June 19, 1956 E. W. ZEARFOSS, JR 2,750,757

REFRIGERATING APPARATUS

Filed April 27, 1955 3 Sheets-Sheet 1

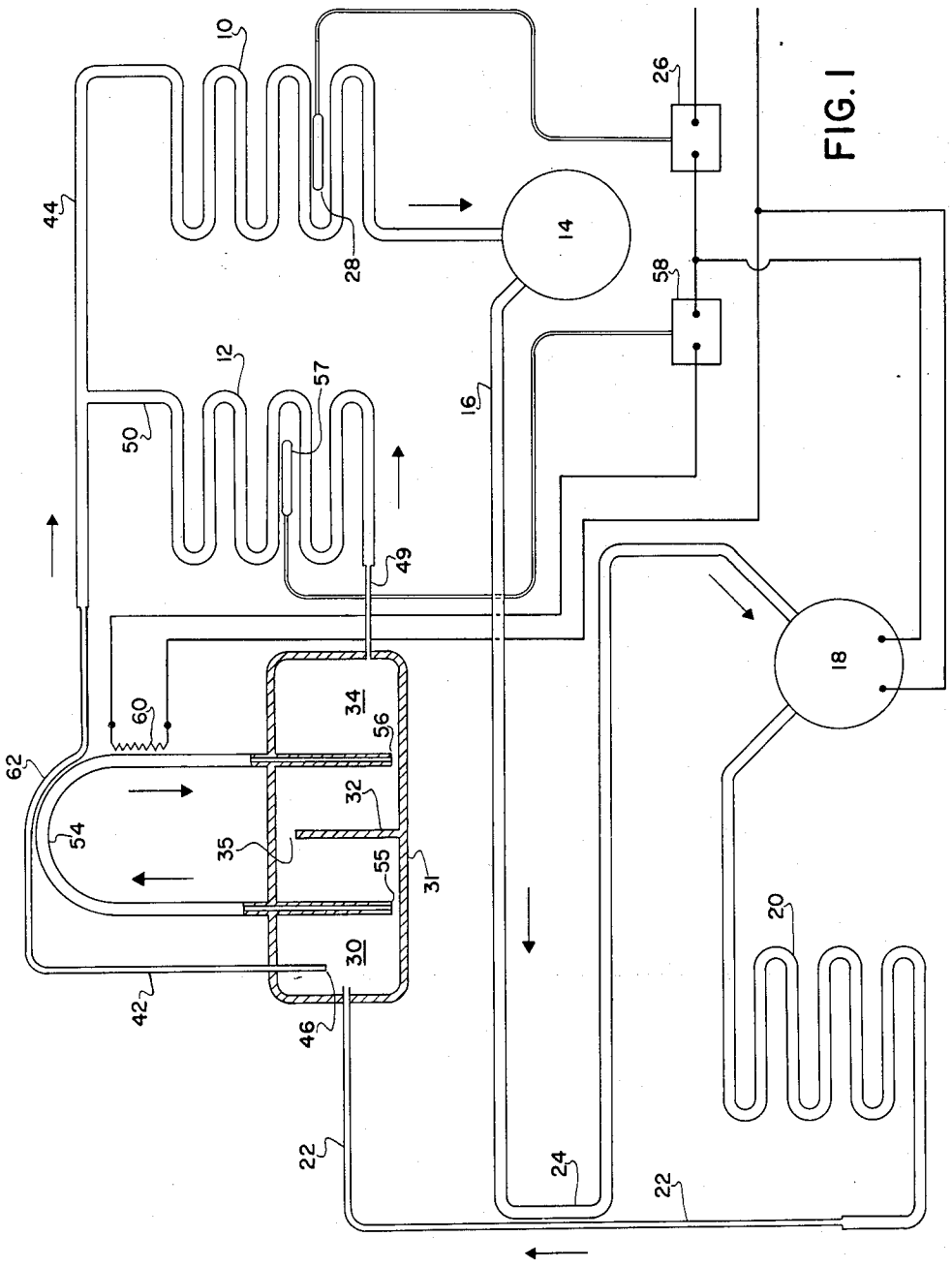


FIG. 1

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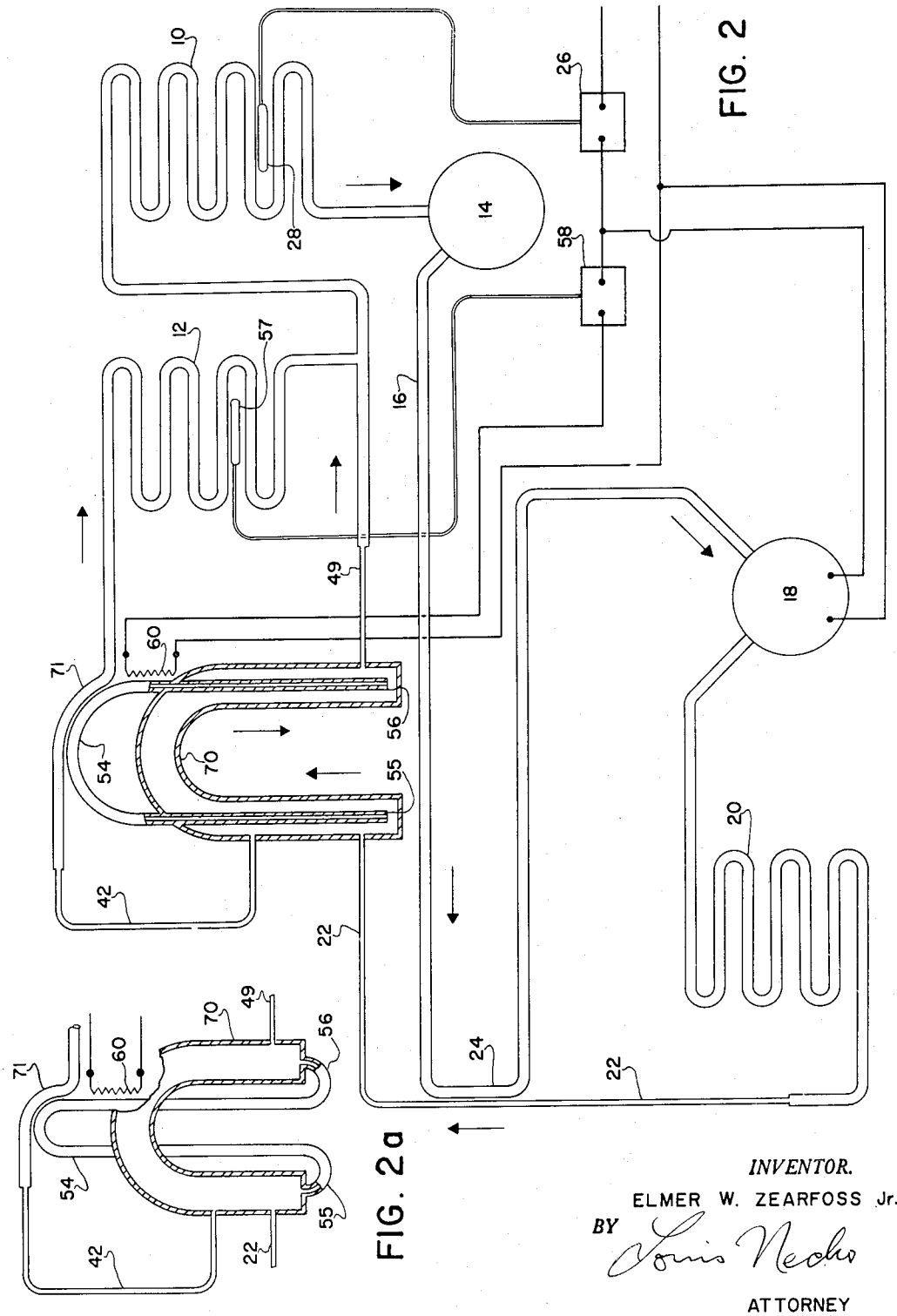


FIG. 2

FIG. 2a

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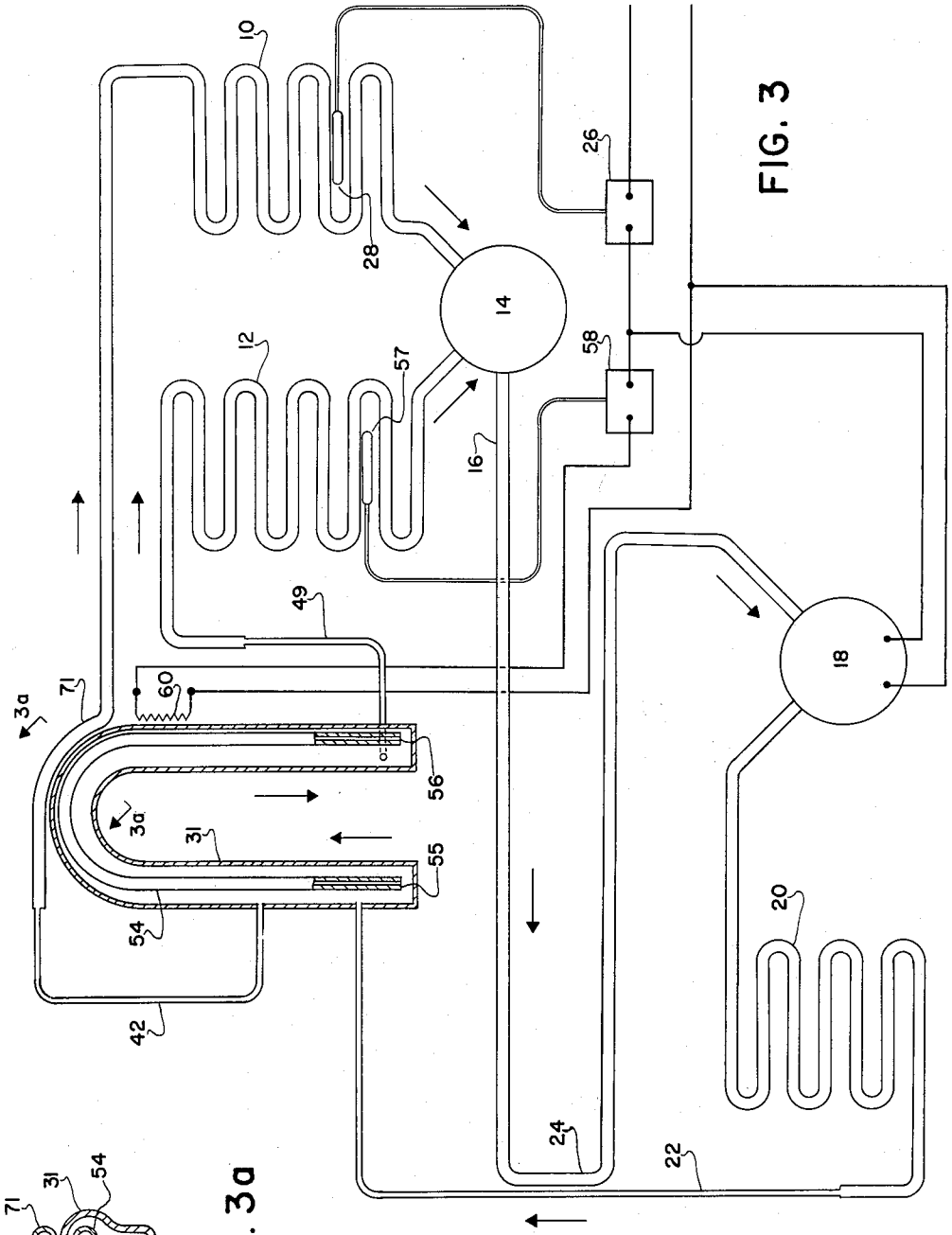


FIG. 3

FIG. 3a

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REFRIGERATING APPARATUS

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11 Claims. (Cl. 62—4)

This invention relates to a refrigerating apparatus of the type which includes two selectively controlled evaporator flow paths which are supplied with refrigerant by a single motor compressor unit.

The general object of the invention is to provide an improved refrigerating apparatus of the type set forth. More specifically, the invention relates to an improved flow control device for the refrigerant supplied to a multi-evaporator circuit.

A further object is to produce a simplified apparatus of this type which is less expensive to manufacture and to service.

A still further object of the invention is to produce an improved means of the type set forth which will operate in an efficient and positive manner and which has no moving parts and is therefore trouble free.

For the purposes of this disclosure, the present invention has been described as applied to a two-compartment or freezer-refrigerator combination. Since the invention resides in a flow control device generally, it is applicable to other multi-circuit systems.

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 representation of one embodiment of my invention.

Fig. 2 is a similar representation of a second embodiment of the invention.

Fig. 2*a* is a fragmentary view, partly in section and partly in elevation, showing a slight modification of the embodiment of Fig. 2.

Fig. 3 is a similar representation of a third embodiment of the invention.

Fig. 3*a* is a section on line 3*a*—3*a* on Fig. 3.

On the drawings the parts forming the subject matter of the invention are shown enlarged, or out of proportion relative to the conventional parts.

The embodiment of Fig. 1 includes a first evaporator **10**, for cooling the "freezer" compartment and a second evaporator **12**, for cooling the "food storage" compartment, of a conventional refrigerator. The manner in which the evaporators are disposed in their respective compartments and the refrigerating apparatus in connection with which said evaporators are used form no part of the invention and are therefore not shown nor described. It is enough for the purpose of this disclosure to say that evaporator **10** is to be maintained at a lower temperature than evaporator **12**. The apparatus shown also includes a conventional accumulator **14** for receiving the spent refrigerant from the outlet end of evaporator **10** and a pipe **16** for conducting the spent refrigerant from the accumulator **14** to a compressor **18**. The compressed refrigerant flows from compressor **18** through condenser **20** where the compressed gas is liquefied in the usual way and delivered to a restrictor, or capillary tube **22**. In order to insure that no liquid refrigerant reaches the compressor, and in order to improve the efficiency of the apparatus by further cooling

the refrigerant in capillary tube **22**, pipe **16** is conventionally brought into heat exchange relation with capillary **22** as at **24**. The operation of the compressor is controlled by a normally open switch **26** which closes and energizes the compressor when expansion of bellows **28** is brought about by a measured rise in the temperature of evaporator **10**, or its environment, and which opens automatically to de-energize the compressor when bellows **28** contracts as a result of a measured drop in the temperature of evaporator **10**, or its environment. Capillary tube **22** delivers the liquid refrigerant and the flash gas generated during the flow of the refrigerant through this tube to compartment **30** of a sump which is divided by partition **32** to form a second compartment **34**. Compartments **30** and **34** intercommunicate through a nonrestrictive opening **35** near the top of the sump. A restrictor tube **42** is used for conducting liquid refrigerant from compartment **30** to the inlet **44** of evaporator **10**. The intake end **46** of restrictor **42** is below opening **35** but above the discharge end of capillary tube **22**. A restrictor tube **49** is used to conduct liquid refrigerant from compartment **34** to evaporator **12**, the outlet end **50** of which leads to the intake end **44** of evaporator **10**. The intake end of restrictor tube **49** is below the intake end **46** of restrictor tube **42**. By this arrangement, evaporators **10** and **12** are series connected with reference to refrigerant flow through restrictor **49**, but are not series connected with reference to refrigerant flow through restrictor **42**. Tubes **22**, **42** and **49** are so proportioned that the restrictive effect of each of these tubes is considerably less than the restrictive effect of tube **22**. By this arrangement, each of restrictors **42** and **49** is alone capable of carrying away all of the liquid refrigerant delivered to the sump by capillary tube **22**. It is to be noted that tube **42** is sufficiently restrictive to produce the pressure drop required to meet the demand of heat exchange shown at **62** and hereinafter explained. An inverted U-shaped tube **54** extends outwardly of the sump with its ends **55** and **56** located adjacent the bottoms of compartments **30** and **34**. Tube **54** is considerably less restrictive than tube **22** and is therefore also capable of carrying away all of the refrigerant delivered to the sump by capillary tube **22**. Associated with evaporator **12** is a bellows **57** which, when contracted due to a drop in the temperature of evaporator **12**, closes normally open switch **58** to energize heater **60**, and vice versa. Switch **58** is series connected to switch **26**.

The operation is as follows: At the beginning of a cycle, and with the temperature of both evaporators above the desired respective values, bellows **57** opens switch **58** to de-energize heater **60** and bellows **28** closes switch **26** to energize the compressor to start the delivery of the refrigerant to compartment **30** of the sump. Some of the gaseous refrigerant reaching compartment **30** will flow through restrictor tube **42** and some of it will flow through opening **35** into compartment **34**. From compartment **34** the gaseous refrigerant will flow through restrictor tube **49** to evaporator **12**. As liquid refrigerant accumulates in compartment **30** it first submerges the end **55** of syphon tube **54** (which has some gas in the uppermost part thereof) and then flows through restrictor tube **42** to evaporator **10**. As above noted, tube **42** is capable of carrying away all of the liquid refrigerant reaching the sump, and therefore only flash gas will flow into compartment **34** and through restrictor **49**. As liquid refrigerant flows through restrictor tube **42**, it expands and cools. Therefore by bringing a portion of tube **42** into heat exchange relation with syphon tube **54** at **62**, the refrigerant gas in syphon tube **54** is condensed and the liquid refrigerant thus produced runs

down and seals the lower end 56 of the syphon tube. With the other end 55 of tube 54 already sealed, and with the pressure within the tube 54 less than the pressure within the sump, tube 54 is drawn full of liquid and a syphon action is set up whereby all of the liquid refrigerant delivered to compartment 30 will flow through tube 54 to compartment 34 and through restrictor 49 to evaporator 12 and to series connected evaporator 10. Since restrictor tube 49 is also capable of carrying away all of the liquid refrigerant which reaches compartment 34, only the flash gas will flow through restrictor 42. The thermal capacity of this flash gas is low and therefore it will have no practical effect on heat exchange 62, that is, it cannot break the syphon action in tube 54. Therefore, the flow of liquid refrigerant through restrictor tube 49 continues until the temperature of evaporator 12 reaches the desired low value whereupon bellows 57 closes switch 58 and energizes heater 60. The heat from heater 60 evaporates the liquid refrigerant in syphon tube 54 and breaks the syphon action so that liquid refrigerant stops flowing into compartment 34 and the flow of liquid refrigerant through restrictor tube 42 is resumed. The heat from heater 60 is enough to overcome the cooling effect produced at 62 by the flow of the liquid refrigerant through restrictor tube 42. This prevents the re-establishment of the syphon action through tube 54 until the temperature of evaporator 12 has again risen to the predetermined high value necessary to activate bellows 57 to de-energize heater 60 whereupon the syphon action through tube 54 will be restablished in the manner above set forth. When the temperature of evaporator 10 has fallen to the predetermined value, bellows 28 opens switch 26 to deactivate the compressor, and when the temperature of evaporator 10 again reaches a value high enough to cause bellows 26 to energize the compressor, a new cycle begins. The flow control disclosed, including the sump, the syphon tube, and the heat exchanges should be insulated from ambient or external heat, so that they may respond exclusively to the factors inherent in the system instead of to extraneously imposed conditions which would defeat the purpose of the control.

The embodiment of Fig. 2 differs from that of Fig. 1 in that an inverted tube 70 is substituted for sump 31; a non-restrictive tube 71 instead of restrictor tube 42 is brought into heat exchange with syphon tube 54; the outlet of restrictor tube 42 leads, through tube 71, to the inlet of evaporator 12 instead of to the inlet of evaporator 10, and restrictor tube 49 leads to the inlet of both evaporator 10 instead of to the inlet of evaporator 12. The only difference in the flow of refrigerant is that, in this embodiment, evaporators are fed by restrictor 42 instead of by restrictor tube 49 as in Fig 1. In Fig. 2 control 58 is reversed so as to close upon a rise in temperature.

Instead of the syphon tube 54 being cut into the outer inverted U-tube 70, as shown in Fig. 2, the syphon tube may be wholly without tube 70 with the lower ends of the syphon tube connected to the lower end of the outer tube or sump 70 as shown in Fig. 2*a*.

The embodiment of Fig. 3 differs from the other embodiments as follows: The evaporators are parallel instead of being series connected, with restrictor tube 42 feeding evaporator 10 and restrictor tube 49 feeding evaporator 12, the outlets of both evaporators are connected to a common accumulator 14, and liquid refrigerant can only be supplied to one of the evaporators or to the other, but never to both.

The length and the diameter of each of tubes 42 and 49 may be varied according to the restrictive effect to be achieved. That being the case, it is possible to dispense with tubes 42 and 49 and to provide measured openings in the walls of compartments 30 and 34 and to connect the inlets of the evaporator circuits directly to said measured openings.

What I claim is:

1. A refrigerating apparatus including a first evaporator and a second evaporator, a motor compressor unit for withdrawing spent refrigerant from said evaporators and for compressing and liquefying it, a closed sump including a first compartment and a second compartment, there being an opening in the upper portion of said sump establishing communication between said compartments, a first conduit for delivering liquid refrigerant and flash gas from said motor compressor unit to said first compartment, a second conduit leading from said first compartment to said first evaporator for delivering the liquid refrigerant reaching said first compartment to said first evaporator, the intake end of said second conduit being below said opening and above the bottom of said first compartment, a third conduit for delivering the liquid refrigerant reaching said second compartment to said second evaporator, the intake of said third conduit being below the intake of said second conduit, a tube connecting said compartments in flow relationship and having its ends near the bottoms of said compartments respectively, said tube being normally filled with flash gas, means for inducing a syphon action in said tube to draw liquid refrigerant from said first to said second compartment to stop the flow of liquid refrigerant through said second conduit to said first evaporator and to cause the liquid refrigerant to flow through said third conduit, to said second evaporator, and means for breaking said syphon action to stop the flow of liquid refrigerant to said second evaporator and to restore the flow of liquid refrigerant to said first evaporator.

2. The structure defined in claim 1 in which said first means is operative to condense the gas in said tube to induce said syphon action and in which said second means is operative to evaporate liquid refrigerant flowing in said tube to break the syphon action.

3. The structure defined in claim 2 in which said first means is in the nature of a heat exchange between a refrigerated portion of said second conduit and a portion of said tube, and said second means is in the nature of a source of heat, and means for activating said source of heat when the temperature of said second evaporator falls to a predetermined value.

4. The structure recited in claim 1 in which said evaporators are series connected with the outlet of said second evaporator leading to the inlet of said first evaporator.

5. The structure recited in claim 4 and means operable by the rise, or by the fall, of the temperature of said first evaporator to activate or to deactivate said compressor.

6. For use in a refrigerating system of the type which includes a condensing unit for delivering liquid refrigerant and two evaporator circuits to be selectively supplied with refrigerant from said condensing unit, a flow control device comprising a first sump and a second sump having their uppermost ends in communication, and an inverted U tube communicating with the lower portions of said sumps; said first sump having a refrigerant inlet port communicating with said condensing unit and also having an outlet port adapted to supply one of said circuits, said second sump having an outlet port disposed at a level below said first outlet port and adapted to supply the other of said circuits; a heat exchange means for inducing liquid flow through said inverted U tube from said first sump to said second sump and toward the other of said circuits; and a second heat exchange means operable to stop the liquid flow through said inverted U tube and to restore the flow of liquid to said first circuit.

7. The structure recited in accordance with claim 6 and further characterized in that said outlet ports are of flow restrictive dimensions.

8. The structure recited in accordance with claim 6 which is characterized in that the first mentioned heat exchange means comprises a portion of the first evaporator circuit communicating with said first outlet port in heat exchange relation with said U-tube.

9. The structure recited in accordance with claim 6 and further characterized in that the second said heat exchange means comprises an electrical resistance heater.

10. The structure recited in claim 6 and further characterized in that said first and second sumps and said inverted U-tube are formed of tubular sections with said inverted U-tube nested within said sumps and disposed for thermal conductivity there.

11. A refrigerating system including a condensing unit for selectively delivering liquid refrigerant to two evaporator circuits, a first sump, a second sump, the uppermost ends of said sumps being in open communication, said first sump having an inlet for condensed refrigerant and an outflow passage adapted to provide flow to one of said circuits, said second sump having an outflow passage

disposed at a level below said first outflow passage and adapted to provide flow to the other of said circuits an inverted U-tube communicating with the lower ends of said sumps; a first heat exchange means adapted to cool said U-tube and cause flow of liquid from said first sump through said U-tube toward said second outflow passage; and a second heat exchange means operable to heat said U-tube thereby to terminate liquid flow therethrough and to restore the flow of liquid toward said first outflow passage.

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