lowered. Only after sufficient heat is withdrawn from the atmosphere surrounding the accumulator will the accumulator regain its normal pressure and serve the function of controlling pressure in the refrigerant circuit. It must be considered that this pressure regain may be relatively slow when one considers that no special means is provided for applying heat to the accumulator.

While the pressure drop in the liquid leg of the refrigerant circuit would clearly be greater if no accumulator were provided, it will be apparent that substantial variations in pressure will exist even if an accumulator is employed for the reason above described.

Now assume the same sudden drop in temperature of the condenser cooling medium with the check valve **18** disposed in the circuit as shown. While the pressure in the condenser will suddenly drop to a lower level, the pressure at the inlet to the expansion valve will be suitably maintained by the accumulator since the accumulator need only feed liquid to the expansion valve at a rate which is consonant with the rate at which the accumulator may withdraw heat from the conditioned space.

It will also be noted that as the compressor moves into the off cycle during these conditions, the refrigerant circuit will continue to operate for a limited time at accumulator pressure thereby reducing short cycling.

Also should the compressor be cycled on during these conditions it will be understood that the motor thereof

will encounter lower compressor starting torque due to low head pressure and consequently consume a smaller amount of electrical power and energy.

Should the condenser temperature and pressure rise, vapor in the accumulator condenses by releasing its latent heat to the conditioned space causing liquid refrigerant to be drawn through check valve **18** into the accumulator limiting the pressure rise in the refrigerant circuit. Thus as the condenser temperature and pressure rise and fall, liquid refrigerant will be alternately withdrawn via conduit **26** from the condenser to the accumulator and substantially all delivered therefrom via conduit **25** to the throttling means by reason of check valve **18**.

Further, it will be apparent that by the addition of this novel check valve arrangement to a refrigerant circuit utilizing accumulator type pressure control, the need for special means for applying heat to the accumulator to obtain adequate control may be eliminated. In other words, the simple and inexpensive check valve may mean in some circumstances the difference between providing, for example, a costly electrically heated accumulator and an accumulator which merely draws heat from the conditioned space.

Although we have described in detail the preferred embodiment of our invention, we contemplate that many changes may be made without departing from the scope or spirit of our invention and we desire to be limited only by the claims.

We claim:

1. Refrigeration apparatus for conditioning a space comprising a refrigerant evaporator disposed in heat exchange relation with said conditioned space; a refrigerant compressor; an air cooled refrigerant condenser; refrigerant throttling means; refrigerant circuit means serially connecting said evaporator, compressor, condenser and throttling means in a closed refrigerant circuit; a liquid refrigerant accumulator disposed in heat exchange relation with said conditioned space; conduit means connecting said accumulator to said refrigerant circuit at a point downstream of said condenser and upstream of said throttling means; and a check valve disposed in said refrigerant circuit between said point and said condenser.

2. The apparatus as defined by claim **1** including means providing fluid communication between the outlet of said evaporator and the inlet of said condenser while the compressor is not in operation.

3. In combination: a conditioned space; a closed refrigeration circuit comprising a refrigerant evaporator disposed in heat exchange relation with said conditioned space, a refrigerant compressor, an air cooled refrigerant condenser, refrigerant throttling means, a first conduit connecting the outlet of said compressor to the inlet of said condenser, a second conduit connecting the outlet of said condenser to the inlet of said throttling means, a third conduit connecting the outlet of said throttling means to the inlet of said evaporator, a fourth conduit connecting the outlet of said evaporator to the inlet of said compressor, and means for preventing refrigerant from backing up into said condenser from said second conduit, said last named means being a check valve disposed in said second conduit; a liquid refrigerant accumulator disposed in heat exchange relation principally with said conditioned space; and a fifth conduit connecting said accumulator to said second conduit at a point downstream of said check valve whereby refrigerant entering said refrigerant circuit from said accumulator is precluded from backing up into said condenser.

4. In combination: a conditioned space; a closed refrigeration circuit comprising a refrigerant evaporator disposed in heat exchange relation with said conditioned space, a refrigerant compressor, an air cooled refrigerant condenser, refrigerant throttling means, a first conduit connecting the outlet of said compressor to the inlet of said condenser, a second conduit connecting the outlet of said condenser to the inlet of said throttling means, a third conduit connecting the outlet of said throttling means to the inlet of said evaporator, a fourth conduit connecting the outlet of said evaporator to the inlet of said compressor, and a check valve positioned to prevent refrigerant from backing up into said condenser from said second conduit; a liquid refrigerant accumulator disposed in heat exchange relation principally with said conditioned space; and a fifth conduit connecting said accumulator to said second conduit at a point downstream of said check valve whereby refrigerant entering said refrigerant circuit from said accumulator is precluded from backing up into said condenser.

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