

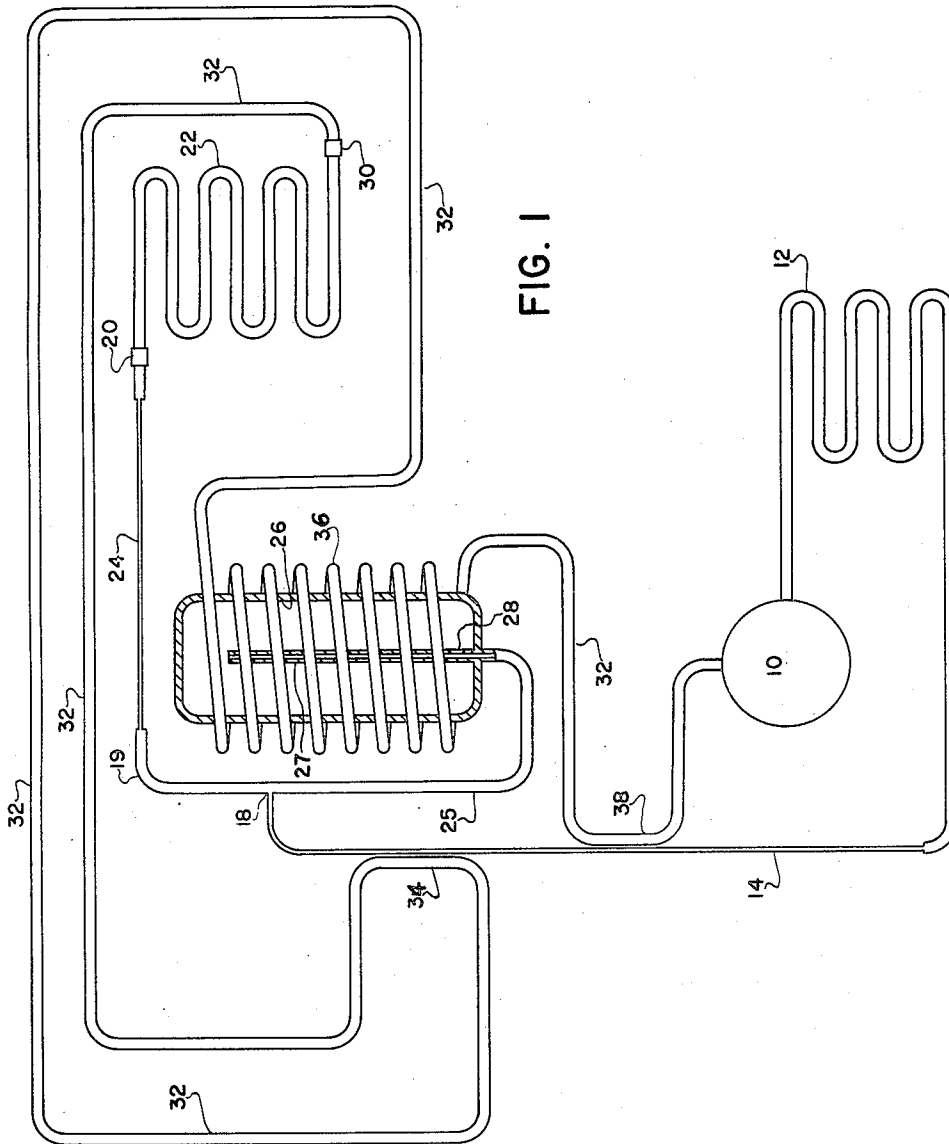
Sept. 1, 1959

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REFRIGERANT CONTROL MEANS

2,901,894

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2 Sheets-Sheet 1



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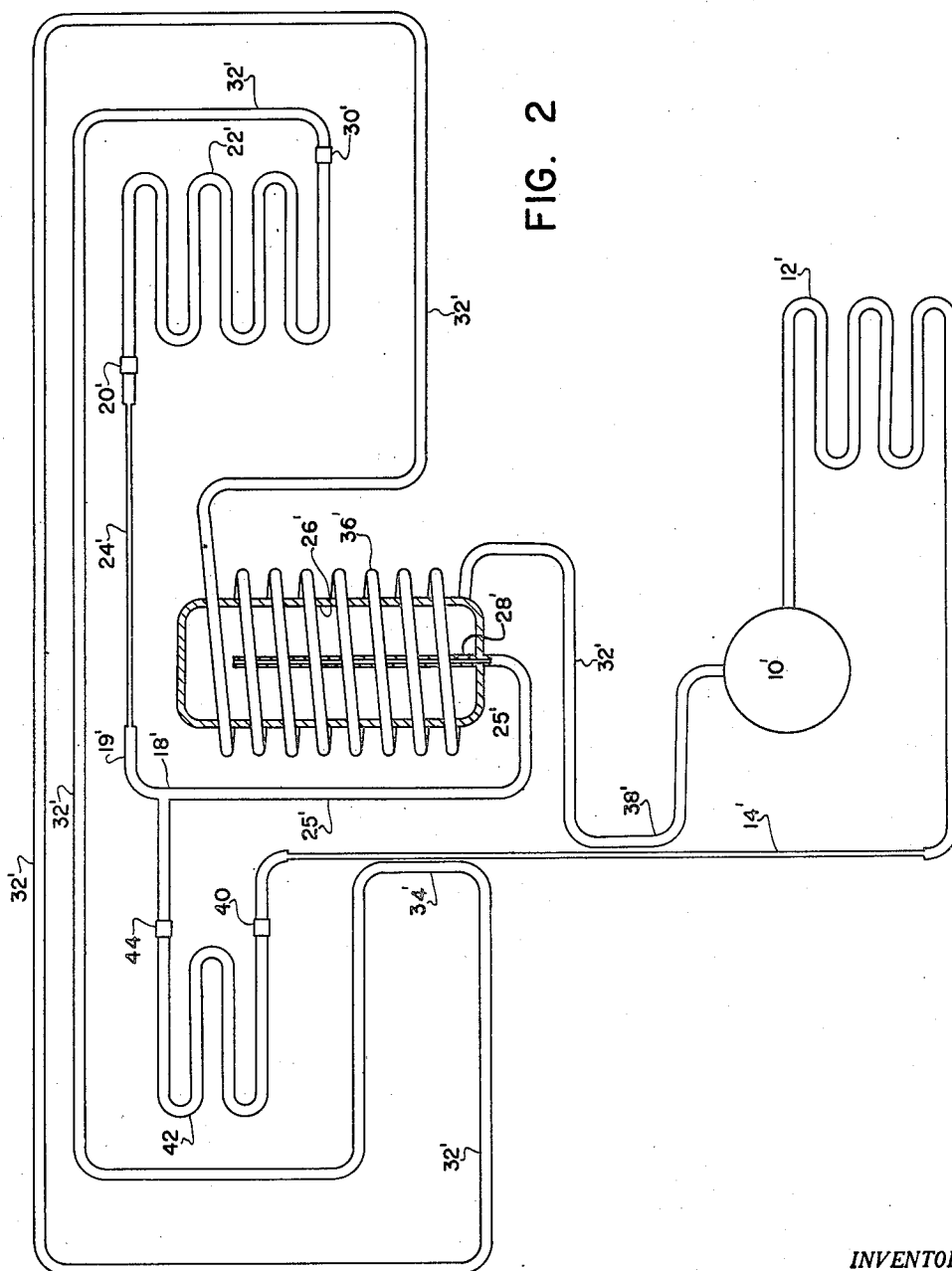
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REFRIGERANT CONTROL MEANS

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1 Claim. (Cl. 62—509)

My invention relates to a refrigerating apparatus of the type in which a capillary tube is employed as the pressure reducing means between the high and low sides of the apparatus.

One object of the invention is to produce an improved refrigerating apparatus of the type set forth.

Under theoretically ideal, controlled operating conditions and given a constant refrigeration load, it is possible to design a system in which all components are balanced and in which the flow of refrigerant through the evaporator is at optimum so that a high degree of efficiency is attained.

But, in practice, the refrigeration load and the temperature-pressure conditions which affect the balance of the system, vary and thus create problems in design and in control.

To solve this problem, it has heretofore been proposed to provide an evaporator circuit having a refrigerant storage capacity such as to suffice for maximum requirements. This expedient is not altogether desirable in a flooded type system because the practicable configurations of the evaporator are limited and because a relatively high refrigerant charge is required. In the dry, or accumulator type of system, the expedient referred to is not desirable because it will result in undesirable peak load and onset cycle performance which reflect improper refrigerant distribution and flow control. Furthermore, the inclusion of an accumulator in the system creates oil logging problems.

It is therefore a further object of the invention to produce a system in which all of the foregoing problems are overcome.

More specifically, the object of the invention is to produce a wholly self-regulating refrigerating apparatus in which the amount of refrigerant which reaches the evaporator is automatically regulated by the demand imposed on the evaporator to the end that the evaporator will, at all times, receive a supply of refrigerant which is, in effect, a function of the temperature of the spent refrigerant gas leaving the evaporator.

A still further object is to produce an improved refrigerating apparatus in which the regulation of the supply of liquid refrigerant reaching the evaporator is effected without any moving parts and in a manner which does not appreciably increase the cost or weight of the apparatus and which involves no maintenance cost whatever.

In those types of apparatus involving the use of a capillary tube it is necessary that the refrigerant charge introduced into the sealed circuit be accurately or, at least, very closely estimated. Otherwise, for well known reasons, satisfactory and efficient operation may become impossible.

It is therefore a still further object of the invention to produce an improved refrigerating apparatus in which the volume of the refrigerant charge initially introduced into the system is not so critical and need not be accurately predetermined.

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In all refrigerating machines, over-rides or extremes of temperature, be they on the cold or on the warm side are not desirable. In other words, uniform operation, within predetermined limits is desirable and, to that end, the cycling of the apparatus should be such as uniformly to maintain the desired temperature.

It is therefore a still further object of the invention to produce an improved refrigerating apparatus which has a cycling performance without "hunting" and undue over-ride.

These and other objects are attained by my invention as set forth in the following specification and as shown in the accompanying drawings in which:

Fig. 1 is a diagrammatic view showing one embodiment of the invention.

Fig. 2 is a similar view showing a second embodiment of the invention.

Referring to Fig. 1, 10 is a compressor, 12 is a condenser and 14 is a capillary tube for conducting the condensed refrigerant to the evaporator. These parts are conventional in structure and in operation and therefore need not be shown nor described in detail.

According to my invention, capillary 14 communicates at 18, with a pipe 19 for conducting refrigerant to the intake end 20 of an evaporator 22 with, or without the interposition of a restrictor 24. Capillary tube 14 also communicates at 18, with a pipe 25 for conducting refrigerant to a blind accumulator 26. It will be noted that the discharge end of capillary 14 (i.e. point 18) is above at least a substantial portion of accumulator 26. Pipe 25 enters the accumulator at its lower end and extends upwardly to form a riser tube 27 which terminates in the upper portion of the accumulator 26. Riser tube 27 is provided with a measured opening 28 near the bottom of the accumulator. The discharge end 30 of the evaporator 22 is connected to pipe 32 for conducting the spent refrigerant to the compressor 10. The refrigerant flowing through pipe 32 is brought into heat exchange relation with at least a portion of accumulator 26 by means of a coil 36 before it reaches the compressor. If desired, the refrigerant in coil 36 may also be brought into heat exchange relation with capillary tube 14 as at 34 before it reaches coil 36. The refrigerant leaving coil 36 is brought into heat exchange relation with capillary tube 14 as at 38 to insure that no liquid refrigerant reaches the compressor and to help cool the relatively hot liquid refrigerant issuing out of the condenser. The heat exchange at 38 is conventional and will not be further referred to.

Restrictor 24, riser tube 27, and heat exchange 34 are optional and if they are omitted and if it is assumed that the apparatus has been out of operation for some time and is just being started up, the operation of this embodiment will be as follows:

As the liquid refrigerant flows thru capillary tube 14, the pressure is gradually decreased and flash gas is produced so that a mixture of liquid and gaseous refrigerant is ultimately delivered at discharge point 18. Some of the liquid component of the refrigerant issuing out of capillary 14 will flow downwardly into pipe 25 and a mixture of liquid and gaseous refrigerant will flow upwardly through pipe 19 and into the evaporator 22. The static pressure exerted by the liquid column in pipe 25 correspondingly increases the pressure drop between the accumulator 26 and coil 36 beyond the value which would otherwise normally prevail, and thus increases the heat exchange potential between the refrigerant in the accumulator and the refrigerant in coil 36. When liquid refrigerant reaches coil 36, the gaseous refrigerant in the accumulator will be more readily condensed and the resultant reduction in volume will cause liquid refrigerant to be withdrawn from pipe 25 into the accumulator. In

this connection it is pointed out that the accumulator is made large enough to hold a substantial portion of the liquid refrigerant with which the system is initially charged so that, in the absence of gaseous refrigerant in the accumulator, it will be capable of receiving most, if not all, of the liquid refrigerant issuing from capillary 14. Therefore, as long as liquid refrigerant flows through coil 36, or as long as the temperature of the accumulator is at or below the saturation or condensing point of the refrigerant in the accumulator, little, or no liquid refrigerant will flow to the evaporator through pipe 19.

The resultant starvation of evaporator 22 will be reflected at coil 36 in that, as the liquid refrigerant ebbs from coil 36 and from the evaporator, the gaseous refrigerant reaching coil 36 superheats and reverses the direction of heat flow between accumulator 26 and coil 36. Some of the liquid refrigerant in accumulator 26 is now evaporated and the gas pressure thus generated will displace liquid refrigerant from the accumulator into pipes 25 and 19 to supply evaporator 22. It will be noted that the cycle just described is not a rigid one and that it is not carried out from start to finish according to any fixed rhythm. In other words, coil 36 need not be filled with liquid refrigerant nor must the evaporator be wholly devoid of liquid refrigerant to start or to finish a cycle. On the contrary, as the frost point moves into, and as it recedes from coil 36, gaseous refrigerant is condensed or liquid refrigerant is evaporated, as the case may be, correspondingly to affect the flow of liquid refrigerant to the evaporator. This constant fluctuation, or "breathing," makes the system extremely sensitive and correspondingly decreases the possibility of override, in either direction, in the temperature of the evaporator.

The inclusion of riser tube 27 prevents the accumulation of non-condensing gases in the top of the accumulator the presence of which would adversely affect the operation of the system as first above described. For example, whenever liquid refrigerant is evaporated in the accumulator, the gas thus formed mixes with any non-condensing gas that may be present at the top of the accumulator and because, in the course of operation, this mixture of gases is from time to time expelled from the accumulator, the non-condensing gases are kept in circulation where they are harmless. When used for this purpose, tube 27 may be essentially non-restrictive. In order to expel liquid refrigerant from the accumulator in response to superheat in coil 36, and vice versa, a measured opening 28 is in the lower portion of riser 27.

The function of opening 28 is not only to establish communication between tube 25 and the accumulator, but also to control the rate of flow of refrigerant into, or from, the accumulator. In other words, if, for one indicated set of conditions, it is desired to retard the flow of liquid between pipe 25 and the accumulator, the size of opening 28 will be reduced, and vice versa.

The inclusion of restrictor 24 increases the pressure differential between accumulator 26 and coil 36 and thus correspondingly increases the heat exchange potential between the accumulator and the coil.

The use of restrictor 24 is especially desirable where it is impractical thermally to insulate the accumulator from the refrigerated medium.

Bringing the refrigerant flowing through pipe 32 into heat exchange relation with a warm portion of capillary tube 14, as at 34 increases the superheat of the refrigerant before it reaches coil 36. This is important when the superheat of the refrigerant discharged from the evapo-

rator is at a low value with reference to the saturation temperature of the refrigerant in accumulator 26. It will be noted that the use of restrictor 24 may bring this condition about.

Since the restrictor 24 serves to intensify heat withdrawal from the accumulator while heat exchange at 34 intensifies heat transfer to the accumulator either may be employed separately as may be indicated. However, the combination of restrictor 24 and heat transfer at 34 serves to dampen the cycling processes and thus eliminates, or reduces, temperature over-ride. It also provides improved flow control generally, and improved response to transient evaporator loads. For example, restrictor 24, by giving added heat transfer potential to coil 36, will rapidly condense gas in the accumulator and will prevent, or reduce the flow of liquid refrigerant to the evaporator or into suction line. Conversely, heat exchange at 34 increases the superheat of the refrigerant flowing to coil 36 and provides adequate heat transfer potential so as to initiate, or to increase, the flow of liquid refrigerant to the evaporator. This insures an adequate supply of liquid refrigerant to the evaporator.

For best results, and to the ends just above recited, the length of pipe 32 between heat exchanger 34 and coil 36 should be kept at a minimum.

When it is necessary to use a relatively long evaporator, it is preferable to split it into two sections 22' and 42 as shown in Fig. 2. This merely involves connecting capillary tube 14' which leads from condenser 10' to the inlet end 40 of evaporator section 42, and connecting the outlet end 44 of evaporator section 42 to the system of Fig. 1. Except for the addition of evaporator section 42, the elements of the embodiment of Fig. 2 are identical, in structure and in function, with the corresponding elements of the embodiment of Fig. 1, and hence, the prime of the reference numerals used in the description of the embodiment of Fig. 1 have been applied to the embodiment of Fig. 2.

When restrictor 24' is included in the embodiment of Fig. 2, evaporation section 42 will operate at a higher pressure than evaporator section 22' and the system will be adapted to a two-temperature application. If restrictor 24' is omitted, both evaporator sections will operate at substantially the same temperature.

What I claim is:

In a refrigeration system including a compressor, condenser, a capillary, an evaporator, and a suction line in a series flow path, of refrigerant control means comprising, an accumulator having a single bottom opening and being in heat exchange relation with said suction line, means defining a passageway communicating with the lower portion of said accumulator opening and with the line leading to said evaporator, and a riser within the accumulator in fluid communication with the upper portion of said accumulator and connected to said passageway means and having an opening therein near the bottom of said accumulator.

References Cited in the file of this patent

UNITED STATES PATENTS

2,183,346	Buchanan	Dec. 12, 1939
2,291,362	Warneke	July 28, 1942
2,423,386	Hubacker	July 1, 1947
2,472,729	Sidell	June 7, 1949
2,510,881	Gerteis	June 6, 1950
2,520,045	McGrath	Aug. 22, 1950
2,740,263	Kritzer	Apr. 3, 1956