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D. E. FRIEDMAN ETAL
HOT GAS DEFROSTING SYSTEM

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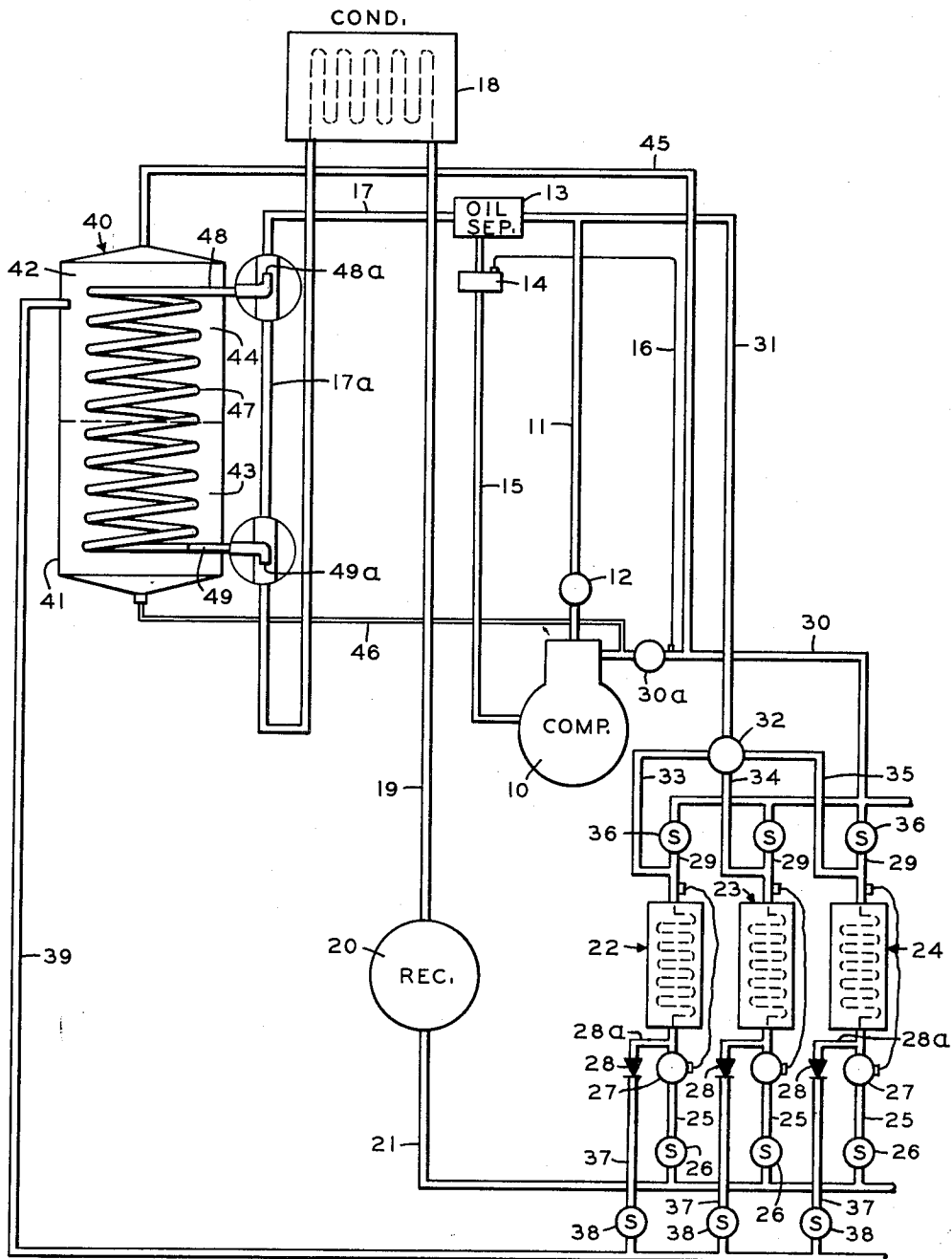


FIG. 1

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1

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HOT GAS DEFROSTING SYSTEM

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This invention relates generally to refrigeration defrosting systems, and more particularly to novel re-evaporator means in combination with a hot gas type defrosting arrangement.

In the past various arrangements have been proposed for utilizing the hot gaseous refrigerant discharged from the compressor as a heat source for defrosting evaporators in a refrigeration system. However, such prior closed refrigeration systems have been complex and expensive, have not provided efficient defrosting, or have created problems in the re-introduction of refrigerant somewhere into the normal refrigerant flow cycle.

The principal object of the present invention is to provide accumulator means to accommodate liquid refrigerant resulting from the defrost of evaporators and efficiently re-introduce such refrigerant into the normal system.

A further object is to provide a hot gas defrosting apparatus wherein liquid refrigerant is received in a novel accumulator and completely vaporized and returned to the low side of the refrigeration system, and wherein a portion of the hot gas discharge from the compressor is used as a heat source.

A further object is to provide an improved, simplified and efficient re-evaporator for liquid refrigerant from a hot gas defrost operation.

These and still other objects and advantages will become more apparent hereinafter.

The invention also consists in the parts and arrangements and combinations of parts hereinafter described and claimed, with particular reference to the single figure of the drawing showing diagrammatically a refrigeration and defrosting system embodying the invention.

The refrigeration system shown is in part conventional and includes a compressor 10 from which hot gaseous refrigerant is discharged into a conduit 11 to the pressure or high side of the system through a compressor discharge valve 12. The discharge conduit 11 connects to an oil separator 13 having an oil receiver 14 with a suitable float valve (not shown) through which oil is returned to the compressor sump through an oil line 15, the receiver 14 also having a degassing line 16 connected to the suction side of the compressor 10 in a typical manner. A discharge conduit 17 connects the oil separator 13 with a condenser 18 of conventional construction, the conduit 17 having a vertically extending section 17a. The refrigerant is condensed to a liquid in the condenser 18 and delivered through conduit 19 to a receiver 20 forming a liquid refrigerant source, although the condenser and receiver may be a combination unit as is also known in the art.

A liquid header 21 is illustrated as connecting the receiver 20 to evaporators 22, 23 and 24 for refrigerating fixtures, but the number of evaporators or fixtures forms no part of the present invention. Each evaporator 22, 23 and 24 is connected to the liquid header 21 by a supply line 25 having a solenoid valve 26 interposed therein. Each evaporator also has refrigerant metering means, such as expansion valve 27, and a uni-directional by-pass or check valve 28 is provided in a conduit 28a connected to the inlet of the evaporators by passing each valve 27. The outlet of each evaporator 22, 23 and 24 is connected by a return line 29 to a suction header 30 connected

2

through a compressor intake valve 30a to the suction or low side of the compressor 10.

The refrigeration system described functions in a conventional manner in respect of each fixture evaporator absorbing heat from its fixture thereby vaporizing and superheating the refrigerant and resulting in the formation of frost or ice on the evaporator. The cumulative heat load of the refrigerant returned to the compressor plus the heat of compression is available for defrosting one or more of the evaporators 22, 23 and 24. A hot gas line 31 is connected to the discharge conduit 11 and to suitable selector valve means 32, such as a four-way valve, from which the line 31 may be selectively connected to branch conduits 33, 34 or 35 to the return lines 29 of the evaporators 22, 23 or 24, or instead of the valve 32 a valve may be provided in each branch conduit 33, 34 and 35. The valve means 32 may be actuated by suitable control means (not shown), such as a time clock or means responsive to fixture or product temperature or pressure indicating a frosted coil condition. Solenoid valve means 36 are interposed in the return conduits 29 of each evaporator to isolate the suction header 30 from the hot gas flow during defrost of each evaporator, as will become more apparent hereinafter.

A branch conduit 37 is connected to each by-pass valve 28 in communication with the by-pass conduit 28a to receive refrigerant from the evaporator during defrost. The conduits 37 have a solenoid valve 38 interposed therein, and each conduit 37 is connected to a refrigerant header 39 connected to an accumulator re-evaporator 40.

The accumulator 40 comprises a tank 41 having a refrigerant chamber 42 of predetermined capacity for accommodating a maximum liquid load in a vertically lower portion 43 and having an upper vapor portion 44 to which the header 39 is connected. A vapor return or suction line 45 is connected from the top of the upper zone 44 to the suction header 30 whereby refrigerant vapor may be returned into the low side of the closed refrigeration system. A capillary oil line 46 connects the lowest point at the bottom of the tank 41 in gravity flow with the suction side of the compressor 10 inasmuch as oil entrained in the hot refrigerant used for defrosting will not be removed in the oil separator 13.

The accumulator chamber 42 houses a vertically disposed coil 47, a substantial portion of which is positioned in the lower liquid zone 43. The coil 47 has an upper feed tube 48 with a free open end 48a extending into the vertical section 17a of the discharge line 17 leading to the condenser 18, and the free end 48a is turned upstream relative to refrigerant flow in the vertical section 17a to receive and divert a portion of hot gaseous refrigerant through the coil 47 for vaporizing liquid refrigerant in the lower zone 43. The coil 47 also has a lower delivery tube 49 with a free open end 49a extending into the vertical section 17a and being turned downstream relative to refrigerant flow in the vertical section.

In the defrost operation of the evaporator 22, which is representative also of the other evaporator defrosts, the solenoid valves 26 and 36 are closed to isolate the evaporator from the liquid and suction headers 21 and 30. The selector valve 32 is actuated to place the conduit 33, which is in communication with the outlet of the evaporator, also in communication with the hot gas header 31 from the compressor discharge conduit 11. Simultaneously the solenoid valve 38 is opened to place the inlet end of the evaporator 22 in communication with the refrigerant header 39 through the by-pass line 28a and valve 28 and the conduit 37 and solenoid valve 38. Since each evaporator will normally have a large amount of liquid refrigerant therein during the normal cooling cycle, the hot gaseous refrigerant flowing into the evaporator 22 for defrost will initially push this liquid refrigerant ahead

of it into the refrigerant header 39 and to the accumulator 40. Furthermore, the hot gaseous refrigerant will give up heat to the evaporator and at least a substantial portion will be condensed to a liquid, as is well known.

The liquid refrigerant flowing through the header 39 may be discharged into the accumulator chamber 42 in a manner to cascade over the coil 47 so that the heat exchange will cause a substantial amount to be changed to a vapor and taken off through conduit 45 to the compressor 10. In the event of large accumulations of liquid in the lower zone 43, the coil 47 will be submerged and therefore will be in intimate heat exchange relationship with the liquid. The coil 47 is adapted to provide a rapid flow of hot refrigerant gas therethrough and efficiently effects the re-evaporation of the liquid.

The hot gaseous refrigerant flowing from the compressor discharge through conduit 17 enters the vertical section 17a and is divided between the normal flow path through section 17a and the coil 47. Refrigerant entering the open end 48a of the feed tube 48 has the full velocity and pressure head of the refrigerant flow to push the diverted portion into the coil 47 and, due to the vertical coil arrangement, a gravitational factor is added to the refrigerant flow characteristics. Furthermore, the removal of a portion of refrigerant at the upper end of the feed tube 48 produces a static pressure differential between this point and the lower end 49a of the delivery tube 49 whereby a negative pressure at the lower end 49a and normal refrigerant flow through the vertical section 17a causes an aspirating effect to draw refrigerant from the coil 47 back into the normal refrigerant flow in the conduit 17 to the condenser 18.

It is now apparent that the present apparatus and method of re-evaporating liquid refrigerant resulting from an evaporator defrost utilizes heat from a portion only of the hot refrigerant flow from the compressor 10, and is rapid and efficient in operation. Any refrigerant condensed in the coil 47 is merged back into the main refrigerant stream to the condenser 18 where all of the refrigerant is condensed to a liquid, and the hot gaseous refrigerant at the outlet end 49a of the coil 47 may be desuperheated thereby reducing the condenser load and helping to control the head pressure of the compressor 10.

It is to be understood that the invention is intended to cover all changes and modifications that will be readily apparent to one skilled in the art, and the invention is limited only by the claims which follow.

What we claim is:

1. In a refrigeration system including compressor means, condenser-receiver means connected to the discharge side of said compressor means, a plurality of evaporator means normally connected between said condenser-receiver means and the suction side of said compressor means, and means for selectively diverting hot gaseous refrigerant from the compressor discharge to said evaporator means for defrosting same, the combination of an accumulator receiving condensed refrigerant from said evaporator means during defrosting thereof, a vapor return line from said accumulator to the suction side of said compressor, and a hot gas coil disposed in said accumulator and having open inlet and discharge ends disposed upstream and downstream, respectively, within the hot gaseous refrigerant connection between the discharge side of said compressor and said condenser-receiver means to thereby restrict the effective cross-sectional area of said hot gaseous refrigerant connection and divert a portion of said hot gaseous refrigerant from said compressor through said hot gas coil.

2. The system according to claim 1 in which said inlet and outlet ends are displaced vertically for gravity refrigerant flow through said coil.

3. The system according to claim 2 in which said coil is positioned vertically in said accumulator for gravity

refrigerant flow therethrough between said inlet and outlet ends.

4. The system according to claim 1 in which said inlet end of said coil is turned in an upstream relationship in respect of the direction of main refrigerant flow in said refrigerant connection between said compressor and condenser-receiver means.

5. The system according to claim 4 in which the inlet end of said coil is positioned substantially concentrically in said refrigerant connection to divert a portion of refrigerant from the main flow path from said compressor into said hot gas coil, said diverted portion of refrigerant moving through said coil under the positive pressure head and velocity impetus of said main refrigerant flow, and said coil being vertically disposed with its outlet end at the lowest point to provide a gravity factor in the flow characteristics of said diverted portion of refrigerant through said coil.

6. The system according to claim 5 in which said outlet end of said hot gas coil is turned downstream relative to the direction of main refrigerant flow whereby an aspiration effect is created in said outlet end of said coil by said main refrigerant flow therepast.

7. In a refrigeration system having a compressor with discharge and suction sides, a discharge conduit connected to the discharge side of said compressor, condenser-receiver means connected to said discharge conduit and providing a liquid refrigerant source, a plurality of evaporator means normally connected to said condenser-receiver means for receiving liquid refrigerant therefrom, said evaporator means producing a refrigerant heat load of predetermined magnitude and returning gaseous refrigerant to the suction side of said compressor, and means for selectively isolating said evaporator means from the condenser-receiver means and the suction side of said compressor and connecting said isolated evaporator means to the discharge side of said compressor for receiving hot gaseous refrigerant to effect the defrost of said isolated evaporator means; the combination of re-evaporator means for vaporizing refrigerant condensed in said isolated evaporator means during defrost thereof comprising an accumulator tank having an upper zone for refrigerant gas connected to the suction side of said compressor and a lower zone for condensed refrigerant, a refrigerant header for delivering refrigerant from said isolated evaporator means to said accumulator tank, an oil return line connected for gravity oil flow from the lower zone to the suction side of said compressor, a hot gas coil in said accumulator tank, said hot gas coil having end portions extending out of said accumulator tank and being disposed within said discharge conduit in upstream and downstream relation relative to said compressor discharge, the upstream end of said hot gas coil receiving a portion of the hot compressed gaseous refrigerant from said discharge conduit and feeding it through said hot gas coil in direct heat exchange relation with the condensed refrigerant in said accumulator tank to vaporize said refrigerant.

8. The refrigeration system according to claim 7 in which said refrigerant header is connected to said upper zone of said accumulator tank in position to cascade liquid refrigerant over said hot gas coil.

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