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DEFROSTING ARRANGEMENT FOR REFRIGERATING SYSTEMS

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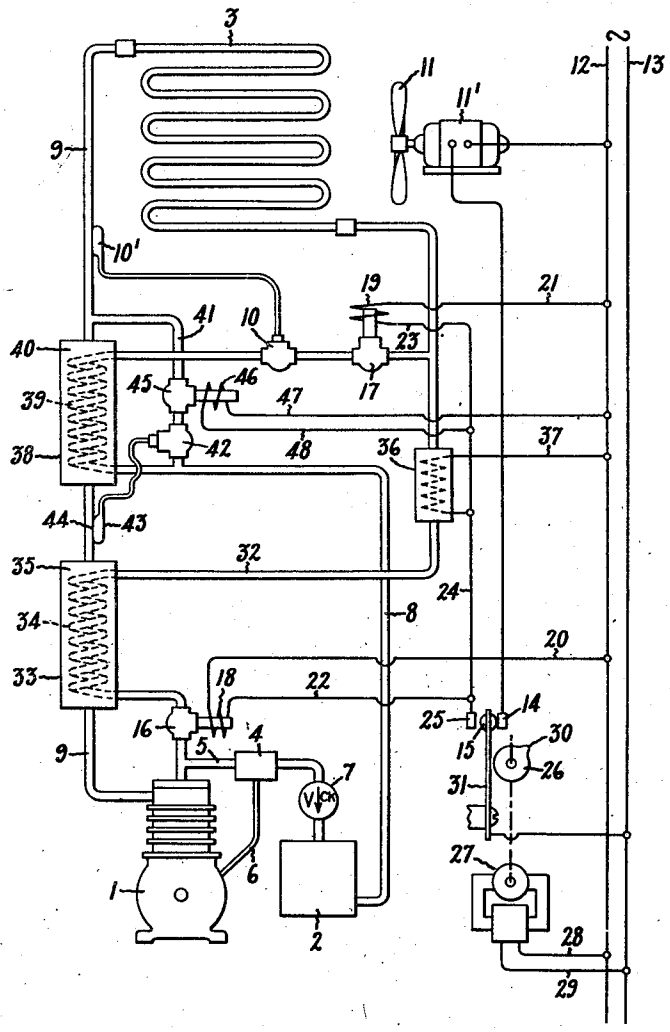

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DEFROSTING ARRANGEMENT FOR REFRIGERATING SYSTEMS

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6 Claims. (Cl. 62—117.55)

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My invention relates to refrigerating systems and more particularly to defrosting arrangements for refrigerating systems.

It is an object of my invention to provide a refrigerating system including an improved defrosting system utilizing hot gases from the compressor of the refrigerating system.

It is another object of my invention to provide an improved defrosting arrangement including a heat exchanger between the hot gas line from the compressor and the suction line to the compressor.

It is a further object of my invention to provide an improved defrosting arrangement including an automatically energized electric heater for the hot gas line.

It is still another object of my invention to provide a refrigerating system including an improved hot gas defrosting system and including provision for operating the system as a heat pump to introduce additional heat into the defrosting gas.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

By my invention, defrosting is facilitated in a hot gas defrosting system by providing a heat exchanger between the hot gas line from the compressor and the suction line. Such defrosting is further facilitated by providing a heat pump arrangement which utilizes the heat exchanger normally provided between the liquid line and the suction line, and which includes a by-pass around the evaporator between the suction line and the liquid line. A timer is provided for energizing solenoid valves to shift from normal operation to defrosting operation and simultaneously to open the by-pass for operation of the heat pump.

For a better understanding of my invention, reference may be had to the accompanying drawing, the single figure of which illustrates schematically a refrigerating system incorporating my invention.

Referring to the drawing, there is shown a closed refrigerating system including a compressor 1, a condenser and receiver 2, and an evaporator 3. An oil separator 4 is incorporated in a conduit 5 from the compressor to remove oil from the refrigerant and oil mixture and return it through a conduit 6 to the crankcase of the compressor. A check valve 7 is also included in the conduit 5 between the compressor 1 and the combined condenser and receiver 2 to prevent reverse flow of refrigerant in this line.

During normal operation of the refrigerating system, compressed refrigerant is circulated from the compressor 1 through the line 5 to the combined condenser and receiver 2. Liquid refrigerant passes through a conduit or line 8 to the evaporator 3, and vaporized refrigerant is returned to the intake of the compressor through a suction line 9. A thermostatic expansion valve 10 is included in the line 8, this valve being controlled by a bulb 10' on the suction line 9. A fan 11 is provided for circulating air over the evaporator 3. This fan is driven by a motor 11' to which power is supplied from lines 12 and 13 through a circuit including a stationary contact 14 and a movable contact 15.

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During the operation of the refrigerating system in normal atmospheric conditions, frost gradually builds up on the evaporator 3. In order to remove this frost, provision is made for automatically changing the flow of the refrigerant in the circuit so as to pump hot compressed gas from the compressor to the evaporator 3 without passing through the condenser and receiver 2. The arrangement for so controlling the flow of refrigerant includes two solenoid valves 16 and 17, these valves being controlled by solenoids 18 and 19, respectively. The valve 16 is arranged to be normally closed, that is, closed when the solenoid 18 is deenergized and the valve 17 is arranged to be normally open, that is, open when the solenoid 19 is deenergized. One side of the solenoid 18 is connected by a line 20 to power line 12 and one side of solenoid 19 is similarly connected by line 21 to the power line 12. The other sides of the solenoids 18 and 19 are connected by lines 22 and 23, respectively, to a common line 24. The line 24 terminates at a stationary contact 25 which, during normal operation, is spaced from the movable contact 15.

The position of the movable contact 15 is controlled by a cam 26 which is driven by a synchronous motor 27. The motor 27 may be, for example, an ordinary electric timer motor which drives the cam 26 at a constant speed. The motor 27 is supplied with power from the lines 12, 13 through lines 28, 29. The cam 26 includes a portion 30 which is formed to periodically engage an arm 31 and move the contact 15 out of engagement with the contact 14 and into engagement with the contact 25. When the arm 31 is so moved, the circuit of the fan motor 11' is broken and a circuit through the contacts 15, 25 is closed to energize the solenoids 18 and 19.

Energization of the solenoid 19 causes the valve 17 to close, blocking the path for the flow of liquid refrigerant from line 8 into the evaporator 3. At that time, the valve 16 is opened by the energization of the solenoid 18 to provide a path for the hot compressed gas from the compressor 1 through a line 32 to the evaporator 3. The hot gas provides heat for melting the accumulated frost from the evaporator. During this defrosting operation, gas is returned from the evaporator to the compressor through the suction line 9 just as during the normal operation of the refrigerating system.

When such a system is changed from refrigerating to defrosting operation, there is a drop

in the head pressure of the compressor and also a considerable drop in the suction pressure. For some time, say 10 minutes, after the defrosting operation begins, the gas leaving the compressor is relatively cool because of refrigerant remaining in the evaporator at the end of the normal refrigerating cycle or condensed from the hot gas entering the evaporator before it has warmed up. In order to overcome these difficulties, a heat exchanger 33 is provided in the hot gas line 32. This heat exchanger includes a coil 34 in series with the hot gas line 32. This coil 34 is positioned within a chamber 35 through which refrigerant passing from the evaporator through the suction line 9 is circulated. The heat exchanger 34 causes a transfer of heat from the gas discharged from the compressor to the gaseous or liquid refrigerant returning to the compressor through the suction line 9. This insures a vaporization of any liquid refrigerant in the suction line 9 and prevents its slugging into the compressor. Further, the heating of the refrigerant returning through the suction line 9 by the hot compressed gas achieves a higher back pressure, the head pressure remains near the normal operating head pressure, and the gas leaving the compressor reaches a satisfactory defrosting temperature sooner than it would in the absence of the heat exchanger 33.

If desired, in order to introduce additional heat into the gases passing through the conduit 32, an electric heater 36 may be provided. One side of this heater is connected by a line 37 to the power line 12 and the other side is connected to the common line 24. The heater is energized at the same time as the solenoids 18 and 19 by the movement of the contact 15 into engagement with the contact 25.

During normal operation of the refrigerating system, a heat exchanger 38 is utilized for transferring heat from the liquid refrigerant passing through the line 8 to the refrigerant returning through the suction line 9 to the compressor. This heat exchanger 38 includes a coil 39 arranged in series with the line 8 and a chamber 40 within which the coil 39 is enclosed. Liquid refrigerant passes through the coil 39 on its way to the evaporator and refrigerant passing through the suction line 9 enters the chamber 40 and circulates around the coil 39. I have provided for utilizing the heat exchanger 38 in a heat pump arrangement for introducing additional heat into the system during the defrosting period. This arrangement includes a by-pass 41 extending from the line 8 to the suction line 9. In this by-pass, there is arranged a thermostatic expansion valve 42 which is controlled by a bulb 43 positioned in heat exchange relationship with the suction line 9 at 44. There is also included in the by-pass 41 a normally closed solenoid valve 45. This valve is controlled by a solenoid 46, one side of which is connected through a line 47 to the power line 12. The other side of the solenoid 46 is connected by a line 48 to the common line 24 and thence to the stationary contact 25. Thus, the solenoid 46 is arranged to be energized to open the valve 45 by the action of the cam 26 in moving the contact 15 into engagement with the contact 25. Where this by-pass arrangement is employed, therefore, the solenoid 46 is energized at the same time as the solenoids 18 and 19. When the solenoid 46 is energized, the by-pass 41 is opened subject to the control of the thermostatic expansion valve 42. Liquid refrigerant may then flow from the condenser-receiver 2 through the line 8 and the by-pass 41 into the suction line 9 and thence into the chamber 40 surrounding the coil 39. It then flows back through the suction line 9 to the intake of the compressor. In the chamber 40, some or all of the liquid refrigerant is vaporized, absorbing heat from the air surrounding the chamber 40. This heat is introduced into the system and assists in the defrosting operation. It can be seen that this portion of the system essentially operates as a heat pump absorbing heat available in the atmosphere under normal ambient conditions.

Reviewing the operation of the system, it can be seen that under normal refrigerating conditions the contacts 14 and 15 are in engagement. This closes a circuit through a fan motor 11', and the solenoids 18, 19, and 46 and the electric heater 36 are all de-energized. Under these conditions, the valves 16 and 45 are closed and the valve 17 is open. Compressed gas from the compressor 1 flows through the oil separator 4 and the check valve 7 to the condenser-receiver 2. Liquid refrigerant passes through the line 8, the coil 39 of the heat exchanger 38 to the evaporator 3 under the control of the thermostatic expansion valve 10. Vaporized refrigerant returns to the compressor through the suction line 9, passing en route through the heat exchanger 38 and absorbing heat from the liquid refrigerant passing through coil 39 of this heat exchanger.

The defrosting period is initiated by the engagement of the portion 30 of the cam 26 with the arm 31. This shifts the contact 15 out of engagement with the contact 14 and into engagement with the contact 25. The solenoids 18, 19, and 46 and the electric heater 36 are thereby energized, the motor 11' of the fan 11 being simultaneously de-energized. Under these conditions, the valves 16 and 45 are open and the valve 17 is closed. The flow of liquid refrigerant to the evaporator 3 is blocked by the valve 17. A path is simultaneously opened through the valve 16 and hot compressed gas from the compressor passes through the valve 16, the coil 34 of the heat exchanger 33, and conduit 32 to the evaporator 3. The refrigerant returns to the compressor through the suction line 9 passing en route through the chamber 40 of the heat exchanger 38 and the chamber 35 of the heat exchanger 33. The heat exchanger 33 in particular effects vaporization of any liquid refrigerant in the suction line before it can pass to the compressor. This liquid refrigerant might be that remaining in the evaporator at the time defrosting is initiated or it might result from condensing of compressed gas in passing through the evaporator. Additional heat is supplied to the hot gas before reaching the evaporator by the electric heater 36 if such heater is employed. If desired, further heat is introduced into the system through the utilization of the by-pass 41 whereby liquid refrigerant is circulated through the heat exchanger 38 to absorb heat from the atmosphere and introduce it into the system.

While I have shown and described a specific embodiment of my invention, I do not desire my invention to be limited to the particular construction shown and described, and I intend, by the appended claims, to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination with a refrigerating system including a compressor, a condenser and an evaporator connected in a closed refrigerant circuit, a hot gas line, means for selectively direct-

ing compressed refrigerant from the compressor through the condenser to the evaporator during normal operation and from the compressor through said hot gas line directly to the evaporator during defrosting operation, a suction line for returning refrigerant from said evaporator to said compressor, and a heat exchanger for transferring heat from said hot gas line to said suction line only during the defrosting operation.

2. In combination with a refrigerating system including a compressor, a condenser and an evaporator connected in a closed refrigerant circuit, a defrosting arrangement comprising a hot gas line for conducting hot compressed gaseous refrigerant from the compressor to the evaporator to remove frost therefrom, a valve for controlling flow of hot compressed gaseous refrigerant, a solenoid for operating said valve, a heater adjacent said hot gas line for imparting additional heat to said hot compressed gaseous refrigerant before passage to said evaporator, and a timer for simultaneously energizing said heater and said solenoid, a suction line for returning refrigerant from said evaporator to said compressor, and a heat exchanger for transferring heat from said hot gas line to said suction line.

3. In a refrigerating system including a compressor, a condenser, and an evaporator connected in a closed refrigerant circuit, conduits for providing parallel paths for refrigerant flow from the compressor to the evaporator, one of said paths providing for flow of refrigerant from said compressor through the condenser to said evaporator for refrigerating said evaporator, the other of said paths providing for flow of hot compressed gas from said compressor to said evaporator for defrosting said evaporator, a valve in each of said paths for controlling the flow therethrough, means for simultaneously opening one of said valves and closing the other, and a suction line for returning refrigerant from said evaporator to said compressor, said suction line being arranged in heat exchange relationship with said other of said paths.

4. In a refrigerating system including a compressor, a condenser, and an evaporator connected in a closed refrigerant circuit, conduits for providing parallel paths for refrigerant flow from the compressor to the evaporator, one of said paths providing for flow of refrigerant from said compressor through the condenser to said evaporator for refrigerating said evaporator, the other of said paths providing for flow of hot compressed gas from said compressor to said evaporator for defrosting said evaporator, a valve in each of said paths for controlling the flow therethrough, means for simultaneously opening one of said valves and closing the other, a solenoid for operating each of said valves, means for simultaneously energizing said solenoids to open one of said valves and to close the other of said valves, said means simultaneously de-energizing said solenoids to open said other of said valves and to close said one of said valves, and a suction line for returning refrigerant from said evaporator to said compressor, said suction line being arranged in heat exchange relationship with said other of said paths.

5. In a refrigerating system including a compressor, a condenser and an evaporator connected in a closed refrigerant circuit, conduits for providing parallel paths for refrigerant flow from the compressor to the evaporator, one of said paths providing for flow of refrigerant from said compressor through the condenser to said evaporator for refrigerating said evaporator, the

other of said paths providing for flow of hot compressed gas from said compressor to said evaporator for defrosting said evaporator, a suction line for returning refrigerant from said evaporator to said compressor, a heat exchanger between said one of said paths and said suction line, said heat exchanger including a chamber through which refrigerant passing through said suction line flows, said chamber being exposed to the atmosphere, and a by-pass about said evaporator for conducting refrigerant from said one of said paths to said suction line, said refrigerant returning to said compressor through said heat exchanger whereby heat absorbed from the atmosphere in passing through said heat exchanger is introduced into the system for facilitating defrosting of said evaporator.

6. In a refrigerating system including a compressor, a condenser, and an evaporator connected in a closed refrigerant circuit, conduits for providing parallel paths for refrigerant flow from the compressor to the evaporator, one of said paths providing for flow of refrigerant from said compressor through the condenser to said evaporator for refrigerating said evaporator, a first valve for controlling flow of refrigerant through said one of said paths, the other of said paths providing for flow of hot compressed gas from said compressor to said evaporator for defrosting said evaporator, a second valve for controlling flow of hot compressed gas through said other of said paths, a suction line for returning refrigerant from said evaporator to said compressor, a first heat exchanger between said one of said paths and said suction line, said first heat exchanger including a chamber through which refrigerant passing through said suction line flows, said chamber being exposed to the atmosphere, a by-pass about said evaporator for conducting refrigerant from said one of said paths to said suction line, a third valve for controlling flow of refrigerant through said by-pass, said refrigerant returning to said compressor through said first heat exchanger whereby heat absorbed from the atmosphere in passing through said first heat exchanger is introduced into the system for facilitating defrosting of said evaporator, a second heat exchanger between said other of said paths and said suction line, an electric heater for supplying additional heat to said other of said paths, a solenoid for controlling each of said valves, and means for simultaneously energizing each of said solenoids and said electric heater, energization of one of said solenoids effecting closing of said first valve to block flow of refrigerant through said one of said paths, the energization of the second of said solenoids effecting opening of said second valve to permit flow of hot compressed gas through said other of said paths, the energization of the third of said solenoids effecting opening of said third valve to provide for flow of refrigerant through said by-pass.

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