United States Patent

Tudury

[15] **3,681,934**

[45] **Aug. 8, 1972**

[54] **REFRIGERATION AND DEFROST SYSTEM**

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[22] Filed: **Sept. 11, 1970**

[21] Appl. No.: **71,434**

[52] **U.S. Cl.** **62/156**, 62/196, 62/276

[51] **Int. Cl.**.....**F25d 21/06**

[58] **Field of Search**.....62/151, 156, 81, 155, 275, 62/278, 196, 197, 498 P

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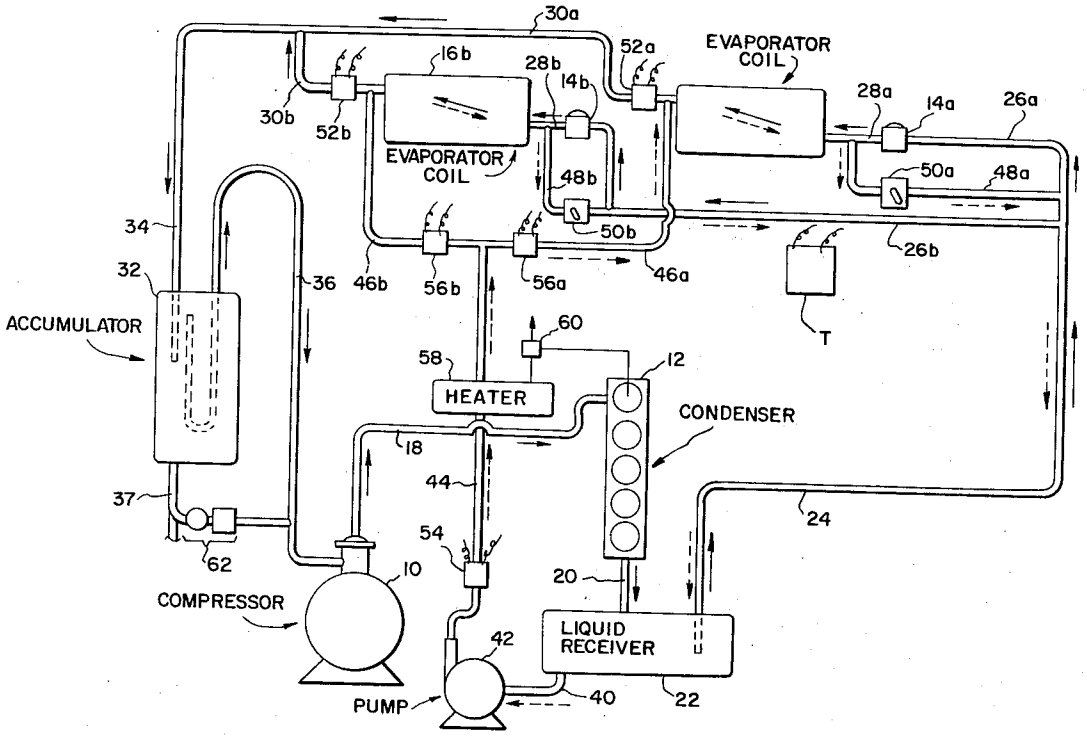
Primary Examiner—Meyer Perlin

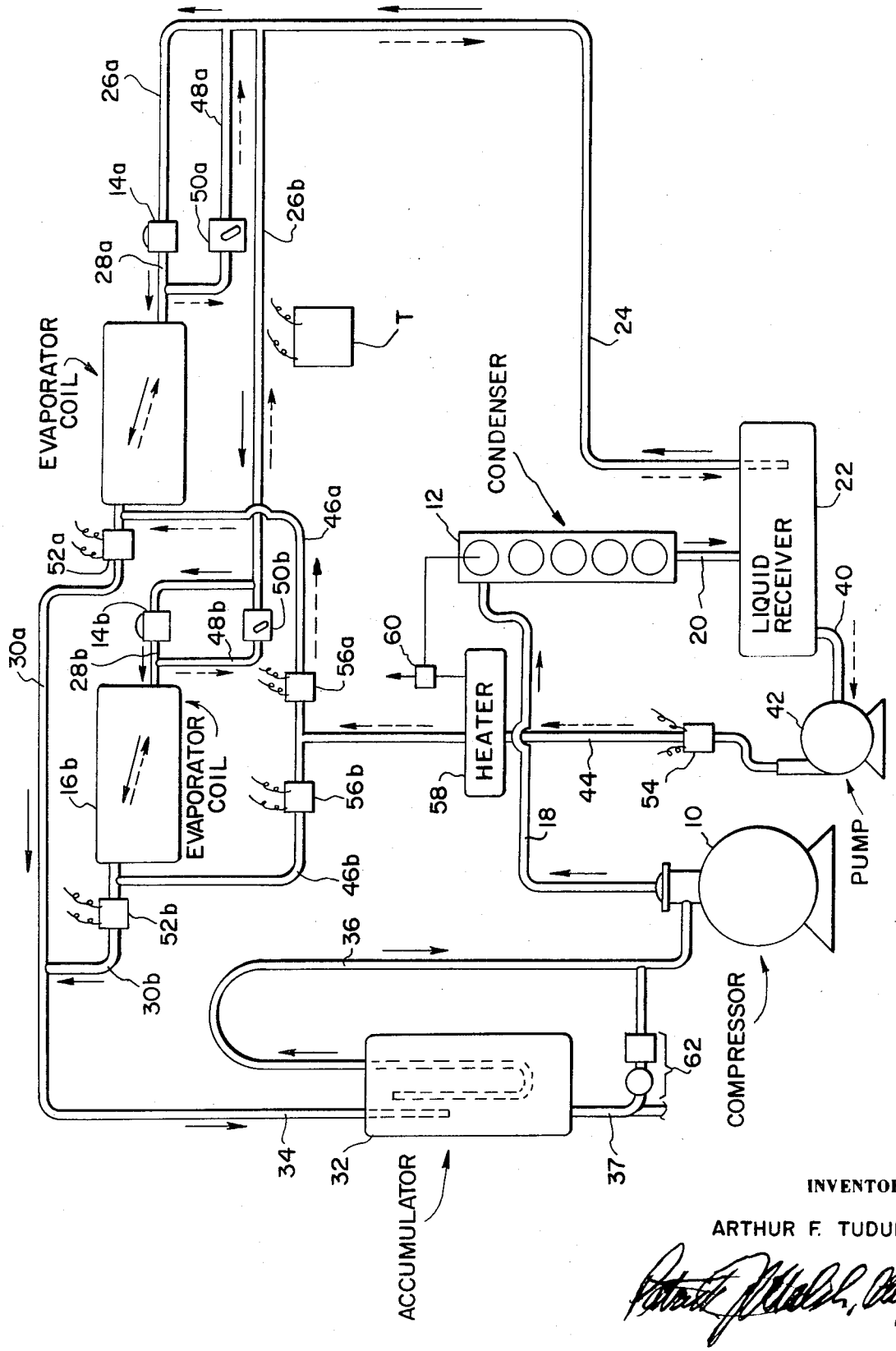
Attorney—Patrick J. Walsh

[57] **ABSTRACT**

The system includes a closed cycle, series connected compressor, condenser, expansion valve and evaporator with refrigerant flowing through the system in one direction for the refrigerating cycle. For defrosting, a conduit is provided for delivery of subcooled refrigerant from the outlet of the condenser to the outlet of the evaporator, a pump being provided to pump refrigerant in the opposite direction through the evaporator to effect defrosting thereof.

4 Claims, 1 Drawing Figure





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REFRIGERATION AND DEFROST SYSTEM

This invention relates to a refrigeration system and particularly relates to a refrigeration system having an improved defrosting system.

In the conventional closed refrigeration cycle, which includes a compressor, condenser, expansion valve and evaporator, the refrigerant passes through several states. On the high pressure side of the cycle, the refrigerant in a superheated vapor state flows from the outlet of the compressor into the condenser whereupon it gives up heat and is subsequently delivered in a subcooled substantially pure liquid state to the expansion valve. On the low pressure side of the cycle on the other side of the expansion valve, cold low pressure saturated refrigerant is supplied to the evaporator whereupon the latter absorbs heat. The state of the refrigerant is thereby changed to a superheated condition at the inlet of the compressor. In conventional defrost systems, a conduit is often provided to connect the outlet side of the compressor to the inlet side of the evaporator bypassing the condenser and expansion valve to provide superheated high pressure refrigerant in the vapor state to the evaporator to warm the coils and hence provide a defrosting action. While this type of system provides a defrosting action, such action is not efficient as the heat capacity of the superheated vapor is quite low, for example as compared to the heat capacity of the refrigerant in the liquid state. Consequently, the defrosting action must be performed over a considerable period of time. It is, in certain instances, desirable to provide a quick, efficient and effective defrosting action.

To the foregoing end, the present invention provides, in a conventional closed refrigerating cycle including a compressor, condenser, expansion valve, and evaporator respectively serially connected one to the other, a defrost system characterized by high efficiency and minimum defrosting time. The present invention provides a conduit connecting between the outlet of the condenser and the outlet of the evaporator coils (as used in the refrigeration cycle) for delivery of subcooled refrigerant to the coil. A pump is also provided in the conduit and pumps the subcooled liquid from the condenser through the coils in a direction opposite to the direction in which the refrigerant flows through the coils for refrigerating purposes. The subcooled liquid has a very substantial heat capacity and accordingly operates efficiently to give up heat at the evaporator coils to provide a quick responsive defrosting action. Also, the provision of a pump in the defrost conduit between the condenser and evaporator coils further pressurizes the subcooled liquid and increases its heat capacity with the result that the refrigerant in the evaporator coils can give up heat even more rapidly thereby providing a quicker defrosting action. Optionally, the subcooled liquid can be pumped through a liquid heater on its way to the evaporator coils whereby the heat capacity of the refrigerant is increased hence further decreasing the time for effective defrosting action. A conduit bypassing the expansion valve is provided for directing, during the defrosting cycle, the refrigerant exiting from the evaporator coils back to the condenser or to a liquid receiver fed by the condenser.

Accordingly, it is a primary object of the present invention to provide an improved defrosting action in a refrigeration system.

It is another object of the present invention to provide a more efficient defrosting system in a refrigeration cycle wherein subcooled refrigerant is employed to provide the defrosting action.

It is still another object of the present invention to provide an improved defrosting system in a refrigeration cycle wherein the defrosting action is accomplished in a minimum of time.

These and further objects and advantages of the present invention will become more apparent upon reference to the following specification, appended claims and drawing wherein the sole drawing FIGURE discloses a schematic representation of a conventional refrigeration cycle employing the improved defrosting system hereof.

Referring now to the drawing, there is disclosed a conventional refrigeration cycle including a compressor **10**, a condenser **12**, a pair of thermal expansion valves **14***a* and **14***b*, and a pair of evaporator coils **16***a* and **16***b*. As will be appreciated, a conduit **18** communicates between the outlet side of compressor **10** and condenser **12** for delivery of refrigerant in a superheated vapor state at high pressure to condenser **12**. The outlet side of condensor **12** lies in communication with a liquid receiver **22** through a conduit **20** from which liquid is withdrawn via a conduit **24**. Conduit **24** supplies the subcooled refrigerant from liquid receiver **22** to the thermal expansion valves **14** via branch conduits **26***a* and **26***b*. The outlet sides of expansion valves **14**a and **14***b* lie in communication with respective evaporator coils **16**a and **16***b* conduits **28***a* and **28***b* respectively, conduits **28**a and **28***b* supplying saturated low pressure refrigerant from the expansion valves to the coils. The low pressure superheated refrigerant flows from coils **16***a* and **16***b* via conduits **30***a* and **30***b* respectively for delivery to an accumulator **32** via a main conduit **34**. Accumulator **32** lies in communication via conduit **36** with the inlet side of compressor **10**.

There is thus disclosed a closed refrigeration cycle where in the direction of flow of the refrigerant is indicated by the arrows in full line in the drawing. Particularly, the superheated refrigerant in the vapor state flows through conduit **18** from compressor **10** to condenser **12** wherein it is cooled and changed to the liquid state. The subcooled liquid refrigerant then flows via conduit **20** from condenser **12** into liquid receiver **22** and from the latter through thermal expansion valves **14**a and **14**b via conduits **24** and **26***a* and **26***b*. Saturated cold low pressure refrigerant is thus delivered via conduits **28***a* and **28***b* to the evaporator coils whereat heat is absorbed from the surrounding medium. The refrigerant is returned in a superheated state to accumulator **32** and compressor **10** via conduits **34** and **36** respectively. The foregoing describes the operation of a conventional refrigeration cycle, dual coil units being employed in the disclosed form rather than a single coil unit.

In accordance with the present invention, a main defrost conduit **40** lies in communication between the liquid receiver **22** and a pump **42**. The pump **42** further pressurizes subcooled refrigerant received from liquid receiver **22** and delivers this subcooled liquid

refrigerant via a conduit **44**, and branch conduits **46***a* and **46***b* which lie in communication with conduits **30***a* and **30***b* respectively on the outlet sides of the evaporator, to coils **16***a* and **16***b*. A pair of conduits **48***a* and **48***b* lie in communication with respective conduits **28***a* and **28***b* between the associated coils and expansion valves and lie in respective communication with conduits **26***a* and **26***b*. Conduits **48***a* and **48***b* thus bypass the respective thermal expansion valves **14***a* and **14***b*. A closed defrost cycle is thus provided comprising liquid receiver **22**, conduit **40**, pump **42**, conduit **44**, branch conduits **46***a* and **46***b*, evaporator coils **16***a* and **16***b*, conduits **28***a* and **28***b*, bypass conduits **48***a* and **48***b* and return conduits **26***a*, **26***b* and **24**.

For reasons to be described, flow control valves are provided in the various conduits. In bypass conduits **48***a* and **48***b*, there are provided respective check valves **50***a* and **50***b* to prevent flow of refrigerant from bypassing the expansion valves **14***a* and **14***b* during operation of the refrigerating system and to permit outflow of refrigerant from the coils to the return line **24** bypassing the thermal expansion valves during the defrosting cycle. A pair of normally open valves **52***a* and **52***b* b provided in conduits **30***a* and **30***b* respectively and a normally closed valve **54** is provided in defrost supply line **44**. Also, a pair of normally closed valves **56***a* and **56***b* are provided in the branch supply conduits **46***a* and **46***b*. Valves **52***a*, **52***b*, **54**, **56***a* and **56***b* are preferrably electrically actuated, by operation of a time clock indicated at T. The time clock may be provided with an electrical output which actuates the valves, through suitable conventional electrical circuitry, not shown, at the time or times set for the defrosting action.

In use, the time clock is set normally to actuate the valves as desired, preferrably from one to four times per day. Actuation of the valves interrupts the normal refrigerating cycle previously described and initiates the defrosting cycle. Particularly, by opening valves **54**, **56***a and 56b*, and closing normally open valves **52***a*, **52***b*, subcooled refrigerant from the receiver **22** may be pumped by pump **42** via conduits **40**, **44**, branch conduits **46***a* and **46***b*, and portions of conduits **30***a* and **30***b* into the evaporator coils **163***,a* and **16***b* for flow therethrough in a direction reversed from the direction of flow of the refrigerant therethrough during the refrigeration cycle. Since the subcooled refrigerant from the outlet side of the condenser or receiver has a high heat capacity, which heat capacity is increased further by action of pump **42**, the subcooled refrigerant supplied to the evaporator coils rapidly, effectively, and efficiently gives up heat to provide a quick defrosting action at the coils. The refrigerant thereupon flows from the coils via conduits **28***a*, **28***b*, bypass conduits **48***a*, **48***b* through check valves **50**a **50***b*, and conduits **26***a*, **26***b* back to the receiver via return conduit **24**. This defrosting action occurs for a predetermined time interval, under the control of timer T, at the expiration of which valves **52***a*, **52***b*, are returned to their normally open positions and valves **54**, **56***a* and **56***b* are closed. Pump **42** is also deactivated such that the refrigeration cycle may once again be initiated. The defrosting action is sufficiently rapid as to permit the main compressor **10** to continue pressurizing the refrigerant from the accumulator **32** for delivery into the condenser **12** and receiver **22**. In other words, the defrosting cycle is completed in a minimum time whereby compressor **10** need not be deactivated.

A liquid heater **58** may be optionally provided in main supply defrost conduit **44**. Additional heat can thus be provided the subcooled liquid prior to entry into the evaporator coils during the defrosting cycle to further increase the capacity of the subcooled liquid to give off beat and hence to further minimize the time for defrosting. A relief valve **60** is carried by heater **58** and is set to relieve the pressure buildup when valves **54** and **56***a*, **56***b* are closed after the defrost cycle.

Also, a valve and sight glass combination **62** is provided on the bottom portion of accumulator **32** for automatically draining liquid refrigerant and oil from accumulator **32**. Particularly, the valve is wired in series with the compressor motor so that the valve is open when the compressor is running and is closed when the compressor is idle.

It will thus be appreciated that the objects of the present invention are fully accomplished in that there is provided an effective and efficient defrosting cycle in a conventional refrigeration system. Particularly, by the foregoing described invention, defrosting time is reduced to a minimum as the subcooled liquid provided the evaporator coils during the defrosting action has significantly greater heat capacity than vaporized refrigerant and can hence give off heat at a more rapid rate than conventional defrost cycles providing vaporized refrigerant directly from the compressor to the evaporator coils.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A refrigeration and defrosting system comprising a compressor, a condenser, receiver, a thermal expansion valve, and an evaporator, conduit means connecting said compressor, condenser, receiver, valve and evaporator in series to define a first circuit for normally flowing a refrigerant therethrough in a direction to provide a refrigeration cycle, a pump having an inlet and an outlet and conduit means connecting said receiver to said pump inlet, said pump outlet to said evaporator, and said evaporator to said receiver to define a second circuit for the flow of subcooled liquid refrigerant from said receiver to said evaporator and return to said receiver for defrosting the evaporator.

2. The system according to claim 1 including a conduit bypassing said expansion valve for returning refrigerant from said evaporator to said receiver during the defrosting cycle.

3. The system according to claim 2 including means for preventing flow of refrigerant in the refrigerating cycle trough said bypass conduit.

4. The system according to claim 1 including a heater disposed in said connecting means defining said second circuit between said condenser and said evaporator for supplying additional heat to the subcooled refrigerant prior to its flow through said evaporator.

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