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[54] **REFRIGERATION SYSTEM**
2 Claims, 1 Drawing Fig.

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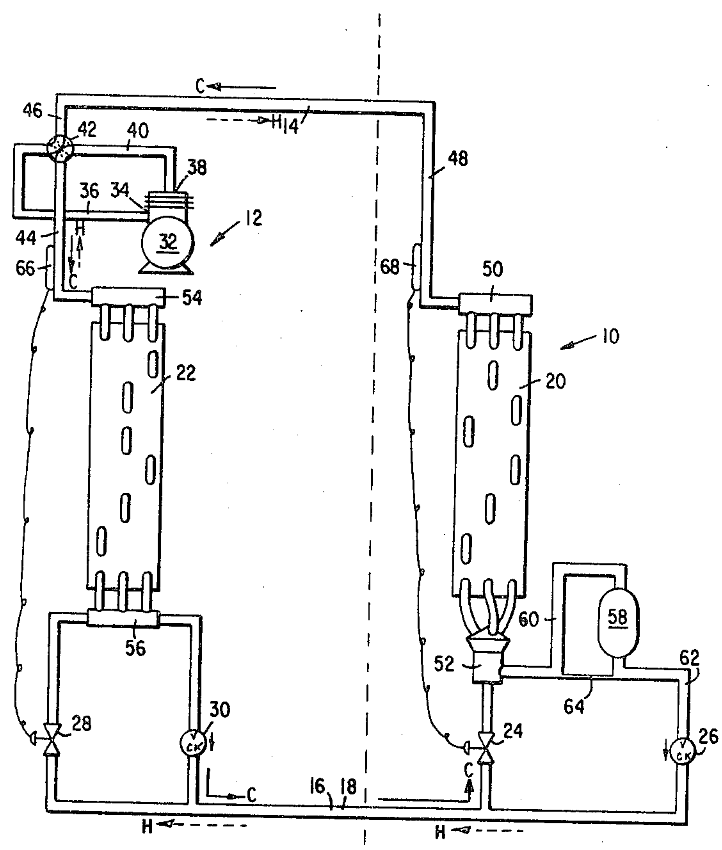
ABSTRACT: The present invention is directed to refrigeration systems of the type referred to in the art as heat pumps comprising a compressor, a pair of series-connected heat exchangers, reversing valve means for reversibly connecting the compressor to the heat exchangers for effecting flow of refrigerant through a portion of the circuit in either direction, refrigerant flow control means in the circuit, and a refrigerant container or receiver connected between the two heat exchangers for storing a portion of the refrigerant charge during operation of the system, the container being so constructed and arranged as to readily accommodate varying charge imbalances in the system and also having in communication therewith tubular means for effecting essentially complete removal of oil entrapped in the container and its return to the compressor when the system is reversed from the heating to the cooling cycle, thereby assuring an adequate supply of oil in the compressor for lubrication purposes.



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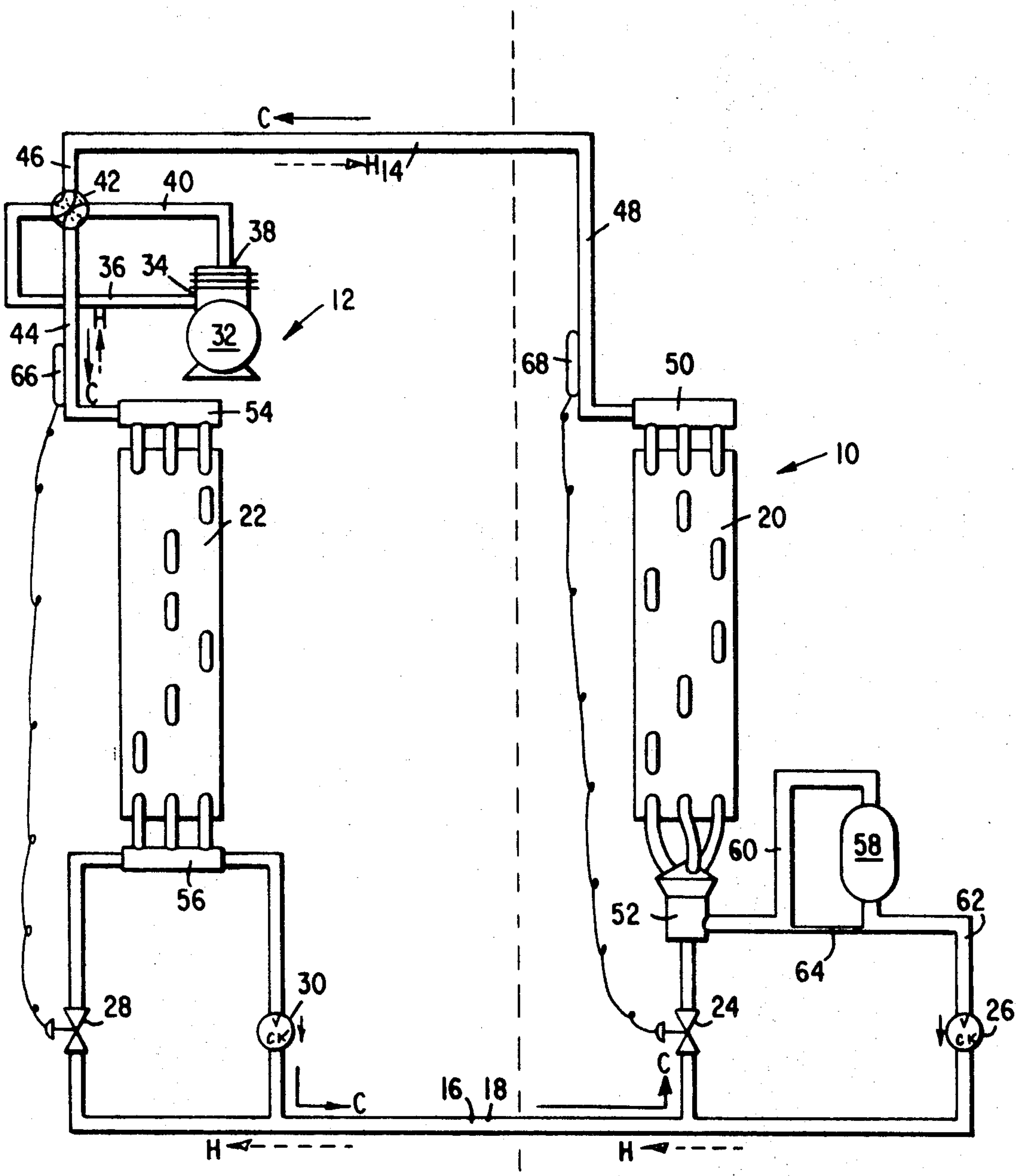

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REFRIGERATION SYSTEM

BACKGROUND OF THE INVENTION

Conventionally, a heat pump is provided with reversing means for directing the flow of high-pressure refrigerant gas from a compressor into either of two series-connected heat exchangers and for returning the low-pressure refrigerant from the other heat exchanger to the compressor. The conditions prevailing during operation of the system in one direction as compared to those which exist while operating in the other direction are usually such as to require, for the most optimum performance of the heat pump, that the refrigerant charge flowing through the system be less in one direction than when operating in the other direction. In most heat pumps, it is desirable to decrease the effective refrigerant charge flowing in the circuit during the winter or heating cycle operation over the charge designed to give optimum performance during the summer or cooling operation.

A well-known arrangement for automatically taking care of the different refrigerant flow requirements of the system is to utilize a receiver in which there is stored a portion of the refrigerant charge during operation of the system on the heating cycle. Various receiver configurations have been employed for this purpose, and an exemplary structure takes the form of a "deal-end" receptacle which houses therein a standpipe normally provided with an orifice adjacent its lower end for facilitating return to the compressor of oil trapped in the receptacle through conduit means connected at one end to the standpipe lower end.

While a receiver of the character just briefly described has proven its effectiveness for most applications, a need exists for a receiver so constructed and arranged in the refrigeration system as to more readily accommodate refrigerant charge imbalance variations in the system and when employed in combination with a relatively slender communicating oil return tube, the receiver is essentially completely emptied of the oil which was trapped therein.

SUMMARY OF THE INVENTION

The present invention is particularly directed to a refrigeration system or heat pump which incorporates therein a refrigerant tank or receiver located in a closed reversible refrigerant circuit between indoor and outdoor heat exchangers, the tank being connected at one end to one of the heat exchangers for receiving during the heating cycle condensed liquid refrigerant therefrom and simultaneously storing within the tank or receiver a portion of the liquid refrigerant while the remainder thereof is passed through the opposite end of the receiver to the other heat exchanger to be evaporated therein. Oil from the compressor naturally is entrapped in the receiver, and when the heat pump is reversed from the heating to the cooling cycle, the stored liquid refrigerant boils off, passes from the top or one end of the receiver to the heat exchanger which supplied the stored liquid, and by provision in accordance with this invention of a relatively slender tube or capillary connecting the lower end of the receiver to the last-mentioned heat exchanger, the trapped oil completely and rapidly drains from the receiver and is returned to the compressor.

By this invention, as will be pointed out in detail hereinafter, the described receiver possesses considerable versatility in that it can accommodate significant variations in the refrigerant charge imbalance in the system as may be occasioned by different component combinations, and the oil return device when constructed and positioned as described assures rapid and complete drainage of the receiver.

BRIEF DESCRIPTION OF THE DRAWING

The single view is a diagrammatic illustration of a reverse cycle refrigeration system of the split-unit type embodying the novel concepts of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, there is shown a heat pump comprising a split refrigeration system which includes an indoor unit **10** and an outdoor unit **12** adapted to be connected in the field during installation of the heat pump by means of refrigerant lines or conduits **14** and **16**, the lengths of which will obviously depend upon the distance between the two units in any particular installation, and therefore, the total volume of the system cannot be determined until after the installation is made. The line **16** comprises part of a relatively longer conduit generally indicated by the reference numeral **18** for connecting an indoor heat exchanger **20** forming part of the indoor unit **10** with an outdoor heat exchanger **22** forming a part of the outdoor unit **12**.

The conduit **18** also includes flow control or flow-restricting means for maintaining the pressure difference between the indoor heat exchanger **20** and the outdoor heat exchanger **22**. In the embodiment of the invention shown, the indoor unit **10** includes flow control means taking the form of a thermal expansion valve **24** and a bypass line including a check valve **26** which bypasses refrigerant around the thermal expansion valve **24** when the heat pump is operated as a heating unit and the indoor heat exchanger **20** is functioning as a condenser. The outdoor unit **12** comprises flow control means desirably in the form of a thermal expansion valve **28** and a bypass line including a check valve **30** which bypasses refrigerant around valve **28** when the heat pump is operating on the cooling cycle in which the outdoor heat exchanger **22** functions as a condenser.

A compressor **32** having an inlet **34** connected to a suction line **36** and an outlet **38** connected to a discharge line **40** and a reversing valve **42** connected to the suction and discharge lines provide means for effecting flow of refrigerant through the refrigerant circuit including the two heat exchangers in either direction, whereby the indoor unit **10** may be operated either as a heating unit in which the indoor heat exchanger **20** functions as a condenser, or as a cooling unit in which the indoor heat exchanger **20** functions as an evaporator. The compressor **32** and reversing valve **42** may be supplied as a separate unit or may be part of either of the units **10** and **12**. In the illustrated embodiment of the invention they form part of the outdoor unit **12** in which case the reversing valve **42** is connected to the outdoor heat exchanger **22** by means of a conduit **44** and to the indoor heat exchanger **20** by means of conduits **46, 14** and **48**.

As also appears in the drawing, the conduit **48** has connected thereto header means **50** which connect with the indoor heat exchanger **20**, the opposite end of this same heat exchanger being in communication with distributor means **52**. Header means **54** and **56** are also provided in connecting relation with opposite ends of the outdoor heat exchanger **22**.

For optimum operation of a heat pump of this type comprising flow control means for controlling the pressure differential between the two heat exchangers, a smaller circulating charge is desired on the heating cycle than on the cooling cycle. To provide a decrease in the effective refrigerant charge when the heat pump is changed over from operation on the cooling cycle to the heating cycle, and an increase in the effective refrigerant charge when the refrigeration system is reversed from heating to cooling, there is provided a storage tank or receiver **58** between the indoor heat exchanger **20** and the flow-restricting means. The container or receiver is connected at one end which is the upper end thereof, to the distributor means or like device **52** by a conduit **60** and at its opposite or lower end to the conduit **18** by means of conduit **62**. Also communicating with the lower end of the receiver **58** is oil return means **64** which preferably takes the form of a relatively small diameter tube or capillary connected to the distributor **52** through the conduit **60** for returning oil to the compressor **32** when the heat pump is changed over from the heating to the cooling cycle and the indoor heat exchanger is functioning as an evaporator. Additionally, the capillary tube **64** performs the important function of minimizing liquid flow when the system is on the heating cycle, thus forcing the liquid through the receiver. While not shown, there may be provided in the conduit **62** a trap of inverted generally U-shape configuration to prevent the accumulation of oil in the conduit **62** from its point of connection to the lower end of the receiver **58** down to the check valve **26** when the heat pump is on the cooling cycle and the valve **26** is closed.

In contrast to known receivers, generally termed as "deadend" receptacles, and which house therein a standpipe open at its upper end and provided adjacent its lower end with an oil discharge orifice for returning trapped oil to the compressor, the receiver of this invention and oil return capillary, when constructed and arranged as shown, have several advantages. First, since the receiver shown is of variable capacity, it possesses considerable versatility in that it can be employed without substantial structural changes thereto for a wide variety of component combinations. For example, under a particular set of environmental conditions, the size of the indoor and outdoor heat exchangers, and more specifically the internal volume thereof, are preselected so that when the system is charged and operating, a particular volume of excess refrigerant will be stored in the receiver when the heat pump is on the heating cycle. Illustratively, and depending in part on he particular refrigerant employed, the optimum charge for the system may be 10 pounds when the heat pump is on the cooling cycle and 8 pounds when on the heating cycle, leaving an excess of 2 pounds of refrigerant to be stored in the receiver during the latter cycle. However, under a different set of conditions, as in a geographical area where the winters are relatively severe and the summers mild, a lesser volume of excess refrigerant would be stored or it may even be desirable to locate the receiver and oil return capillary on the line leading to the outdoor heat exchanger in relatively close proximity thereto and to store refrigerant during the cooling cycle. In any event, and particularly when the heat pump is being operated as shown in the drawing, refrigerant imbalances in he system from any one of a number of causes can be readily accommodated.

Second, and as was pointed out earlier, the provision of a relatively slender tube or capillary as the oil return means, when located as shown, assures rapid and complete drainage of oil from the receiver when the heat pump cycle is reversed from heating to cooling.

The operation of the refrigeration system of this invention will now be described. On the cooling cycle, hot compressed refrigerant gas is discharged from the compressor **32** through the discharge conduit **40** to the reversing valve **42** which directs it through the conduit **44** and the header **54** into the outdoor heat exchanger **22** wherein the refrigerant is condensed and flows to the header **56**. It is to be noted at this point that the thermal expansion valve **28** is connected by a capillary to sensing means **66** on the conduit **44**, the capillary transferring the pressure in the sensing means or bulb **66** to the valve. Condensed refrigerant from the outdoor heat exchanger **22** and header **56** bypasses valve **28** and flows through the check valve **30** which is open by reason of the presence of essentially balanced high-pressure liquid on opposite sides thereof. The refrigerant accordingly takes the path of least resistance. The condensed refrigerant then passes through the conduit **16** forming a part of the line **18** and through the valve **24**.

During operation of the heat pump on the cooling cycle, a pressure differential exists on opposite sides of the check valve **26** as between high-pressure liquid refrigerant from the conduit **16** and low-pressure refrigerant gas acting upon the opposite side of the check valve. This discourages flow of refrigerant from the receiver **58** through check valve **26**. High-pressure liquid bypasses the check valve **26**, as noted, moves through the valve **24** which is connected to sensing means **68** in the manner of valve **28** and the bulb **66**, and from the distributor means or like device **52** into the indoor heat exchanger **20** in which the refrigerant is evaporated by absorbing heat from the surrounding atmosphere, whereby the air in the dwelling or other structure being conditioned by the heat pump is cooled. Gaseous refrigerant from the heat exchanger **20** is withdrawn at relatively low temperature and pressure and passes through the conduits **48**, **14**, and **46**, the reversing valve **42** and suction conduit **36** into the compressor **32**.

When the reversing valve **42** is reversed by hand-manipulable means (not shown) or a similar device for operation of the refrigeration system on the heating cycle, hot compressed refrigerant gas from the compressor **32** is discharged through the discharge conduit **40** to the reversing valve **42** which directs it through the connecting conduits **46**, **14**, and **48** to the header **50** communicating with the indoor heat exchanger **20** functioning on the heating cycle as a condenser. The hot refrigerant gives up its heat of condensation to the space being conditioned, and the condensed or liquid refrigerant flows through the distributor means **52** and conduit **60** into the receiver **58** wherein a portion thereof collects, the volume of this portion depending generally upon the refrigerant charge imbalance in the system as controlled by the particular component combination selected to meet the environmental needs.

The volume of liquid so collected in the receiver **58** represents the difference between the optimum charges on the heating and cooling cycles, and as was previously noted, the collected liquid has trapped therewith oil which has passed to the heat exchanger **20** from the compressor **32**. The condensed liquid not collected, which constitutes the optimum charge for efficient operation on the heating cycle, passes through the conduit **62**. Since the check valve **26** is subjected on opposite sides thereof to relatively high-pressure liquid refrigerant and is thereby open, valve **24** is bypassed and high-pressure liquid refrigerant, with some oil entrained therewith, passes through the conduit **16**. The check valve **30** is closed at this time by reason of high-pressure liquid acting upon one side and low-pressure gas on the other, the refrigerant thereby bypasses the valve **30**, and flows through valve **28** and moves therefrom as a liquid-gas mixture into the outdoor heat exchanger **22** extracting heat from the outdoor air. The low-temperature low-pressure gas then passes through the reversing valve **42** and suction line **36** to the compressor **32**.

Upon reversal of the heat pump from the heating to the cooling cycle, liquid refrigerant which has condensed in the receiver and been collected therein during the heating cycle evaporates or boils off when the system is changed over to the cooling cycle and passes as vapor from the upper end of the receiver **58**, through the conduit **60** and into the distributor **52** where it combines with refrigerant passing through valve **24** from the conduit **16** into which it flowed from the outdoor heat exchanger **22**. It is to be noted at this point that the refrigerant evaporating in the receiver is added slowly to the system, thereby reducing floodback on changeover. Generally simultaneous with evaporation of the excess refrigerant in the receiver **58**, the oil trapped therein flows from the bottom of the receiver **58**, as the boiling refrigerant entrains same flows through the oil return capillary **64** to the distributor **52**, and is returned to the compressor **32** entrained with refrigerant leaving the indoor heat exchanger **20** and moving through conduits **48**, **14**, and **46** to reversing valve **42**.

It will be appreciated that capillary tubes may be substituted for the thermal expansion valves shown and that the combination of a receiver and oil return means may be in close association with the outdoor heat exchanger rather than in the location appearing in the drawing. These and other modifications may of course be effected without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. A heat pump comprising a refrigeration system including a first heat exchanger, a second heat exchanger series connected to the first heat exchanger, means including a compressor having an inlet and outlet, and reversing valve means for reversibly connecting said compressor to said heat exchangers for effecting flow of refrigerant through said heat exchangers in either direction whereby said heat pump may be operated on a cooling cycle with said first heat exchanger functioning as an evaporator or on a heating cycle with said second heat exchanger functioning as an evaporator, first expansion means for regulating supply of refrigerant to the first heat exchanger, second expansion means for regulating supply of refrigerant to the second heat exchanger, a bypass conduit about said first expansion means, a check valve in said bypass permitting refrigerant flow therethrough when the heat pump is operating on a heating cycle, and preventing refrigerant flow therethrough when the heat pump is operating on a cooling cycle, a container connected in said bypass, said container receiving a portion of said total charge when said heat pump is operated on the heating cycle and discharging said portion into said circuit when said heat pump is operated on the cooling cycle, refrigerant passing through said bypass and said container to said second heat exchanger when the heat pump is operating on a heating cycle, and a capillary tube forming a part of and connecting portions of said bypass on opposite sides of said container and communicating with said first heat exchanger and with said container for returning to said compressor when said heat pump is reversed from the heating to the cooling cycle any oil which is trapped in said container with said portion of said total refrigerant charge when said heat pump is operated on the heating cycle.

2. A heat pump according to claim 1 in which the refrigeration system includes a second bypass conduit about said second expansion means and a check valve in said second bypass conduit permitting refrigerant flow therethrough when the heat pump is operating on a cooling cycle and preventing refrigerant flow therethrough when the heat pump is operating on a heating cycle.