Sept. 10, 1963 V. W. TIPTON 3,103,106

REFRIGERATION SYSTEM WITH JET INJECTOR NOZZLE

Filed July 27, 1961 2 Sheets-Sheet 1

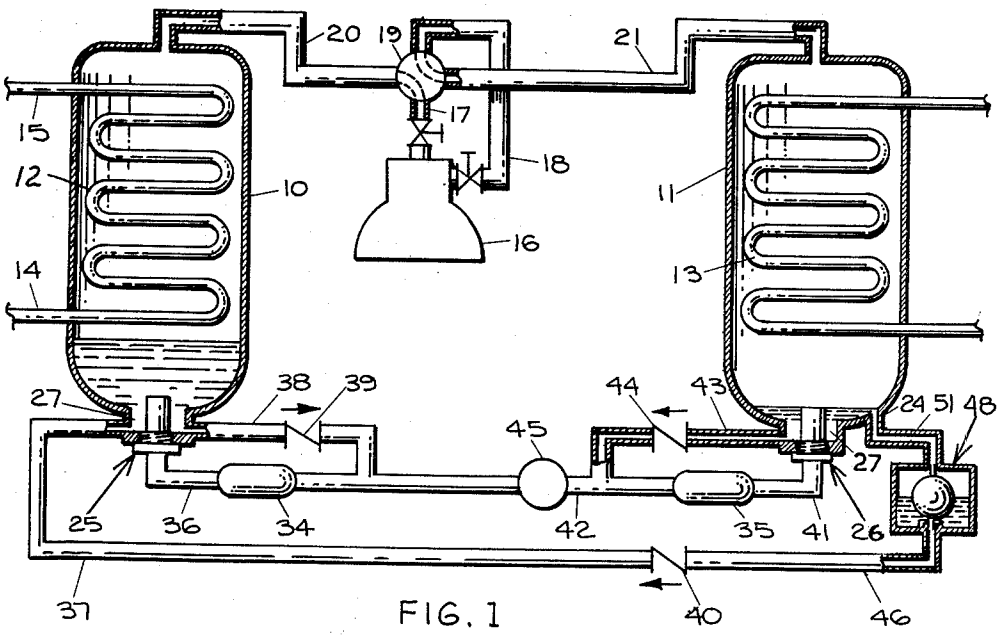


FIG. 1

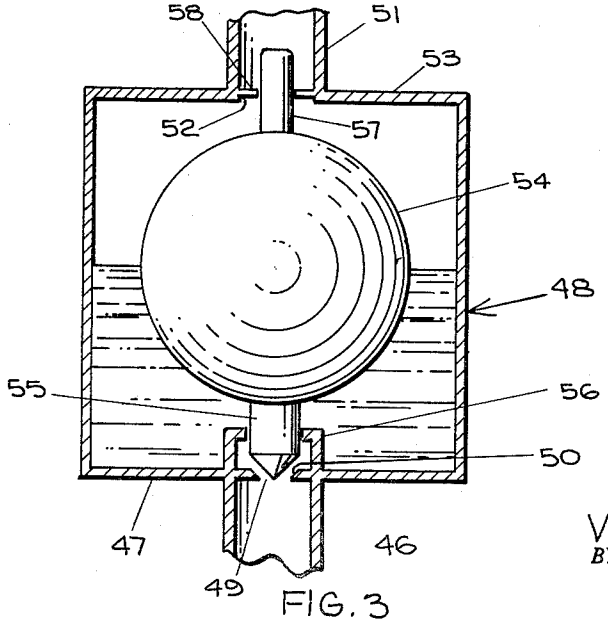


FIG. 3

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REFRIGERATION SYSTEM WITH JET INJECTOR NOZZLE

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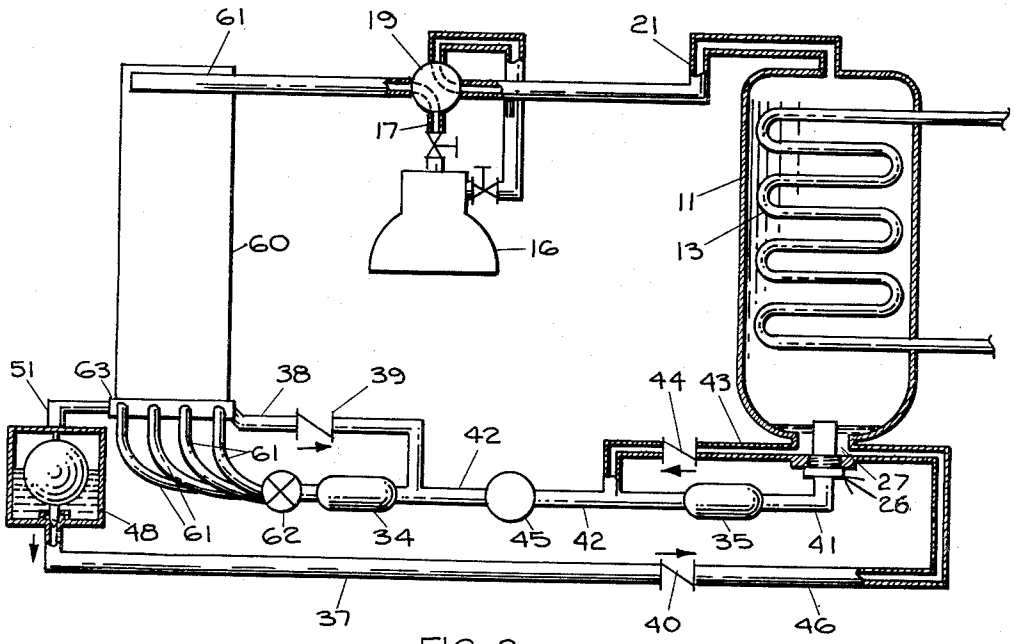


FIG. 2

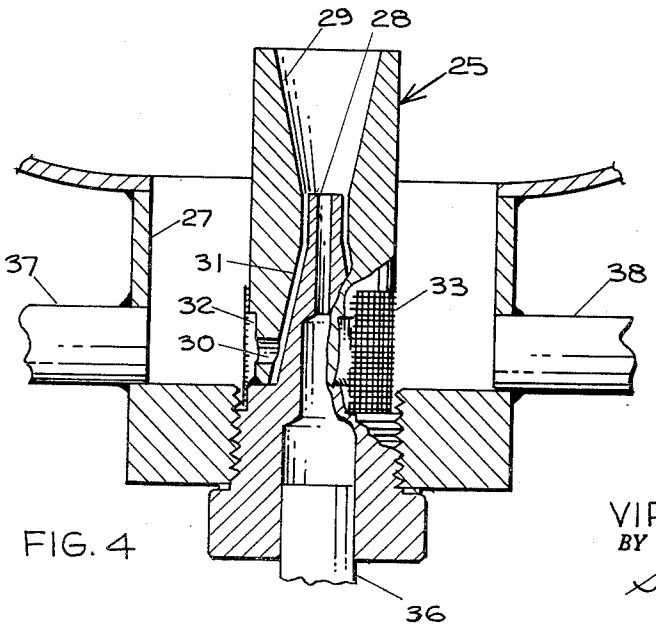


FIG. 4

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REFRIGERATION SYSTEM WITH JET INJECTOR NOZZLE

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This invention relates to refrigeration systems and is more particularly directed to a refrigeration system which utilizes a jet type atomizing injector nozzle.

It has been found that refrigeration systems utilizing a jet type atomizing injector nozzles operate at their highest efficiency when most of the liquid refrigerant is in the heat exchanger which is operating as the evaporator. This allows the secondary jet, of the injector nozzle to re-circulate the highest amount of liquid refrigerant and spray it over the water coils. At the same time, this condition insures a most effective oil return back to the compressor via the suction gas. The primary orifice in the injector nozzle is of such size to maintain proper conditions during normal differential pressure, between normal head pressure and normal suction pressure. However, when the differential pressure drops below normal conditions, the liquid refrigerant tends to accumulate in the bottom of the high side, thus starving the low side and causing a considerable reduction over an extended period in the efficiency of the refrigeration system. This condition occurs when the refrigeration system, water to water type is operating for cooling and its cycle reversed for heating purposes. Also, in a refrigeration system of air to water type, when there is a climate change resulting in a decided drop in temperature, the differential pressure drops below normal and the system becomes extremely inefficient for a considerable period.

Therefore a principal object of the present invention is to provide a refrigeration system utilizing jet type atomizing injector nozzles with means for transferring liquid refrigerant to the evaporator which accummulated in the condenser by virtue of an abnormal drop in head pressure.

Another object of the present invention is to provide a refrigeration system utilizing jet type atomizing injector nozzles with a float valve which prevents the accummulation of liquid refrigerant in the condenser and dumps it into the evaporator thereby insuring oil return to the compresser otherwise an oil separator would be required in the system.

Another object of the present invention is to provide a refrigerator system water to water type, utilizing jet type atomizing injector nozzles with a float valve for transferring excess liquid refrigerant from the condenser to the evaporator when converting from a cooling cycle to a heating cycle of operation in lieu of the necessity for costly water regulating valves and the automatic mechanism for operating the valves for avoiding the abnormal drop in head pressure resulting from the too rapid cooling of the refrigerant in the condenser.

A still another object of the present invention is to provide an air cooled refrigeration system utilizing jet type atomizing injector nozzles with a float valve for transferring excess liquid refrigerant from the condenser to the evaporator when a climate change causes a drop in air temperature.

A still another object of the present invention is to provide jet type atomizing injector nozzle in a refrigeration system with a cylindrical wire mesh at the position of the secondary jet to prevent the malfunctioning of the system by virtue of the aspiration bores in the secondary jet becoming clogged by scale and foreign matter in the system.

With these and other objects in view, the invention

will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawings forming a part of this specification, with the understanding, however, that the invention is not confined to any strict conformity with the showing of the drawings but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

FIGURE 1 is a schematic diagram of a water to water reverse cycle refrigeration system embodying my invention.

FIGURE 2 is a schematic diagram of an air to water heat pump refrigeration system embodying my invention.

FIGURE 3 is a detailed and enlarged cross sectional view of the float valve.

FIGURE 4 is a detailed cross sectional view of a jet type atomizing nozzle constructed in accordance with my invention.

Referring to the drawings wherein like numerals are used to designate similar parts throughout the several views, there is shown in FIGURE 1 a conventional water reverse cycle refrigeration system to which has been added my invention as is explained in detail hereinafter. The system consists of a steel tank **10** which operates as a condenser when the system is operating as a cooling unit, and a similar steel tank **11** which operates as an evaporator.

Within tanks **10** and **11** are coils of piping **12** and **13** respectively. Pumping **12** is connected to a pump (not shown) for pumping from a source of well water at its lower end **14** while the discharge end **15** of the piping **12** is connected to a dry well sewer and the like. The tubing **13** is connected to other tubing for the flow of water to an area to be cooled or warmed as the case may be.

A compressor **16** is provided with a valved discharge line **17** and a valved suction line **18** both of which are connected to a reversing valve **19**. Tubing **20** and **21** are connected at one end to the top of the steel tanks **10** and **11** respectively and at their other end to the reversing valve **19** so that in one position of the reversing valve **19** tubing **21** communicates with the suction line **18** and the tubing **20** communicates with the discharge line **17** in the cooling operation. In the reverse position of the valve **19**, the tubing **21** communicates with the discharge line **17** and the tubing **20** communicates with the suction line **18** in the heating operation.

At the bottom wall of the steel tanks **10** and **11** are jet type atomizing injector nozzles **25** and **26** respectively mounted in a well **27** formed thereon. The nozzles **25** and **26** are substantially similar in construction and operation as is explained in detail hereinafter.

Each of the nozzles **25** and **26** which are cylindrical in shape is provided with a centrally disposed primary jet orifice **28** and an annular secondary jet orifice **29**. The discharge jet orifice **29** is connected to a plurality of radially disposed bores **30** by a plurality of ducts **31**. At the base of the cylindrical nozzles **25** and **26** is an annular slot **32** over which extends a fine wire mesh **33**, the latter being in contact relation with the cylindrical side wall of the nozzle and overlying the annular slot **32** so that refrigerant discharged through the secondary jet orifice **29** must pass from the well **27** through the screen mesh **33**, the slot **32**, the bores **30** and the ducts **31**. If there is any refuse, scale or any foreign matter collected in the well **27**, none of it will pass through the wire mesh **33**, but will collect in the well **27** or be entrained in the strainers **34** and **35** to prevent malfunctioning of the refrigeration system.

The nozzle **25** is connected by a line **36** to the strainer

34 while lines 37 and 38 are connected at one end to the well 27 of the nozzle 25 and at their other end to check valves 39 and 40 respectively to permit the flow of refrigerant in the direction indicated on the schematic drawing shown by FIGURE 1. The jet nozzle 26 is connected by tubing 41 which extends to the strainer 35, which in turn is connected by a line 42 to the strainer 34 and the check valve 39. The well 27 of the jet nozzle 26 is connected by a line 43 which extends to a one way check valve 44 which joins the main refrigerant line 44 permitting the flow of refrigerant from the well 27 of the jet nozzle 26 to the line 42. A sight glass 45 mounted in the line 42 permits visual perception of the flow of refrigerant in the line.

Connected to the inlet side of the check valve 40 is a line 46 which extends to a bottom wall 47 of a float valve tank 48 communicating with the interior of the tank 48 through a valved port 49 having a valve seat 50. A tube 51 is connected at one end at an opening 52 in the top wall 53 in the float valve tank 48, the other end being connected to the lower portion of the steel tank 11 as at 24 at which position it is desired to maintain the level of the refrigerant therein when the tank 11 is operated as a condenser (high pressure). Mounted for vertical movement within the float valve tank 48 is a float 54 having a valve 55 positioned adjacent the valve seat 50 and held in proximity of the valve seat 50 by guide members 56. At the top portion of the float 54 is a stem 57 which extends upwardly into the opening 52 and maintained therein by a spider 58 mounted in the opening 52. In accordance with this construction, when refrigerant is received by the tank 48 through the opening 52, the level of the refrigerant in the tank 48 will rise and the float 54 will slide upwardly unseating the valve 55 from the valve seat 50. The refrigerant in the tank 48 will escape through the open port 49 pass through the tubing 46, check valve 40 and into the well 27 of the jet nozzle 25. Such refrigerant will flow from the steel tank 11 to the steel tank 10 by way of the float valve tank 48 until the level of refrigerant in the steel tank 11 has dropped to the position of the opening 24.

In the normal operation of the refrigeration system for cooling function, the gaseous refrigerant leaving the steel tank 11 by the tubing 21 will enter the compressor 16 through the suction line 18. The compressor 16 now places the refrigerant under pressure and discharge the hot gaseous refrigerant through the discharge line 17, valve 19, tubing 20 and into the top of the steel tank 10 where it impinges on the cold well water coils 12 to become liquified. The liquid refrigerant collects in the well 27 and flows therefrom through the tubing 38, past the check valve 39, through the tubing 42, sight glass 45 and through the strainer 35 after which the refrigerant enters the jet nozzle 26 of the tank 11 via the tubing 41. The refrigerant is discharged through the primary jet orifice 28 where the liquid refrigerant is vaporized and atomized asperating liquid refrigerant that collected in the well 27 and is now suctioned through the screen mesh 33, bores 30, ducts 31 and discharged by the secondary jet orifice 29 along with the primary jet of refrigerant. The vaporization of the jets of refrigerant causes the cooling of the water in the coils 13 as they impinge thereon and then passing out of the steel tank 11 through the tubing 21.

When it is desired to effect a heating of the closed water coils 13, the reversing valve 19 is rotated so that the compressor discharge line 17 which was previously connected to the tubing 20 is now connected to the tubing 21 and the compressor suction line 18 which was previously connected to the tubing 21 is now connected to the tubing 20. The flow of refrigerant in the system is now reversed, the steel tank 10 which in the cooling operation functioned as a condenser now functions as the evaporator and the steel tank 11 previously functioning as the evaporator now functions as the condenser. High pressure hot gaseous refrigerant will flow from the compressor 16 through the discharge line 17, valve 19, tubing 21 and into the steel tank 11 where these gases will become liquified upon impinging on the cold water coils 13. Since the flow of cold water in the coils 13 is continued at the same rate as in the cooling cycle of operation, the hot gaseous refrigerant entering the condenser 11 is converted to a liquid state very rapidly, in fact too rapidly to maintain the normal head pressure since the gaseous refrigerant is entering the condenser 11 at a constant velocity. Therefore, there results a considerable drop in head pressure, upsetting the normal differential pressure and the liquid refrigerant begins to collect in the bottom portion of condenser 11 due to the reduced flow of liquid refrigerant through the primary nozzle 25. The evaporator 10 now is starved of liquid refrigerant, there being less refrigerant collected in the evaporator 10, so that the jet nozzle 25 will be operating at less than its normally high efficiency.

If the liquid refrigerant collected in the condenser 11 were permitted to remain therein until the system was able to "catch up" so to speak, the system would be operating at a very low efficiency for a relatively long period of time until the differential pressure was restored to normal.

However, in accordance with the present invention, means are provided for evacuating from the condenser 11 any liquid refrigerant that accumulates in the condenser 11 beyond the normal level at the moment it occurs. As soon as liquid refrigerant rises above the opening 24, the excess refrigerant will flow through the tubing 51, through the port 52 and into the float valve tank 48. The float 54 will rise in the tank 48 and unseat the valved port 49 to permit the refrigerant to flow through the line 46 past the check valve 40, tubing 37 and into the well 27 of the evaporator tank 10. The jet nozzle 25, which previously was discharging and atomizing liquid refrigerant through its primary port 28 only, since there was no excess liquid refrigerant in the well 27, now will aspirate into the primary port 28, via the ports 30, 31 and secondary jet port 29, the liquid refrigerant that has flowed into the well 27. The jet nozzle 25 is now operating at its maximum efficiency. After a period of operation, the differential pressure in the system will increase to normal and liquid refrigerant will cease to accumulate in the condenser 11 but will flow to the jet nozzle 25 of the evaporator 10 by way of the well 27, tubing 43, check valve 44, tubing 42, strainer 34 and tubing 36 to be atomized as it is discharged through the main jet port 28. At the same time the liquid refrigerant accumulated in the well 27 is aspirated through the screen mesh 33, the slot 32, into the ports 30 and ducts 31 to be intermixed in the secondary jet port 29 with the primary jet discharged through the primary jet port 28. The surplus liquid refrigerant is now in the well of the evaporator 10 where it is available to maintain the high efficiency of the jet nozzle 25 and insures the return of oil to the compressor 16, the oil being intermixed with the refrigerant. Thus there is eliminated the need for an oil separator in the refrigeration system as well as water regulating valves in the closed water coils, which valves would have to diminish the rate of flow of cold water into the evaporator when the system is converted to a heating cycle in order to prevent the drop in differential pressure in the system by the too rapid cooling of the hot liquid refrigerant entering the evaporator 11.

Referring now to FIGURE 2 there is shown an air to water refrigeration system, namely one that is cooled by air. This system differs from the system shown by FIGURE 1 in the construction of the condenser 60 which is provided with a multitude of fins for permitting air to flow therealong for cooling the hot gaseous refrigerant being discharged through the discharge header 61 as the refrigerant is cooled and liquidfied, it is deposited in the bottom of the condenser 60 and flows therefrom through tubing 38, check valve 39 line 42, past the sight

glass 45, strainer 35 and tubing 41 to enter the jet nozzle 26 of the evaporator 11. This cycle of operation is substantially the same as that of the refrigeration system described above with reference to FIGURE 1.

Now, if there is a sudden and considerable drop in temperature such as occurs when a sudden rain squall results in causing a drop of air temperature as much as 20 degrees, or more, the gaseous refrigerant entering the condenser 60 will be cooled more rapidly and liquify at a greater rate than heretofore. However, the rate of flow of gaseous refrigerant into the condenser remains constant thus causing a drop in head pressure in the condenser 60. This drop in pressure will not force sufficient liquid refrigerant out of the condenser 60 and into the evaporator 11 and will consequently cause an accumulation of liquid refrigerant in the bottom of the condenser 60 and preventing the efficient operation of the jet nozzle 26 in the evaporator 11.

The accumulated liquid refrigerant in the condenser 60 will now flow through a discharge port 63 into line 51 and into the float valve tank 48 causing the float 54 to rise and lift the valve 55 off the valve seat 50. Liquid refrigerant now flows through the line 37 past the check valve 40, into the line 46 and is deposited in the well 27 of the evaporator 11 to now permit the efficient operation of the jet nozzle 26 as explained in detail hereinabove. When the level of the liquid refrigerant in the condenser 60 has dropped to its normal level at the position of the discharge port 63, the liquid level will drop and the float 54 will likewise drop until the valve 55 becomes seated on the valve seat 50 and cut off the flow of further refrigerant into the well 27 of the evaporator 11 by way of the line 46. The liquid refrigerant now flows to the jet nozzle 26 in its normal manner, namely through the tubing 38, 42 and 41 and into the main or primary jet orifice 28 of the jet nozzle 26.

During the heating operation, the valve 19 is actuated to direct the high pressure gas through line 21 to the tank 11. The heat absorbed from the high pressure gas converts the gas to liquid refrigerant while the heat is absorbed by the water in the coils 13 to heat rooms, etc. The liquid refrigerant which collects in the well 27 of the tank 11 will flow through pipe 43 check valve 44, sight glass 45, strainer 34 and into a thermostatic expansion valve 62 where the liquid refrigerant is metered through distributing tubes 61 into fin coil 60. Here, the liquid refrigerant evaporates at a low temperature and pressure removing heat from the outside air. During the heating operation, the float valve system 48 does not function.

Having described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A refrigeration system comprising a condenser, an evaporator, a compressor, duct means connecting an upper portion of said evaporator and said compressor, further duct means connecting said compressor and an upper portion of said condenser for the normal flow of refrigerant from said evaporator to said condenser, a well in said evaporator, a jet nozzle mounted in said well, pipe means connecting a lower portion of said condenser to said jet nozzle for the flow of liquid refrigerant from said condenser to said evaporator, a float valve tank, means connecting said float valve tank at a desired position in a lower portion of said condenser for discharging surplus liquid refrigerant to said float valve tank, further means connecting said float valve tank and said well of said evaporator, and float valve means mounted in said tank for discharging refrigerant to said well of said evaporator all of the liquid refrigerant accumulated above said desired position in said condenser.

2. A refrigeration system comprising a condenser, an evaporator, a compressor, duct means connecting an upper portion of said evaporator and said compressor, further duct means connecting said compressor and an upper portion of said condenser for the normal flow of refrigerant from said evaporator to said condenser, a well in said evaporator, a jet nozzle mounted in said well, pipe means a lower portion of said condenser to said jet nozzle for the flow of liquid refrigerant from said condenser to said evaporator, a float valve tank, said float valve tank having an inlet and an outlet, a valve seat mounted at said outlet, a discharge opening in said condenser at a desired position in a lower portion of said condenser, duct means connecting said discharge opening and said inlet, a float mounted in said float valve tank, a valve mounted on said float normally positioned on said seat, duct means connecting said outlet and said well in said evaporator whereby upon the rising of liquid refrigerant in said condenser above said discharge opening, said excess refrigerant will flow into said float valve tank, open said valve and flow to said well in said evaporator.

3. In a refrigeration system having a condenser and an evaporator, a well in said evaporator, the combination comprising substantially cylindrical jet nozzle mounted in said well of said evaporator and extending thereabove, said jet nozzle having a centrally disposed main orifice, pipe means connecting said condenser and said main orifice of said jet nozzle in said evaporator, an annular secondary orifice positioned about said main orifice, an annular slot formed about said jet nozzle in said well, a screen mesh mounted about said jet nozzle over said annular slot, ducts connecting said annular slot and said secondary orifice whereby refrigerant discharged through said main orifice will aspirate refrigerant accumulated in said well through said screen mesh, said annular slot, said ducts and said annular secondary orifice, a float valve tank, means connecting said float valve tank at a desired position in a lower portion of said condenser for discharging liquid refrigerant to said float valve tank, further means connecting said float valve tank and said well of said evaporator, and float valve means mounted in said tank for discharging refrigerant to said well of said evaporator all of the liquid refrigerant accumulated above said desired position in said condenser.

4. In a refrigeration system having a condenser and an evaporator, a well in said evaporator, the combination comprising a substantially cylindrical jet nozzle mounted in said well of said evaporator and extending thereabove, said jet nozzle having a centrally disposed main orifice, pipe means connecting said condenser and said main orifice of said jet nozzle in said evaporator, an annular secondary orifice positioned about said main orifice, an annular slot formed about said jet nozzle in said well, a screen mesh mounted about said jet nozzle over said annular slot, ducts connecting said annular slot and said secondary orifice whereby refrigerant discharged through said main orifice, will aspirate refrigerant accumulated in said well through said screen mesh, said annular slot, said ducts and said annular secondary orifice, a float valve tank, said float valve tank having an inlet and an outlet, a valve seat mounted at said outlet, a discharge opening in said condenser at a desired position in a lower portion of said condenser, duct means connecting said discharge opening and said inlet, a float mounted in said float valve tank, a valve mounted on said float normally positioned on said seat, duct means connecting said outlet and said well in said evaporator whereby upon the rising of liquid refrigerant in said condenser above said discharge opening, said excess refrigerant will flow into said float valve tank, open said valve and flow to said well in said evaporator.

References Cited in the file of this patent

UNITED STATES PATENTS

1,691,286	Hiller	Nov. 13, 1928
1,994,037	Gay	Mar. 12, 1935
2,132,932	Boileau	Oct. 11, 1938
2,983,113	Koch	May 9, 1961