

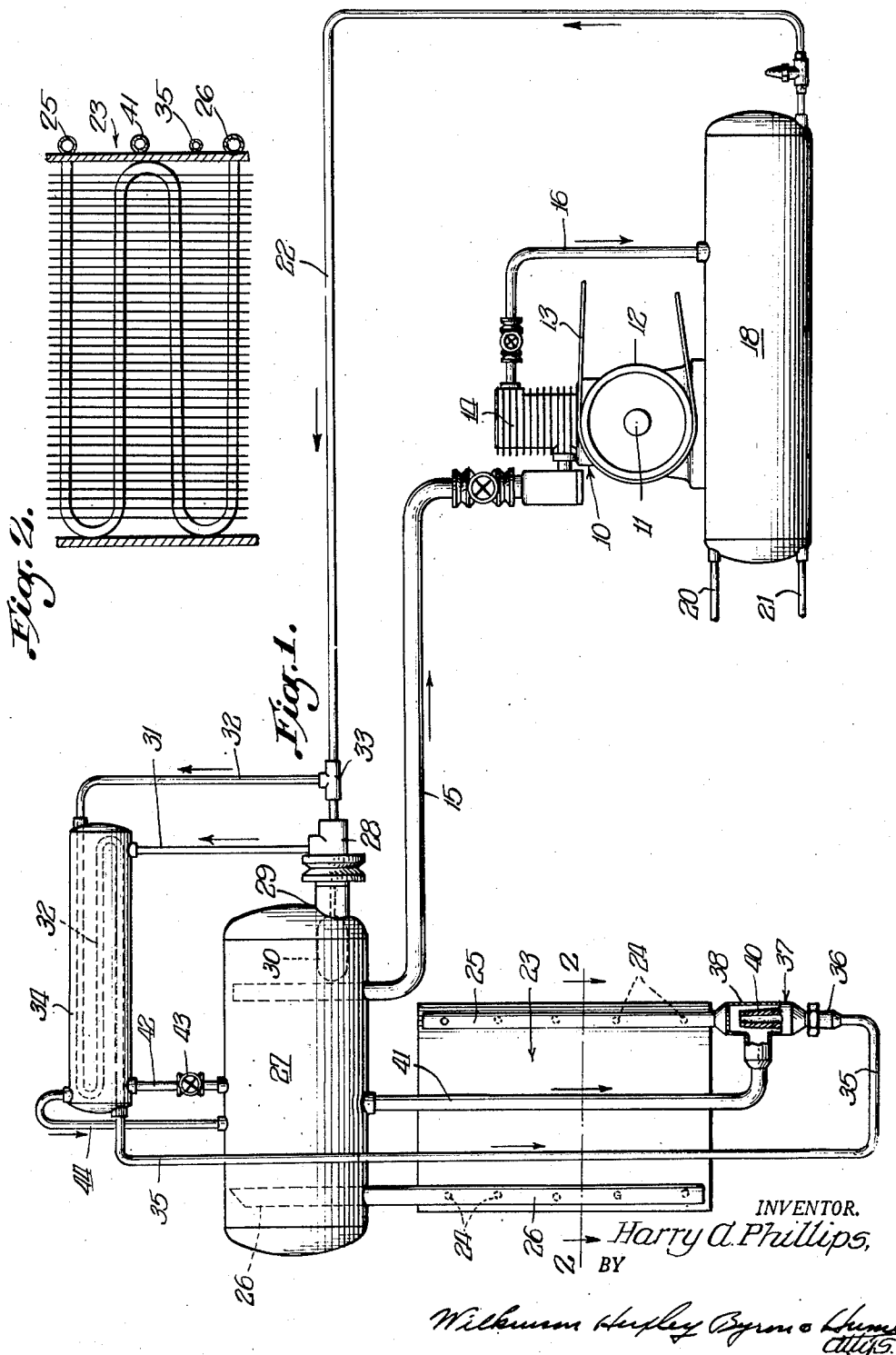
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FEED FOR REFRIGERANT INJECTOR FOR EVAPORATORS

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FEED FOR REFRIGERANT INJECTOR FOR
EVAPORATORS

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6 Claims. (Cl. 62-8)

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The invention relates to a system of refrigeration and has reference more particularly to a method and apparatus for modulating the flow of liquid refrigerant through a nozzle by controlling the temperature of the liquid refrigerant.

In my Patent No. 2,123,021 granted July 5, 1938 I describe and claim the use of liquid refrigerant injectors for recirculating liquid refrigerant through an evaporator equipped with a surge drum. By the method of parallel flow, as explained in the patent, improved circulation of the liquid refrigerant through the evaporator coils is secured with automatic control of the refrigerating effect under varying load conditions. This parallel method of refrigerant flow is preferred to pressure regulation in front of the injectors for the reason that the hunting and cycling action is apt to be excessive when pressure control is employed.

As a result of further investigations I have found that the flow of liquid refrigerant through an injector nozzle of fixed size can be modulated by controlling the temperature of the entering liquid. With fixed condenser and evaporator pressures the flow of liquid through the nozzle is increased by sub-cooling the liquid and is decreased by allowing the temperature of the liquid to rise and approach the temperature of the liquid refrigerant condensed in the receiver. Thus a very desirable type of liquid flow modulation of refrigerant injectors is established, based on the degree of cooling of the liquid refrigerant supplied thereto.

Accordingly, an object of the invention is to provide a refrigerating system including apparatus which will modulate the flow of liquid refrigerant through a nozzle of fixed size in response to the temperature of the liquid refrigerant supplied to the nozzle.

A further object of the invention resides in the provision of apparatus for use in connection with refrigerant injectors which will modulate the flow of liquid refrigerant through the injector in response to the temperature of the liquid refrigerant and wherein the modulating liquid flow may be combined with the parallel flow method of my Patent No. 2,123,021 to secure improved liquid control for a large number of evaporators operating under maximum variations in load conditions.

Another object of the invention is to provide apparatus for sub-cooling the liquid refrigerant supplied to one or more refrigerant injectors and which will incorporate means such as a float valve for controlling the cooling effect.

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A further object of the invention resides in the provision of apparatus as above described which will essentially comprise a heat exchanger for cooling the high pressure liquid refrigerant with provision being made for draining liquid refrigerant and oil from the heat exchanger to the surge drum and for venting refrigerant gas from the exchanger to the surge drum or to some other part of the system.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation, as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the device and wherein like reference characters are used to designate like parts:

Figure 1 is a diagrammatic view showing a conventional refrigerating system equipped with the modulating flow apparatus of the invention, and

Figure 2 is a horizontal sectional view taken through the evaporator substantially along line 2-2 of Figure 1.

The refrigerating system shown in the drawings consists of a compressor 10 of the usual type having an operating shaft 11 to which is secured pulley 12 driven through belt 13 by an electric motor or any other suitable source of power, not shown, to cause rotation of the operating shaft 11 of the compressor. The pressure head of the compressor is formed with a plurality of fins 14 providing cooling surfaces for the pressure head which is supplied with refrigerant gas by the suction line 15 connecting with the pressure head at the base thereof. The refrigerant gas is compressed by the compressor, the temperature and pressure of the same being thereby raised, and this high pressure refrigerant gas is then delivered to the compressor discharge line 16.

The refrigerant gas from the compressor discharge line enters the condenser-receiver 18 in the form of an elongated tank having water cooling means associated therewith for which purpose the tank has connection with a water inlet line 20 and a water outlet line 21. The condenser-receiver has connection at its lower right hand end with the liquid refrigerant supply line 22. The high pressure refrigerant gas supplied to the condenser-receiver is condensed by the cooling action of the water cooling means and said liquid refrigerant condensing within tank 18 accumulates in the bottom of the tank

and is eventually supplied to said liquid refrigerant line.

The evaporator of the refrigerating system is designated by numeral 23. The evaporator is conventional in design and construction including a plurality of evaporator coils 24 which extend horizontally in parallel relation, being supported by fins to form the evaporator structure. At their inlet end the coils have connection with a liquid header 25 and at their outer end the coils connect with a gas header 26. The gas header extends upwardly to connect with a surge drum 27, and said header terminates within the surge drum in the upper portion thereof so that the evaporated refrigerant is discharged within the drum while liquid refrigerant is prevented from entering the gas header. The suction line 15 also connects with and terminates within the surge drum in the upper portion thereof and therefore the refrigerant gas accumulating within and generated within the surge drum is suctioned off and eventually supplied to the compressor.

In accordance with the invention the liquid refrigerant line 22 has connection with float valve 28, said valve having suitable connection at 29 to the surge drum 27 and being controlled by float 30. The float 30 is located within the surge drum and more particularly in the lower portion of the drum so as to float on the liquid refrigerant accumulating in the lower portion of the drum. Accordingly, the position of float 30 varies as the liquid level within surge drum 27 may vary. This action of the float 30 controls the valve 28 and thus regulates the quantity of liquid refrigerant flowing from line 22 through the valve to the feed line 31 for the sub-cooler to be presently described. The line 32 extends parallel to line 31 and is in effect a continuation of the liquid refrigerant line 22 connecting therewith at 33 in advance of valve 28.

The sub-cooler or auxiliary evaporator for cooling the liquid refrigerant in line 32 comprises a cylinder 34 through which the liquid refrigerant line 32 extends, said line having a number of bends within the cylinder in order to provide the necessary surface area for cooling the liquid refrigerant flowing through pipe 32 to the desired temperature. At the exit end of the sub-cooler 34 the pipe 32 connects with a liquid refrigerant feed line 35 which in turn connects at 36 with a refrigerant injector 37. The refrigerant injector essentially consists of a housing 38 enclosing nozzle 40. The nozzle 40 receives liquid refrigerant directly from the refrigerant feed line 35. The housing 38 in turn connects at its upper end with the inlet header 25 and intermediate its ends said housing has connection with pipe 41 comprising an auxiliary feed line for liquid refrigerant. Said pipe 41 has connection with the bottom of surge drum 27. Liquid refrigerant from the sub-cooler 34 is drained to the surge drum by means of connection 42 having a needle control valve 43 which provides for regulation of the quantity of liquid refrigerant draining from the sub-cooler. Conduit 44 connects the upper portion of the cooler with the surge drum and accordingly said conduit operates to vent gaseous refrigerant from the same, delivering said refrigerant to the surge drum whereby said gaseous refrigerant is eventually suctioned off by line 15 and returned to the compressor.

In operation of the refrigeration system as shown in the drawings and as described above,

it will be understood that the liquid refrigerant in line 22 is at a high pressure and a relatively high temperature. This refrigerant will be delivered to the parallel branch lines 31 and 32. Thus the total quantity of liquid refrigerant flowing in line 22 is divided, with the major portion being delivered to line 32 and a relatively minor portion being delivered to line 31 as controlled by float valve 28. The liquid refrigerant from line 31 is delivered to the sub-cooler 34. The cooler 34 connects with the surge drum 27 and with the suction line of the compressor so that the liquid refrigerant supplied to the cooler is evaporated to produce the desired cooling effect. Actually the cooler 34 comprises an auxiliary evaporator of the flooded type and a heat exchanging effect therefore takes place between the evaporating refrigerant within the cooler and the liquid refrigerant flowing through pipe 32. The temperature of the liquid refrigerant in pipe 32 is materially lowered and the gaseous refrigerant generated within the cooler is vented to the surge drum by pipe 44. Also the excess liquid refrigerant within the cooler 34 is continuously drained by connection 42 to the surge drum 27. Additional liquid refrigerant is supplied to the surge drum as a result of slop-over of refrigerant from the gas header 26. The level of this refrigerant within the surge drum determines the position of float 30 which in turn controls valve 28 and thus the supply of refrigerant to the cooler.

When the level of liquid refrigerant within the surge drum is high the float 30 is elevated and valve 28 is closed so that the flow of liquid refrigerant to the cooler is terminated. When different conditions exist, that is, when the liquid level within the surge drum is below its maximum level, the float 30 will drop to a lower position, opening valve 28 and supply of liquid refrigerant to the cooler will be resumed.

The conditioned refrigerant from the cooler is supplied by the feed line 35 to the nozzle 40 of the injector 37. Since this refrigerant is at a high pressure it will issue from the nozzle with considerable velocity. The liquid refrigerant having surrounding relation with the nozzle is supplied thereto by auxiliary pipe 41 which drains said refrigerant from the surge drum. As a result of the injector action of the refrigerant issuing from nozzle 40 the velocity of the refrigerant flowing through header 25 is greatly accelerated and thus the flow of refrigerant through the evaporator coils 24 is materially increased.

The modulating action of the injector is controlled by the cooling of the liquid refrigerant supplied to the nozzle. In explanation it can be pointed out that as heat is removed from the entering liquid refrigerant the amount of flash gas generated at the nozzle decreases and the actual weight of the liquid refrigerant flow increases. The modulating action is controlled by one of the most common means of liquid control, namely, a float valve. In operation, therefore, the float valve 28 will control liquid flow adequate to modulate the amount of liquid passed through the nozzle and which has a capacity many times the capacity of the float valve in refrigerating effect.

A wide variation of liquid control becomes possible through the use of the liquid-temperature modulation system as described in combination with the parallel flow method through the injector. The refrigerant supplied by the auxiliary feed 41 is recirculating refrigerant and the quantity of the same may be several times as great,

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during a given period, as the total quantity of refrigerant supplied by pipe 22 and drawn away through the suction line 15 which corresponds to the refrigerating effect or load during such a period. By the recirculation of liquid through the coils it is possible to secure heavy duty operation since the maximum heat transmission is obtained from the coils under difficult load conditions regardless of load changes. The present method of control in combination with the injector also permits flooding of a multiplicity of evaporators. In the past it has been possible to take care of only minor load changes in evaporators having continuous processing. The temperature method of modulation makes it possible to apply injector-recirculatory equipment to a large number of evaporators operating under varying load conditions.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings, as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In refrigerating apparatus, the combination with an evaporator and a liquid refrigerant line for supplying refrigerant thereto, of a surge drum interposed in the suction line of said evaporator for accumulating liquid refrigerant to be recirculated through the evaporator, an injector having a nozzle of fixed size located at the inlet to the evaporator and connecting with the liquid refrigerant line whereby said refrigerant is delivered to the evaporator by the injector action of the nozzle at a high velocity, an auxiliary cooling drum having the liquid refrigerant line extending through the same, means supplying liquid refrigerant to the drum so that upon evaporation thereof the same has heat exchanging relation with the liquid refrigerant line, and a float valve for controlling the supply of liquid refrigerant to the cooling drum, the float of said valve being located within the surge drum whereby the level of the refrigerant in the surge drum controls the actuation of the valve.

2. In refrigerating apparatus, the combination with an evaporator and a liquid refrigerant line for supplying refrigerant thereto, of a surge drum interposed in the suction line of said evaporator for accumulating liquid refrigerant to be recirculated through the evaporator, an injector located at the inlet to the evaporator, said injector including a nozzle of fixed size connecting with the liquid refrigerant line whereby said refrigerant is delivered to the evaporator by the injector action of the nozzle at a high velocity, an auxiliary refrigerant feed line connecting the surge drum with the injector for supplying recirculating liquid refrigerant from the drum to the injector in surrounding relation with the nozzle thereof whereby said recirculating refrigerant is fed to the evaporator by the injector action of the nozzle, an auxiliary cooling drum having the liquid refrigerant line extending through the same, means supplying liquid refrigerant to the drum so that upon evaporation thereof the same has heat exchanging relation with the liquid refrigerant line, and a float valve for controlling the supply of liquid refrigerant to the cooling drum, the float of said valve being located within the surge drum whereby the level of the refrigerant in the surge drum controls the actuation of the valve.

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3. In refrigerating apparatus, the combination with an evaporator and a liquid refrigerant line for supplying refrigerant thereto, of a surge drum interposed in the suction line of said evaporator for accumulating liquid refrigerant to be recirculated through the evaporator, an injector located at the inlet to the evaporator, said injector including a nozzle of fixed size connecting with the liquid refrigerant line whereby said refrigerant is delivered to the evaporator by the injector action of the nozzle at a high velocity, an auxiliary refrigerant feed line connecting the surge drum with the injector for supplying recirculating liquid refrigerant from the drum to the injector in surrounding relation with the nozzle thereof whereby said recirculating refrigerant is fed to the evaporator by the injector action of the nozzle, means controlling the temperature of the refrigerant in the liquid refrigerant line for the purpose of modulating the flow of the refrigerant through the nozzle, and other means for regulating said temperature controlling means in accordance with the level of the liquid accumulated in the surge drum.

4. In refrigerating apparatus, the combination with an evaporator and a liquid refrigerant line for supplying refrigerant thereto, of a surge drum interposed in the suction line of said evaporator for accumulating liquid refrigerant to be recirculated through the evaporator, an injector located at the inlet to the evaporator, said injector including a nozzle of fixed size connecting with the liquid refrigerant line whereby said refrigerant is delivered to the evaporator by the injector action of the nozzle at a high velocity, an auxiliary refrigerant feed line connecting the surge drum with the injector for supplying recirculating liquid refrigerant from the drum to the injector in surrounding relation with the nozzle thereof whereby said recirculating refrigerant is fed to the evaporator by the injector action of the nozzle, means controlling the temperature of the refrigerant in the liquid refrigerant line for the purpose of modulating the flow of the refrigerant through the nozzle, said means including an auxiliary heat absorbing element having heat exchanging relation with the liquid refrigerant line, a drain from the element to the surge drum for draining liquid refrigerant, and a gaseous refrigerant vent connecting the element with the surge drum.

5. A refrigeration control method for an evaporator wherein liquid refrigerant is recirculated through the evaporator, which consists in dividing the total quantity of liquid refrigerant supplied to said evaporator into a first portion and a second portion, flowing the first portion through a heat exchanger and then feeding the same to an injector located at the inlet to the evaporator for injection by the nozzle of said injector, regulating the quantity of the second portion in accordance with the demands of the evaporator, supplying the second portion to the heat exchanger for vaporization whereby to cool the first portion in advance of feeding the same to the injector so as to modulate the flow of liquid refrigerant delivered by the injector, accumulating unevaporated liquid refrigerant returning from the evaporator and from the heat exchanger to provide a quantity of liquid refrigerant for recirculation, and feeding said last mentioned refrigerant to the injector in surrounding relation with the nozzle thereof to supply additional refrigerant to the evaporator by the injection action of said injector.

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6. A refrigeration control method for an evaporator wherein liquid refrigerant is recirculated through the evaporator, which consists in dividing the total quantity of liquid refrigerant supplied to said evaporator into a major portion and a minor portion, flowing the major portion through a heat exchanger and then feeding the same to an injector located at the inlet to the evaporator for injection by the nozzle of said injector, supplying the minor portion to the heat exchanger for vaporization whereby to cool the major portion in advance of feeding the same to the injector so as to modulate the flow of liquid refrigerant delivered by the injector, accumulating unevaporated liquid refrigerant returning from the evaporator and from the heat exchanger to provide a quantity of liquid refrigerant for recirculation, feeding said last mentioned refrigerant to the injector in surrounding relation with the nozzle thereof to supply additional

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refrigerant to the evaporator by the injection action of said injector, and controlling the minor portion of liquid refrigerant supplied to the heat exchanger in accordance with variations in the quantity of unevaporated liquid refrigerant that has accumulated.

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