April 25, 1967 R. R. ROSS 3,315,484

PRESSURIZED REFRIGERATION CIRCULATING SYSTEM

Filed May 17, 1965 4 Sheets-Sheet 1

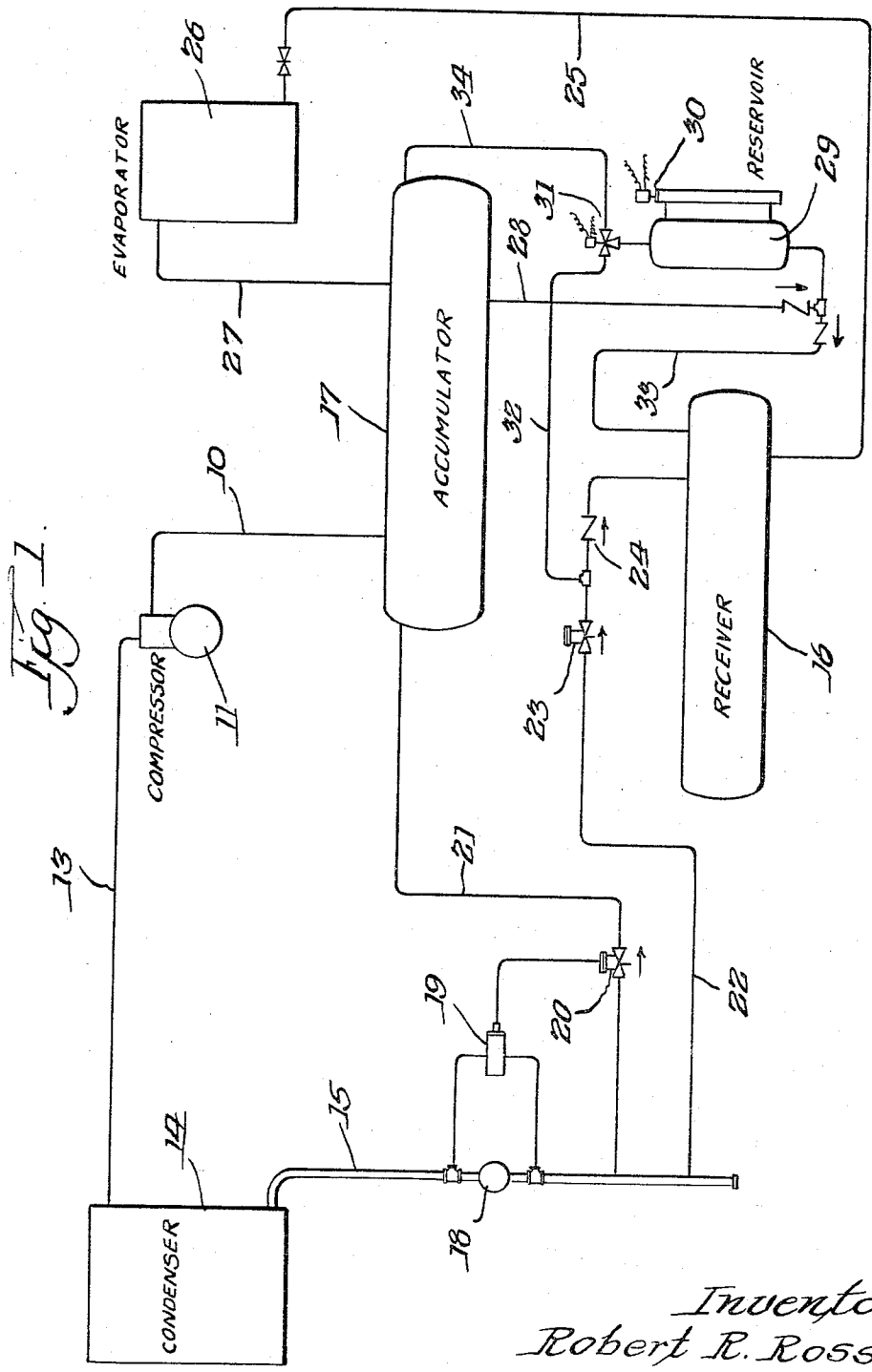


Fig. 1.

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PRESSURIZED REFRIGERATION CIRCULATING SYSTEM

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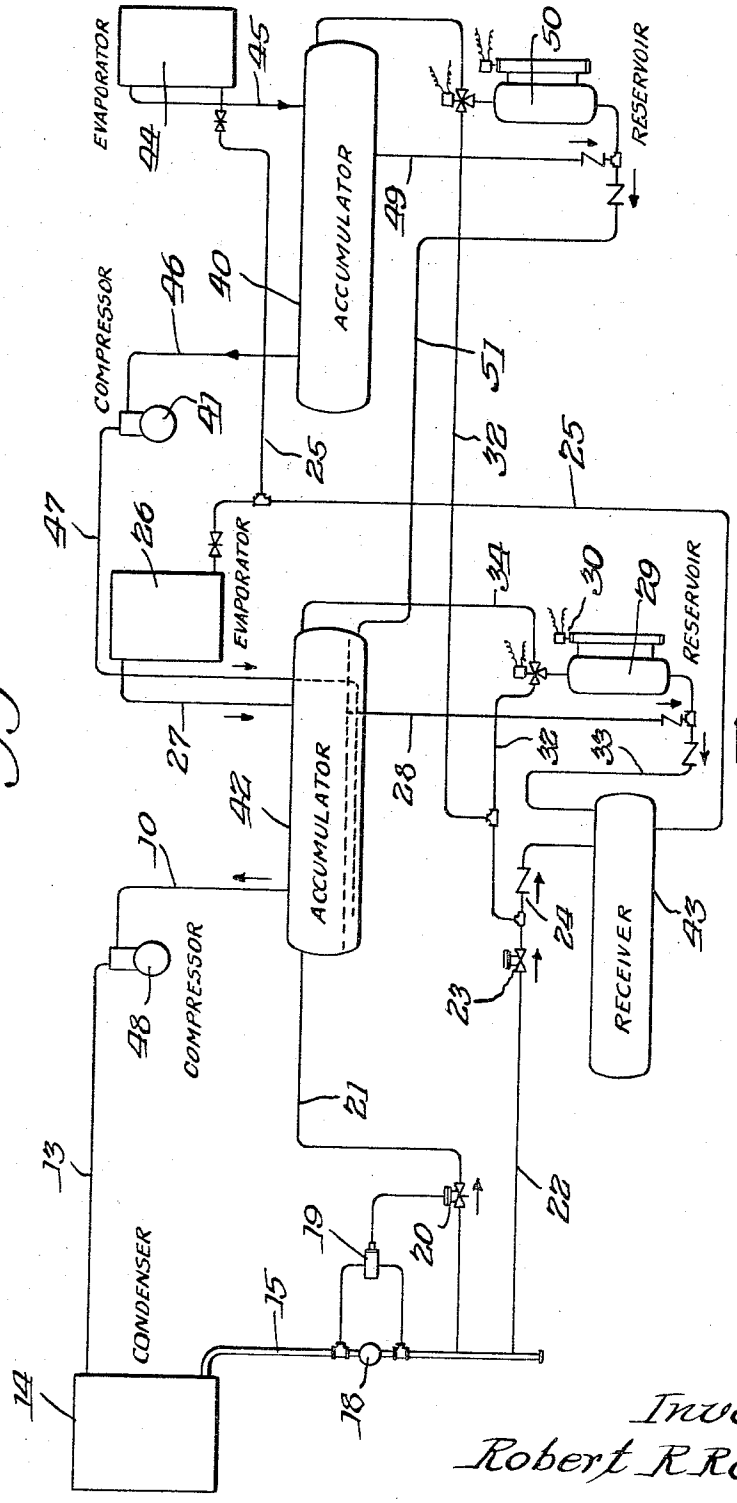


Fig. 2.

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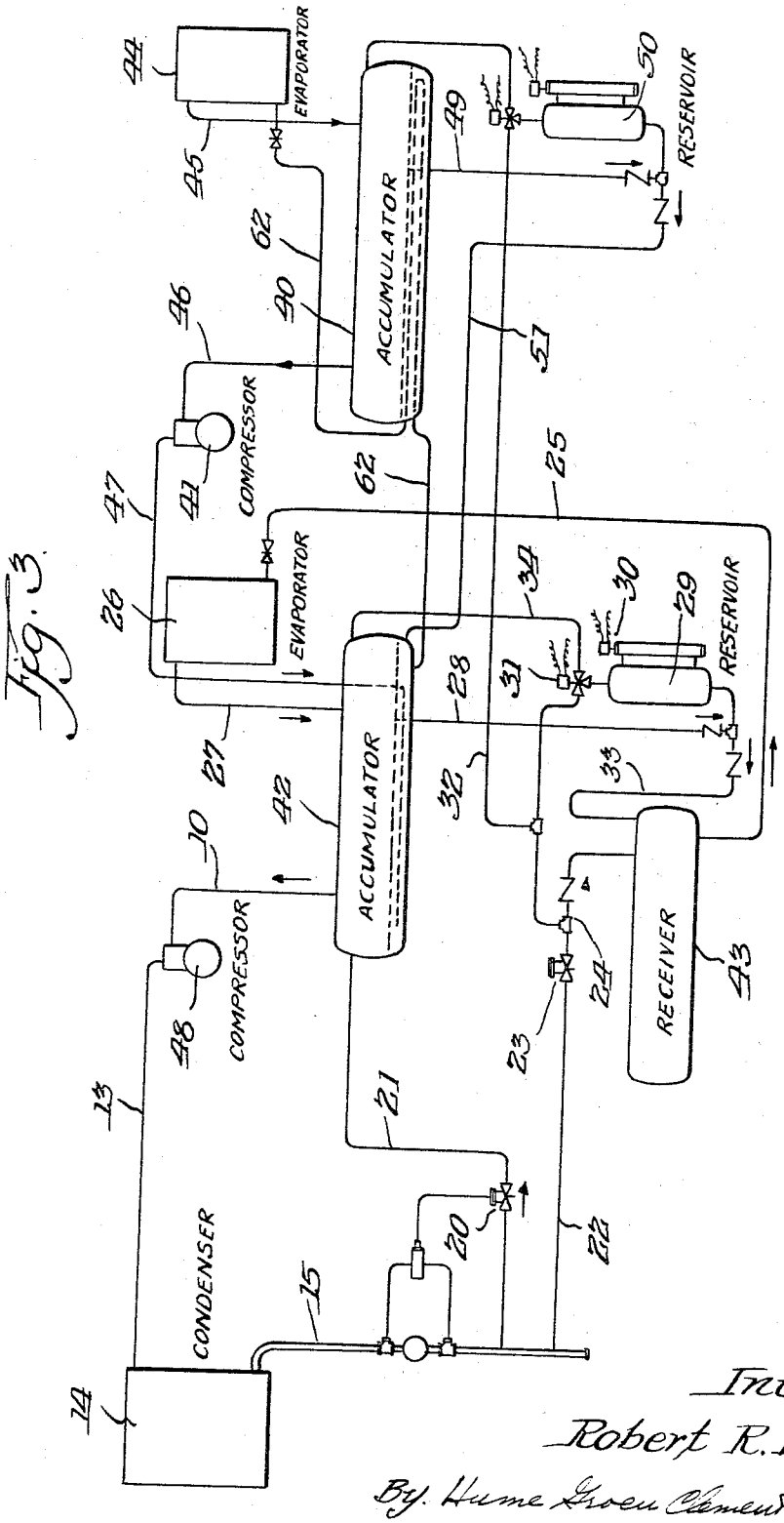
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PRESSURIZED REFRIGERATION CIRCULATING SYSTEM

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Fig. 3



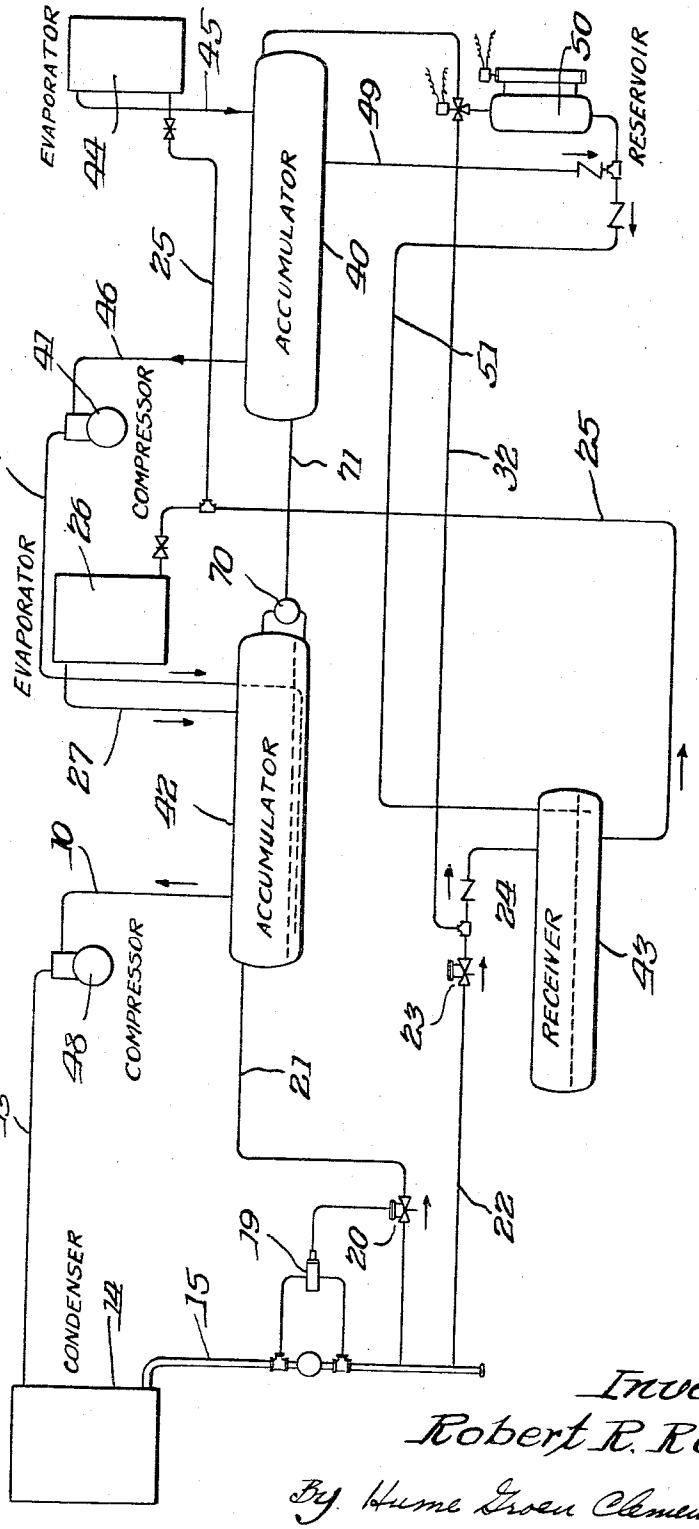
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PRESSURIZED REFRIGERATION CIRCULATING SYSTEM

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Fig. 4



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3,315,484

PRESSURIZED REFRIGERATION CIRCULATING SYSTEM

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7 Claims. (Cl. 62—174)

The invention relates to refrigerating systems and has reference more particularly to large capacity industrial type refrigerating systems wherein it is necessary to protect the compressor of the system from liquid refrigerants such as would otherwise return in the suction line to the compressor and cause damage to the compressor.

The refrigerant circulating system of the invention is designed for incorporation in the refrigerating system of an industrial plant such as may operate with multi-stages of compression and with evaporators discharging to the high stage compressor suction as well as to the booster suction. However, the system may also be applied to refrigeration plants using single stage operation.

An object of the invention is to provide improvements in refrigerating systems whereby complete and constant circulation of both the liquid and gaseous refrigerant is accomplished without adding to the power requirements of the plant.

Another object of the invention is to provide an apparatus for the circulation of the liquid refrigerant in a controlled manner and which will be caused to by-pass the compressor of the system so that the evaporators can be operated continuously and in a flooded condition.

Another object of the invention resides in the provision of a refrigerant circulating system of the type as described, having a constant pressure for feeding liquid refrigerant to a plurality of evaporators operating at different suction pressures.

A more specific object is to provide a refrigerant circulating system incorporating the improvements as described and wherein the required pressure is produced by using the pressure of the available refrigerant in the system, thus eliminating the need for additional mechanical pumps.

Other objects and advantages of this invention will be apparent from the following description and the accompanying drawings wherein—

FIGURE 1 is a diagrammatic view illustrating a refrigerating system having incorporated therein evaporators and a compressor, together with the necessary components comprising the improved combination of the invention;

FIGURE 2 is a diagrammatic view of a modified refrigeration system, basically similar to FIGURE 1, but incorporating two separate suction circuits at two different suction pressures;

FIGURE 3 is a diagrammatic view of a modified form of the invention, the same including a system with high and low temperature evaporators with two compressors; and

FIGURE 4 is a diagrammatic view of another modified refrigeration system coming within the invention.

Referring to FIGURE 1 of the drawings, the numeral **10** indicates the suction line for returning the evaporated refrigerant from the evaporators to the compressor **11**, the compressor having a high pressure discharge line **13**. The compressor is conventional in construction and in operation, increasing the pressure of the gas in the suction line which results in a corresponding temperature increase. The high pressure discharge line **13** delivers into the condenser **14**, having an outlet connection **15** leading through line **22** to the receiver **16** and through line **21** to the suction line accumulator **17**. The outlet connection **15** also has interposed therein a pilot receiver **18**

and with which is combined the high side float valve **19** and pilot operated control valve **20**, the said pilot operated control valve being interposed in the connection **21** leading to the accumulator **17**. The downstream pressure regulating valve **23** and the pressure reducing valve **24** are interposed in line **22** leading to the receiver **16**. The pressure in the receiver **16** will be maintained at a pressure below the condensing pressure (which may be in the range of 160 p.s.i.), and above the suction pressure, by means of the downstream pressure regulator **23**. It is understood that the receiver pressure will be maintained at a level sufficient to allow flow to the evaporators **26** through the feed line **25** which is connected to the receiver. Should the receiver pressure drop below the pressure controlled by the setting of pressure regulator **23**, and valve **24**, the regulator **23** will allow a flow of liquid, together with its flash gas, to pass into the receiver to maintain the pressure. The amount of liquid which passes through regulator **23** may be less than the amount passing out of the condenser **14**. This will cause a liquid level rise in pilot receiver **19**, which will cause the opening of pilot operated valve **20**, and cause some liquid to flow into accumulator **17**.

The said accumulator also receives gas, together with the excess liquid which passes from the evaporators **26** through **27**. The excess liquid is termed the "slop over" and must by-pass the compressor. Only the gas is returned by suction line **10** to the compressor **11**.

The liquid feed line **25** to the evaporators **26** connects with the receiver **16**.

The transfer of the liquid refrigerant from the accumulator **17** to the receiver **16** is accomplished by a return system of the type disclosed and claimed in the Phillips Patent 2,589,859, granted Mar. 18, 1952, and entitled, Suction Line Liquid Return Trap. Liquid refrigerant flows by gravity from accumulator **17** by means of line **28** to the trap **29**. When the liquid level in the trap reaches a predetermined level, the differential float switch **30** will actuate the three-way valve **31** to connect the top of the trap to the discharge of the pressure regulator **23** by means of line **32**. The flash gas flowing from the regulator with the liquid will displace the liquid in the trap **29** and force the liquid within the trap into the receiver **16** through the connecting line **33**. Valve **24** which permits flow in one direction only to the receiver and which is downstream of regulator **23** feeding the receiver imposes a pressure drop so that the receiver pressure may be slightly below the set pressure of regulator **23**. This aids in inducing flow to take place from the trap to the receiver. When the liquid refrigerant in the trap reaches a predetermined low level, the switch **30** will again actuate the three-way valve **31** to close line **32** and connect the trap with line **34** leading to the accumulator **17**. With the accumulator and trap thus equalized in pressure, the liquid refrigerant will again flow by gravity into the trap.

The circulating system of FIGURE 2 is similar in its aspects to that shown in FIGURE 1 with the exception that another suction line circuit with a corresponding suction line accumulator **40** and booster compressor **41** is added. Liquid is fed to high and low temperature evaporators from the receiver **43**. Liquid and gas flowing from the low temperature evaporators **44** pass through line **45** to the low temperature accumulator **40**. The gas enters suction line **46** and passes to the suction side of the booster compressor **41**. Line **47** connects the discharge side of the booster compressor to the accumulator **42**. Gas from the booster discharge passes through this line and is desuperheated in the accumulator **42** and is then passed with the gas from the high temperature evaporators to the suction side of compressor **48**.

The excess liquid returning from evaporators **44** passes out of accumulator **40**, through line **49** into an added second trap **50**. This second trap is actuated in the same manner as described for the trap **29** in FIGURE 1, but discharges liquid through line **51** to accumulator **42**.

The circulating system of FIGURE 3 is similar and has the same basic components as FIGURE 2. The only difference is that the liquid to the low temperature evaporators **44** is fed directly from the accumulator **42** through line **62** in which is interposed a sub-cooling coil which passes through accumulator **40**. This system can be used when the pressure in accumulator **42** is of sufficient elevation to cause liquid feed to the low temperature evaporators **44**.

The circulating system of FIGURE 4 is similar to that in FIGURE 2. The trap **50** connected to low temperature accumulator **40** is actuated in the same manner as previously described, but discharges the liquid directly to receiver **43**. High side control **70** will be actuated by the liquid level in accumulator **42** and will allow the liquid to flow through line **71** to accumulator **40** should the liquid in accumulator **42** rise above a predetermined level.

In the refrigerating structure herein described it will be understood that the feed line for the evaporators includes the high pressure gaseous line **13**, the condenser **14**, lines **15** and **22**, the receiver **16** and line **25**. Since the accumulator **17** is supplied with liquid refrigerant by the connections **21**, it is possible to connect the receiver **16** with the gaseous refrigerant line **13** instead of having line **22** connect with **15** as shown. An additional alternative as regards the modification of FIGURE 2 resides in the fact that line **51** instead of delivering to the accumulator **42** can be connected to the receiver **43** for delivery of the liquid refrigerant directly to the receiver.

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 of the scope of the claims.

What is claimed is:

1. In a refrigerating system, in combination, a condenser, an evaporator, a feed line for supplying liquid refrigerant under pressure to said evaporator in an amount greater than the evaporator is capable of evaporating, said feed line including a receiver and said feed line connecting the condenser with the receiver, a suction line for drawing off the vaporized and liquid refrigerant from the evaporator, an accumulator in the suction line for trapping the liquid refrigerant passing through the evaporator, liquid return means including a reservoir for receiving and temporarily storing the liquid refrigerant from said accumulator, a conduit connecting said reservoir with the receiver, means operable in response to changes in the level of the liquid in the reservoir, valve means controlled by said liquid level responsive means for introducing refrigerant from the feed line of the system into the said reservoir to force the liquid from the reservoir into the receiver for eventual delivery to the evaporator, means for controlling receiver pressure including a downstream pressure regulator located in the feed line in advance of the receiver, whereby the receiver is maintained at a pressure below condenser pressure but above evaporator pressure, and conduit means having connection with the feed line between the condenser and the pressure regulator for delivering liquid refrigerant to the accumulator.

2. A refrigerating system as defined by claim **1** additionally including a second evaporator and a second accumulator, the second accumulator being located in the suction line of the second evaporator for trapping any liquid refrigerant passing through the second evaporator, a feed line for the second evaporator having connection with the first mentioned accumulator for feeding liquid refrigerant trapped by the first mentioned accumulator to the second evaporator, said feed line for the second evaporator including a coil located in the second accumulator below the level of the liquid refrigerant within the second accumulator for cooling the refrigerant flowing in the feed line in advance of feeding the same to the second evaporator, and liquid return means for returning excess liquid refrigerant from the second accumulator to the first mentioned accumulator.

3. In a refrigerating system, in combination, an evaporator, a feed line for supplying liquid refrigerant under pressure to said evaporator in an amount greater than the evaporator is capable of evaporating, said feed line including a receiver, a suction line for drawing off the vaporized and liquid refrigerant from the evaporator, an accumulator in the suction line for trapping the liquid refrigerant passing through the evaporator, liquid return means including a reservoir for receiving and temporarily storing the liquid refrigerant from said accumulator, a conduit connecting said reservoir with the receiver, means operable in response to changes in the level of the liquid in the reservoir, valve means controlled by said liquid level responsive means for introducing refrigerant from the feed line of the system into said reservoir to force the liquid from the reservoir into the receiver for eventual delivery to the evaporator, means for controlling receiver pressure including a downstream pressure regulator located in the feed line in advance of the receiver, whereby the receiver is maintained at a pressure below condensing pressure but above evaporator pressure, a second evaporator, a second accumulator, the second accumulator being located in the suction line of the second evaporator for trapping any liquid refrigerant passing through the second evaporator, a feed line for the second evaporator having connection with the receiver, and liquid return means for returning the excess liquid refrigerant from the second accumulator to the first mentioned accumulator.

4. In a refrigerating system, in combination, an evaporator, a feed line for supplying liquid refrigerant under pressure to said evaporator in an amount greater than the evaporator is capable of evaporating, said feed line including a receiver, a suction line for drawing off the vaporized and liquid refrigerant from the evaporator, an accumulator in the suction line for trapping the liquid refrigerant passing through the evaporator, means for controlling receiver pressure including a downstream pressure regulator located in the feed line in advance of the receiver, whereby the receiver is maintained at a pressure below condensing pressure but above evaporator pressure, a second evaporator, a feed line for the second evaporator having connection with the receiver, a second accumulator, the second accumulator being located in the suction line of the second evaporator for trapping any liquid refrigerant passing through the second evaporator, liquid return means for returning the excess liquid refrigerant from the second accumulator to the receiver, and conduit means connecting the first mentioned accumulator with the second accumulator for supplying liquid refrigerant in excess of a predetermined amount from the first mentioned accumulator to the second accumulator.

5. In a refrigerating system, in combination, a condenser, an evaporator, a feed line for supplying liquid refrigerant from the condenser to the evaporator in an amount greater than the evaporator is capable of evaporating, said feed line including a receiver, a suction line for drawing off the vaporized and liquid refrigerant from the evaporator, a first accumulator and a second accumulator, the second accumulator having location in the suction line for receiving and trapping the liquid refrigerant passing through the evaporator, means for controlling receiver pressure including a down stream pressure regulator located in the feed line in advance of the receiver, whereby the receiver is maintained at a pressure below condensing pressure but above evaporator pressure, conduit means connecting with the feed line between the condenser and said pressure regulator for supplying liquid refrigerant to

the first accumulator whereby the first accumulator receives and stores liquid refrigerant supplied thereto from the condenser, a connection between the first accumulator and the second accumulator for supplying liquid refrigerant in excess of a predetermined amount from the first accumulator to the second accumulator, and liquid return means for returning the excess liquid refrigerant from the second accumulator to the receiver.

6. In a refrigerating system, in combination, a condenser, an evaporator, a feed line for supplying liquid refrigerant from the condenser to the evaporator in an amount greater than the evaporator is capable of evaporating, said feed line including a receiver, a suction line for drawing off the vaporized and liquid refrigerant from the evaporator, an accumulator in the suction line for trapping the liquid refrigerant passing through the evaporator, liquid return means for receiving the liquid refrigerant from the accumulator and for returning the same to the receiver for eventual delivery to the evaporator, means for controlling receiver pressure including a downstream pressure regulator located in the feed line in advance of the receiver, whereby the receiver is maintained

at a pressure below condensing pressure but above evaporator pressure, and conduit means connecting with the feed line between the condenser and the pressure regulator for delivering liquid refrigerant to said accumulator.

7. In a refrigerating system as defined by claim **6**, additionally including a valve in the feed line between the pressure regulator and the receiver permitting flow in the direction of the receiver only, said valve effecting a pressure drop to maintain the receiver at a pressure below the set pressure of the pressure regulator.

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