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REFRIGERANT FLOW CONTROL MEANS

Filed April 22, 1959

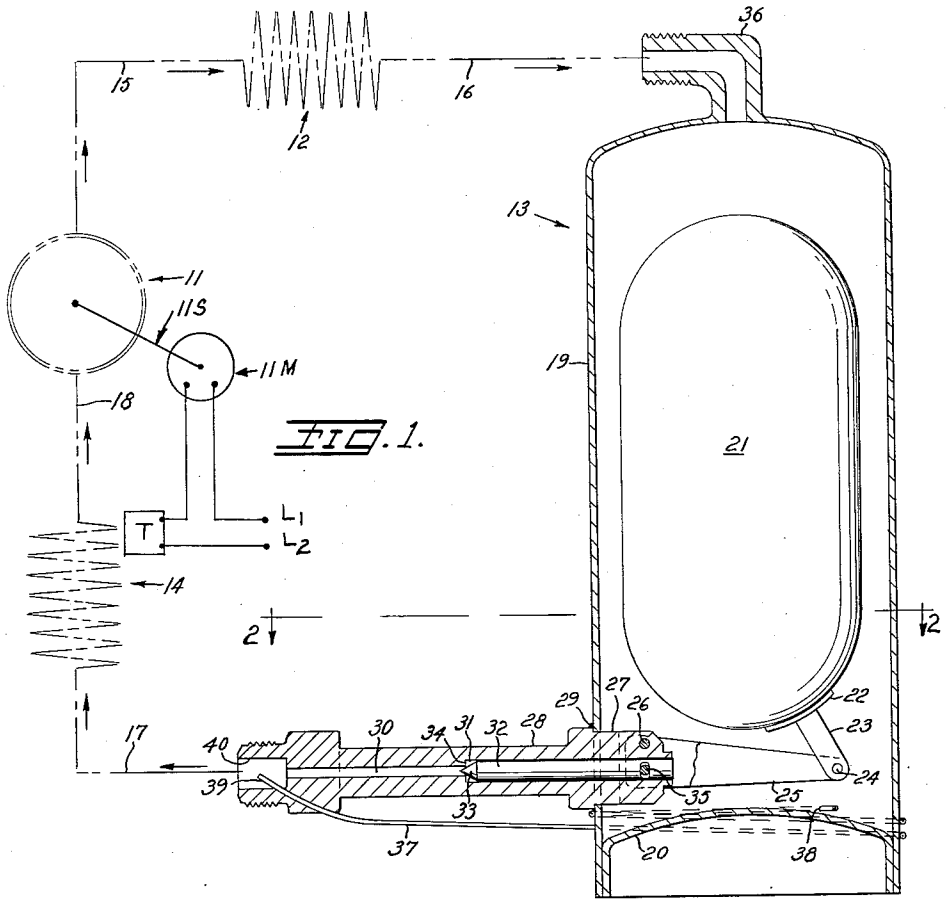


FIG. 1.

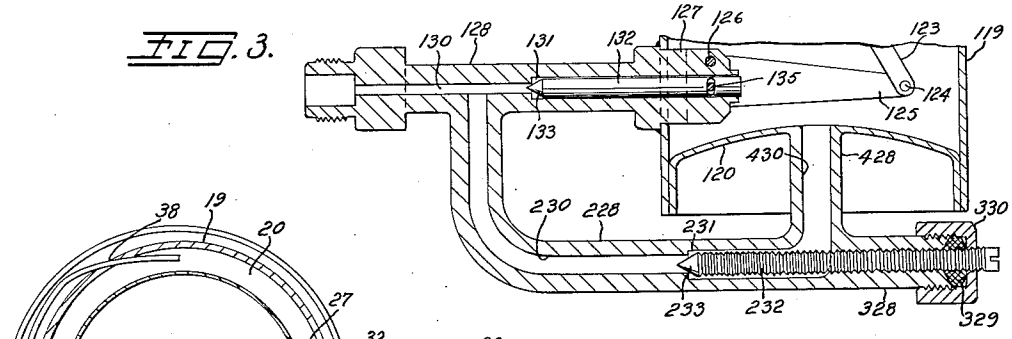


FIG. 3.

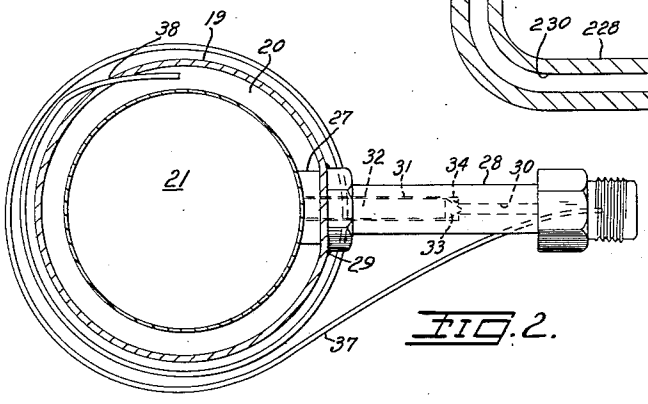


FIG. 2.

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REFRIGERANT FLOW CONTROL MEANS

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2 Claims. (Cl. 62—197)

This application is a continuation in part of my copending application, Serial Number 428,303, filed May 7, 1954, now abandoned.

This invention relates generally to systems of mechanical refrigeration and more particularly to a flow control means or refrigerant distributor for liquid refrigerant as it is allowed to flow from the condenser on the high pressure side of the system to the evaporator on the low pressure side of such a system.

Specifically this invention provides two parallel conduits each of which has its exclusive inlet port from the high pressure side of the system and its exclusive outlet port to the low pressure side of the system. Flow through one of the conduits is controlled by a high side float valve while flow through the other conduit is controlled separately from the high side float valve.

As is well known, a refrigerant distributor of some type is required in every mechanical refrigeration system to contol the separation of the high pressure side of the system from the low pressure side. The mechanical compressor, power driven as required by the load, takes heat laden refrigerant gas at low pressure from the evaporator where heat is absorbed from the cooling load and compresses the gas to a high pressure at which the hot refrigerant is delivered to a condenser where it is cooled and liquified. From the high pressure condenser the liquid refrigerant is throttled or leaked to the low pressure evaporator through some sort of refrigerant distributor. Distributors of the form of expansion valves either temperature or pressure controlled, float valves with the float either in the high or low pressure side of the system and capillary tubes have all been used. In this art a refrigerant conduit of small cross sectional area and relatively long length may be called a capillary tube whether or not the cross section of the refrigerant conduit is round or V-shaped as it sometimes is when the conduit is made of an externally threaded rod fitted closely into a smooth bored tube. The latter construction has the advantage of being more compact and easier to assemble into the system.

Each of the above forms of distributors are in common use on present day equipment. In a few cases more than one of the above types are installed in series in the liquid line between the condenser and the evaporator.

One of the mechanical dangers in the operation of a mechanical refrigeration system is to have liquid present in a compressor cylinder at the end of the compression stroke and thus break a cylinder head. The temperature controlled expansion valve is liked because it is set to maintain the temperature of the gas as it leaves the evaporator at about ten degrees of superheat thus avoiding the possible presence of liquid in the cylinder. But this also reduces the capacity of the system.

To give the system its maximum capacity superheat at the compressor should be avoided and the evaporator should be maintained in a substantially flooded condition to make the greatest use of its heat transfer ability. Therefore when a compact unit of high capacity is required the float valve type of distributor is favored and the refrigerant charge in the system is limited to the extent that in operation no liquid refrigerant is available to the compressor.

With either expansion valves of the temperature operated or float operated types, the distributor operates as a tight shut off valve when the compressor shuts down and therefore the compressor has to start against substantially its full operating pressure when next it is called on for operation. A compressor unloading mechanism is required. Also at certain load conditions these on and off type valves tend to hunt or open and close with undesired frequency.

The capillary type of distributor is simple, has no moving parts and obviates the necessity for an unloader, but does not respond quickly to a sudden increase in load, is difficult to size for most efficient operation when used alone, and, having been a proprietary device, has formerly been restricted in use.

Applicant is an experienced practical worker in this art. In regularly servicing and installing the various types of equipment now in use he has found in many instances the particular type of distributor used will not allow the system to develop its intended cooling capacity on certain types of loads. In studying this problem he came to realize the need for a more flexible system of distributor control and conceived the idea that if the high side float valve could be used to cause the system to respond quickly to load changes and to develop the full load of the system and is a capillary type distributor could be used to get a continuing high efficiency and smooth operation over the lower load range of operation of the system, the problem would be solved.

He experimented with various ways of providing the desired operation and discovered that his proposed solution of the problem was successfully practicable, economical and improved the operating efficiency and load carrying ability while at the same time reducing the service required by the systems with which he was working.

It is a principal object of this invention to provide a refrigerant distributor of simple structure having a minimum of parts, inexpensive to provide, which will cause a minimum of service expense, which will not require an unloader for the compressor to start the motor, which will not hunt and which will operate the evaporator and therefore the system at its best efficiency at all times.

It is a second object to provide such distributor including a float chamber having an entrance at the top thereof for receiving refrigerant from the condenser of a mechanical refrigeration system and a first exit near the bottom of said chamber for discharging refrigerant therefrom to a first refrigerant conduit leading to the evaporator of said system, said first refrigerant conduit including a valve and said chamber including therein a float and means operable by said float to position the opening of said valve in response to the height of said refrigerant in said chamber, said chamber having a second exit below said first exit for discharging refrigerant from said chamber to a second refrigerating conduit leading to said evaporator, said second conduit including means for determining a desired rate of continuous flow of said refrigerant from said chamber to said evaporator when said valve in said first conduit is closed.

It is a third object to provide such a distributor for use in a mechanical refrigeration system having a motor driven compressor, a condenser, said distributor and an evaporator in a series circuit of flow of liquid refrigerant, the load on said system being understood to be the rate of heat absorption by said refrigerant at said evaporator, said motor being operated in response to the temperature of said evaporator, said distributor including a float

chamber in said series circuit, a float valve for discharging liquid refrigerant from said chamber to said evaporator at a rate varying from zero up to a predetermined rate responsive to the liquid level in said chamber, and an independent liquid conduit for discharging liquid from an outlet of said chamber below said float valve to said evaporator, said independent conduit including means determining a pre-set rate of continuous flow of liquid therethrough.

It is a fourth object to provide such a distributor in which the second liquid line which parallels the first liquid line which includes the float valve is a capillary tube of such pre-determined size as to limit the continuous liquid flow therethrough to less than required by the maximum load on the system.

It is a fifth object to provide such a distributor in which the second liquid line includes means for setting the rate of continuous flow therethrough to a desired rate less than required by the maximum load on the system.

It is a sixth object to provide such a system in which the entrance of liquid from the condenser into the distributor is at the top of the distributor float chamber which in turn is lower than the operating level of the liquid in the condenser for the purpose of eliminating vapor lock from the operation of the system. It is seen that applicant has provided a refrigerant distributor having a high side float valve with the inlet from the condenser at the top of the float chamber so that it cannot become vapor locked and with the float valve paralled by a second restricted flow conduit below the float valve so that the second conduit will be flooded at all times the system is in operation.

Applicant is aware of and has serviced many installations of distributors like the device of Rolaff, U.S. Pat. No. 1,650,046, in which the liquid entrance to the float chamber is below the float supporting level of the liquid and which therefore requires and provides a gas relief passage from above the liquid in the float to the low pressure or evaporator side of the valve in order that the float chamber will not be gas pressure bound and prevent liquid entrance from the condenser. With his liquid entrance at the top applicant has eliminated the need for the Rolaff by-pass as clearly explained in the Rolaff patent description. Applicant's flooded conduit for continuously by-passing his float valve is not to prevent vapor lock but rather is to assure that at lower load demands his evaporator is continuously fed with liquid at a desired limited rate thereby securing the low load advantages of the capillary type of distributor while continuing to make use of the quick response and maximum system capability secured with the high side float valve type of distributor.

Applicant also is aware of the Fourness, U.S. Pat No. 1,830,022, which discloses and requires in all claims a refrigerating system having two evaporators in the series flow refrigerant path of the system, one of which evaporators must be within the float chamber of the distributor or so closely associated therewith as to chill all of the vapor refrigerant in the float chamber to prevent vapor lock therein. To make it possible for the one evaporator to be effective to prevent vapor lock in the distributor and thus allow the other evaporator to do useful work, provision is made to prevent the float valve from completely closing on its seat. By this method sufficient liquid refrigerant is allowed to leak to the low pressure side of the float valve to cool the distributor float chamber by the one evaporator associated therewith.

As opposed to the practice of Fourness, applicant provides a distributor of the high pressure side float valve type with an inlet opening in the top of the float chamber into which condensed refrigerant will drain from above and with an outlet for refrigerant liquid to the single evaporator of the system controlled by the float valve near the bottom of the float chamber. In addition the invention of applicant includes a second conduit for continuously conducting liquid refrigerant from near the bottom of the float chamber to the single evaporator of the system, the second conduit being so sized as to relieve the float valve from opening when the system is operating at a low load. Thus at low loads the system will operate smoothly without the float valve opening but as the load on the evaporator suddenly increases quick response will be had from the float valve which will modulate the liquid flow therethrough to follow the needs of the evaporator for liquid beyond the steady rate of flow of liquid through the second conduit.

Thus by the newly conceived process effectuated, as here shown, by appilcant's distributor which provides a low load continuous open conduit paralleled with a high or variable load modulatedly open conduit to supply liquid from the float chamber to the single evaporator as required, applicant has made it possible for a refrigerating system economically to follow its load smoothly and quietly from nothing to the full rated capacity of the system.

The means of applicant's invention will be described with reference to the attached drawing as follows.

Fig. 1 shows in schematic arrangement and partial section the elements of a refrigerating system using one form of the refrigerant distributor of this invention.

Fig. 2 shows a plan sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 shows a fragmentary sectional elevation of a second form of the refrigerant distributor of this invention.

Like numerals of reference refer to like parts in the several figures of the drawing.

Referring now to the drawing, in Fig. 1 a mechanical compressor **11** is indicated to receive expanded refrigerant vapor at low pressure from evaporator **14** through conduit **18** and discharge hot compressed refrigerant at high pressure through conduit **15** to condenser **12** where the refrigerant at high pressure is cooled and condensed to a liquid. The compressor driving electric motor **11M** is energized from a power source **L1, L2,** through a thermostat T responsive to the temperature at the evaporator **14.**

From the condenser **12,** through conduit **16** the cooled liquid refrigerant drains through top inlet **36** into the interior of float chamber **19** in applicant's refrigerant distributor **13** from where the high pressure liquid will be continuously passed at a rate predetermined by the pressure built up by the compressor and the resistance to the flow of the liquid built into the conduit **37.** As shown conduit **37** is a capillary tube of small cross section relative to its length. One end of conduit **37** is seen to penetrate the wall of tank **19** and to be brazed therein as at **30.** The other end **39** of conduit **37** is sealed into the enlarged outer end **40** of fitting **28** as shown. An equivalent capillary tube is commonly made of an externally threaded rod closely fitted into the smooth interior of a straight pipe whereby the fluid path is the spiral V-sectioned path between the thread of the rod.

The liquid from conduit **37** expands into low pressure conduit **17** on its way to evaporator **14** where it does useful work by taking up heat from material with which it is in contact. When sufficient heat has been absorbed to increase the temperature at evaporator **14** to a preset value the evaporator thermostat, not shown, starts the compressor motor, not shown, to continue the above described process of passing the refrigerant around the system continuously or until the evaporator thermostat is satisfied.

Again as shown in Figs. 1 and 2 the float chamber **19** of applicant's distributor **13** is shown with a lower end closure **20** and with a hermetically sealed metal float **21** therein. Float **21** is brazed to flange **22** of arm **23** the other end of which is pivoted by pin **24** to operating lever **25** which in turn is pivoted by pin **26** to the inwardly extending end **27** of outlet fitting **28** sealed into tank **19** by brazing as at **29.**

Fitting 28 is formed with a liquid conducting bore 30 axially therethrough. Bore 30 at its inner end is enlarged at 31 to form a cylindrical surface adapted slidably to guide stem 32 of conical valve 33 adapted to seat on the circular peripheral intersection of bore 30 with the bottom 34 of enlarged bore 31. Pin 35 engaged in a vertical slotted hole formed horizontally through the inner end of stem 32 pivots lever 25 to valve stem 32 so that on a preset rise of liquid in tank 19 float 21 is buoyed up by the liquid and valve 33 is separated from its seat to pass high pressure refrigerant from tank 19 to low pressure bore 30 of fitting 28 and on through liquid line 17 to evaporator 14.

In Fig. 3 is shown another form in which this invention may be practiced. Fragmentarily shown is float tank 119 with lower head 120 and outlet end fitting 128 with float arm 123 pivoted to lever 125 and lever 125 fulcrumed on pin 126 in end 127 of fitting 128 and adapted to operate valve stem 132 through pivot pin 135. Valve 133 and bores 130 and 131 are similar in construction and function to their counterparts 30, 31 and 33 in Figs. 1 and 2.

But in Fig. 3 the capillary conduit 37 of Figs. 1 and 2 is replaced by a manually adjustable basic flow control valve 233 formed on the end of valve stem 232 threaded for substantially its full length and threadedly engaged in the internally threaded bore of horizontal end extension 328 of loop 228 of fitting 128. Upward extension 428 formed downwardly from lower head 120 of tank 119 has an internal bore 430 connecting the interior of tank 119 to enlarged internal bore 231 of loop 228. Bore 230 of loop 228 connects enlarged bore 231 with bore 130 of fitting 128 and at its junction with enlarged bore 231 forms a seat for valve 233. The free end of extension 328 of loop 228 is sealed around the extending end of valve stem 232 with high pressure packing 329 held in place by cup 330 having a central clearance hole formed therethrough for the clear passage of valve stem 232.

As noted above a form of compact capillary tube can be made of an externally threaded rod closely fitted into a tube having an internal bore and such a capillary structure of variable capacity is seen to be formed by valve stem 232 closely fitted into bore 231 of loop 228. In Fig. 3 to prevent the blurring of the drawing the tops of the external thread of stem 232 are not shown in contact with the inside surface of bore 231 as they are actually made for their disclosed use.

The particular value of the capillary form of Fig. 3 is that by turning valve stem 232 in extension 328 of loop 228 into which it is threaded, the refrigerant flow resistance of the capillary 231—232 can be lowered to a minimum by withdrawing stem 232 entirely out of bore 231 or can be raised to a working maximum and then to infinity by moving stem 232 progressively into bore 231 and finally seating valve 233 against the entrance to bore 230.

It is seen that applicant has provided for a mechanical refrigerating system a refrigerant distributor comprising capillary means for passing liquid refrigerant from the high pressure float chamber to the evaporator continuously at a limited rate when there is liquid in the float chamber, together with a float valve in parallel with said capillary means for passing refrigerant liquid at a rate responsive to the refrigerant level in said float chamber up to the capacity of the system to supply the liquid to the float chamber, the liquid inlet to the float chamber being in the top thereof to receive liquid gravitationally,

the float valve being below the liquid level in said float chamber at which said float valve is closed and said capillary means being below said float valve and said evaporator to form a liquid seal against the passage of vapor therethrough.

Having recited some of the objects of his invention, illustrated and described two forms in which his invention may be practiced and explained their operation, he claims:

1. A refrigerant distributor for a refrigerating system including in series connection an evaporator, a compressor and a condenser, said distributor being adapted for connection between said condenser and said evaporator to close said series circuit, said distributor comprising: means forming a high pressure float chamber with a refrigerant inlet formed through an upper wall thereof for receiving refrigerant from said condenser; a first refrigerant outlet means formed through a lower wall of said chamber for passing liquid refrigerant from said chamber to said evaporator; a second refrigerant outlet means formed through a lower wall of said chamber for passing liquid refrigerant from said chamber to said evaporator; said first outlet means comprising a continuously flooded capillary restrictor to restrict the flow of liquid refrigerant therethrough to the requirements of a pre-determined refrigerant load on the system and to prevent the flow of vapor in either direction therethrough; said second outlet means comprising a float operated valve means responsive to the liquid level in said chamber to pass liquid refrigerant from said float chamber to said evaporator as additional refrigerant load is added to the system; and said refrigerant distributor including means for varying the resistance to refrigerant flow of said first outlet means as required by the character of the refrigeration load for which the refrigeration system is installed.

2. A refrigerant distributor for a refrigerating system including in series connection said distributor, a low pressure evaporator, an electric motor driven compressor and a high pressure condenser, said system including means responsive to a condition at said evaporator for starting and stopping said motor, and said distributor consisting of a high pressure float chamber with means for receiving liquid refrigerant from said condenser into the top thereof, a first outlet for liquid refrigerant from said chamber through a lower wall thereof, a second outlet for liquid refrigerant lower than said first outlet through said lower wall of said chamber, a high pressure float controlled expansion valve operable in said first outlet to expand high pressure liquid refrigerant to low pressure liquid refrigerant therethrough to said evaporator and a flooded restrictor passageway of relatively small area and relatively great length connecting said high pressure float chamber from said second outlet with said low pressure evaporator and dividing the pressure drop from said float chamber to said evaporator along the length of said restrictor, said distributor including means for varying the length of said flooded restrictor passageway while said system is in operation.

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2,068,249	Terry	Jan. 19, 1937
2,089,851	McIntosh	Aug. 10, 1937

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252,647	Great Britain	May 28, 1926