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REFRIGERATING SYSTEM WITH HOT GAS DEFROSTING MEANS AND ADAPTED FOR USE WITH A LOW TEMPERATURE COMPRESSOR

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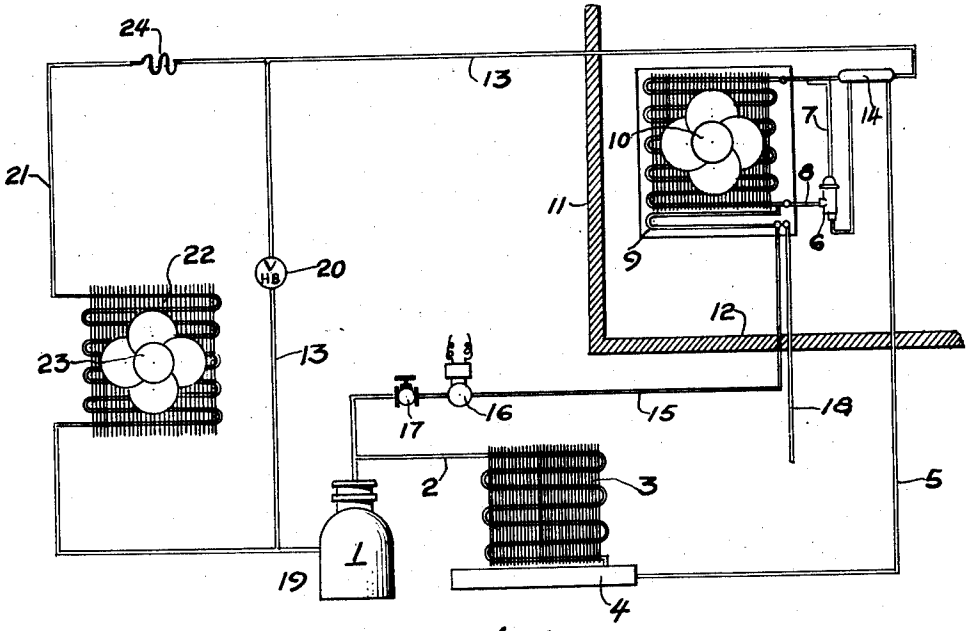


Fig. 1.

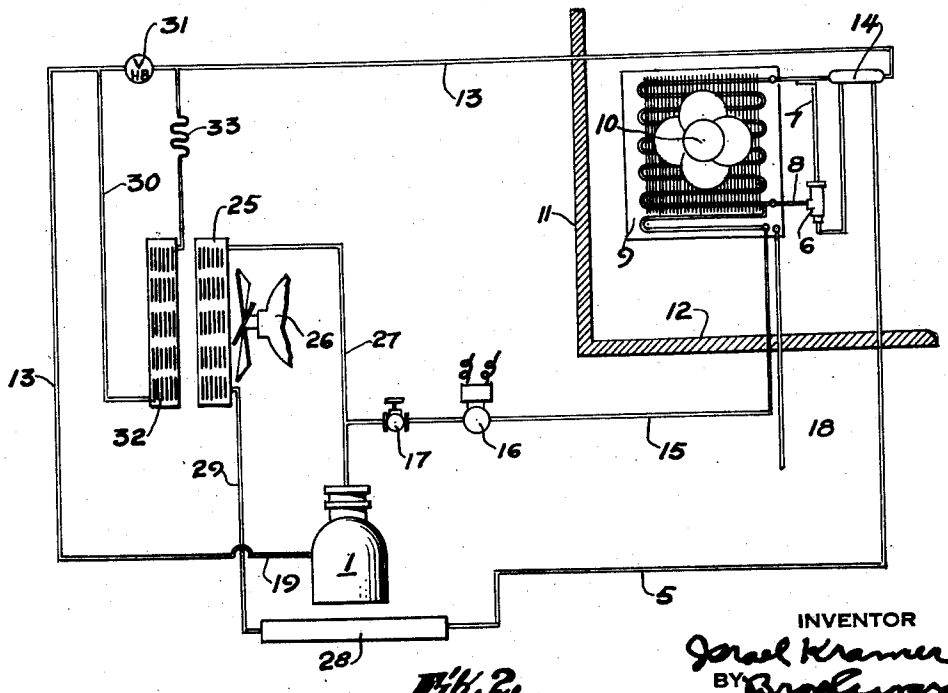


Fig. 2.

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REFRIGERATING SYSTEM WITH HOT GAS DEFROSTING MEANS AND ADAPTED FOR USE WITH A LOW TEMPERATURE COMPRESSOR

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1 Claim. (Cl. 62—196)

This invention relates to a refrigerating system with hot gas defrosting means and adapted for use with a low temperature compressor, particularly of the hermetically sealed type. It has for an object to provide such a system in which the suction line leading from the outlet of the refrigerating evaporator to the inlet of the compressor includes a conduit for the flow of refrigerant during refrigerating cycles of the system, in which conduit is positioned a flow regulating device, and a branch conduit in which is positioned a reevaporator; the flow regulating device being of such character as to be adjustable to permit free flow through the first named conduit during refrigeration and automatically to inhibit flow therethrough and compel the refrigerant to flow through the said branch conduit and its reevaporator during defrosting.

Another object is to provide such a system in which the said flow regulating device is a hold back valve.

Another object is to provide such a system which includes a pressure reducing device positioned in the above mentioned branch conduit between the evaporator and the reevaporator.

Another object is to provide such a system in which the said flow regulating device is subject to pressure conditions in the suction line between itself and the compressor, and will serve as a metering or modulating valve during the brief periods following defrosting cycles when there is a substantial amount of liquid refrigerant in the suction line, thereby preventing undesirable flow of liquid to the compressor inlet.

Another object is to provide such a system from which the branch conduit and its reevaporator may be omitted in connection with the use of an hermetically sealed suction-gas cooled low temperature compressor wherein heat generated by the motor assembly, e.g., motor windings, can serve for reevaporating liquid refrigerant during defrosting in cooperation with the flow regulating device in the suction line.

Another object is to provide such a system in which the reevaporator fan and its motor may be eliminated and air circulation through the reevaporator coils be supplied by juxtaposing the same with respect to the condenser so as to be subject to the air current generated by the condenser fan.

A further object consists in providing certain improvements in the form, construction and arrangement of the parts whereby the above named and other objects inherent in the invention may be effectively attained.

In recent years there has been a trend in the compressor industry to supply the refrigerating trade with compressors designed for systems of three different evaporator temperature levels, i.e., suited to human comfort, product cooling, and freezer chambers. This program has been induced largely, if not primarily, by the factors of manufacturing and marketing efficiency and economy; and, arising from similar considerations, the compressors designed for freezing chamber systems are now commonly fitted with motors of such small power as to be subject to overloading and stoppage if the suction pressure of the gas entering the compressor crank case exceeds a certain degree, such as ten pounds per square inch when using the well known refrigerant Freon 12. Furthermore, these compressors, denominated low temperature compressors, are to an increasing extent being produced as a unit in which the compressor and its motor are permanently sealed in an envelope or casing; thus being known as of the hermetically sealed type. This sealing, of course, prevents the motor's resistance to overloading from being ameliorated by lowering the ratio of drive between motor and compressor, and confronts the refrigeration engineer with the problem of so devising his system as to avoid operational conditions leading to such increase in crank case pressure as to overload the compressor motor and cause it to cease functioning.

The present invention, while not limited in scope thereto, is well adapted to utilization of low temperature hermetically sealed compressor-motor units, and also embodies features of simplicity, economy, and operational efficiency that lend notably to its practical desirability.

Practical embodiments of the invention are shown in the accompanying drawing, in which

Fig. 1 diagrammatically represents the layout of a system according to the invention; and

Fig. 2 similarly represents a modification thereof.

Turning to the showing of Fig. 1, the compressor is denoted by **1** and is driven in any approved manner by its motor, not shown, which may be of the kind commonly employed in connection with the above mentioned "low temperature" compressors, and the compressor and its motor may be of the hermetically sealed type if desired. The discharge of the compressor is connected by a conduit **2** with a condenser **3**, the outlet of which latter communicates with a receiver **4**; both the condenser and receiver being of any approved form either constructed separately or combined as a unit. The outlet of the receiver communicates by a refrigerant supply conduit **5** with any suitable form of pressure reducing device, such, for instance, as a thermostatic expansion valve **6**, which latter is controlled by the usual feeler bulb and capillary tube denoted generally by **7**. The valve **6** is connected by a conduit **8** with an evaporator **9** that is fitted with the usual fan and fan motor denoted collectively by **10**; the said evaporator being usually located within a refrigeration chamber, two walls of which are shown and marked **11**, **12**.

The outlet of the evaporator **9** communicates with a suction conduit **13**, and portions of the supply conduit **5** and suction conduit **13** lie adjacent each other within a heat exchanger for elevating the temperature of the refrigerant outflowing from the evaporator through the suction conduit **13**. The said heat exchanger **14** may be of any approved construction, which is well understood by those skilled in this industry, and the same is true of the expansion valve **6** and evaporator **9**.

The discharge of compressor **1** is also directly connected by a conduit **15** with the inlet of the evaporator **9**, as through the usual drip pan (not shown), for the purpose of defrosting the evaporator coil at intervals, and a solenoid valve **16** is positioned in conduit **15**, the opening and closing of the said valve being suitably controlled, as by an electric timer (not shown because the arrangement is so well known in this field) for the purpose of initiating and terminating defrosting operations at desired times. Or, the electric timer may be used to initiate the defrosting, and a pressurestat or thermostat responsive to pressure or temperature at the outlet of the evaporator be used to terminate the same; or

other suitable means for the same purpose could be employed. A manual valve 17 may be installed in conduit 15 between the compressor and solenoid valve 16 for shutting the defrosting conduit when servicing the system. A drain pipe 18 is provided, as usual, for removal of the defrosting water from the drip pan of the evaporator.

The suction conduit 13 leads, as usual, to the inlet of the compressor 1 as indicated at 19, and in the said conduit is positioned a refrigerant flow regulating device, which is preferably a valve of the hold back type, denoted by 20; the said valve being of such character as to be adjustable to permit free flow of the refrigerant therethrough during refrigeration cycles of the said system and automatically to inhibit flow therethrough during defrosting cycles. The said valve may also be adjusted to serve as a metering or modulating valve, especially during brief periods subsequent to termination of defrosting cycles. Valves of this type are well known to this industry and may be obtained in the open market, so that there is deemed to be no occasion further to describe or illustrate the same herein.

With the suction conduit 13 a branch conduit 21 is connected at two points, as clearly shown in the drawing, and in this conduit is positioned a reevaporator, which is designated as a whole by 22, and may be of any approved construction, preferably fitted with a fan and motor unit 23 similar to the unit 10 associated with the evaporator 9. A pressure reducing device, such as a capillary 24, is fitted in the branch conduit 21 in advance of the inlet of reevaporator 22, for cooperating with the latter in performing its function of revaporizing liquid refrigerant flowing from the evaporator 9 to the compressor during defrosting periods. A capillary is economical and has been found suitable in this connection but, if preferred, it could be substituted by any appropriate pressure reducing device such, for instance, as an automatic expansion valve of correct size, or a hold back valve similar to valve 20 but set to open at a higher pressure than valve 20, or even a hand valve properly adjusted.

In the operation of this form of the invention exhibited in Fig. 1, during refrigerating cycles the hot gas from the compressor discharge passes through the condenser 3, where it is liquefied and then deposited in the receiver 4, from which latter the liquid refrigerant under pressure flows through supply conduit 5 to thermostatic expansion valve 6 where its temperature is reduced and from which it passes into the evaporator 9 to impart a chilling effect to the interior of chamber 11, 12, all as is common and well understood by operatives in this field. In passing through the evaporator 9, the refrigerant is largely, if not entirely, vaporized and then flows from the evaporator through the suction conduit 13 and hold back valve 20 for recompression and repetition of the refrigerating cycle. The hold back valve 20 is preferably adjusted to remain open unless the pressure in the suction conduit equals or exceeds ten pounds per square inch and, as the system is readily operable during refrigerating cycles at a suction pressure or pressures lower than ten pounds, the said valve 20 permits unhampered flow of the refrigerant from the evaporator to compressor during such cycles in the use of the system.

When the electric timer, or other means for controlling the initiation, duration and termination of defrosting cycles, operates to initiate such a cycle, it opens solenoid valve 16, which is closed during refrigeration cycles, and permits hot gas to flow from the compressor discharge through conduit 15 directly to evaporator 9 and, in passing through the evaporator, the hot gas melts the frost thereon which has accumulated during refrigeration periods. In thus serving to defrost the evaporator, the gas becomes condensed and flows from the evaporator largely, if not entirely, in the form of liquid. This defrosting action necessarily raises the temperature at the

evaporator 9 and substantially correspondingly increases the pressure in suction conduit 13, which may rise from less than ten pounds to, perhaps, the neighborhood of thirty pounds. This increase in pressure causes hold back valve 20 to close, thereby compelling the refrigerant liquid outflowing from the evaporator 9 to traverse branch conduit 21, with its reevaporator 22 and capillary 24, before entering the inlet of compressor 1. The combined action of the pressure reducing capillary 24 and the reevaporator 22 revaporizes the liquid refrigerant and thus serves to prevent injury to the compressor which would be apt to occur if the refrigerant should reach the latter in liquid form. The fan unit 23 serves to enhance the vaporizing effect of reevaporator 22 by causing a flow of ambient air therethrough.

At the end of the defrosting cycle, the automatic control, e.g., electric timer, closes solenoid valve 16 and reestablishes flow of refrigerant from the compressor discharge through condenser 3, receiver 4, expansion valve 6, evaporator 9, and suction conduit 13 back to the compressor, in the regular refrigerating cycle hereinabove mentioned. This return to refrigeration activity lowers the pressure in the suction conduit 13 and this re-opens hold back valve 20 to permit free flow of the vaporized refrigerant from evaporator 9 to compressor inlet 19. However, there is usually a short period of time following each defrosting cycle in which liquid refrigerant that has accumulated in conduit 13 will flow toward the compressor, and, during such periods, the valve 20 will, because of continuance of relatively high pressure at its outlet or compressor side, throttle to a certain extent and meter the said flow of refrigerant so that it reaches the compressor in small components and thus avoids injury. It should be mentioned that fan units 10 and 23 are preferably in circuit with the control for solenoid valve 16 in such a way that the opening of the said valve deactivates fan unit 10 and activates fan unit 23; while the closing of solenoid valve 16 is accompanied by reactivation of unit 10 and deactivation of unit 23.

If the compressor 1 is of the low temperature, hermetically sealed, suction-gas cooled type hereinabove mentioned, it is practical to elimnate from the system illustrated in Fig. 1 the branch conduit 21, together with its reevaporator 22 and pressure reducing device 24, because, in such a case, the heat generated by the operation of the compressor motor, e.g., the windings thereof, will serve, during defrosting periods, to perform the revaporizing function of the reevaporator 22 and eliminate the effect of its friction drop, while the hold back valve 20 will serve to perform the function of the pressure reducing capillary 24. This enables substantial simplification and economy in the construction, installation and operation of the system, and constitutes an important feature of advantage inherent in this invention, particularly in view of the expanding adoption of the hermetically sealed compressor and motor unit.

Turning now to the form of the invention represented in Fig. 2, the compressor 1, supply conduit 5, expansion valve 6, bulb and tube 7, conduit 8, evaporator 9, fan and motor unit 10, refrigeration chamber walls 11, 12, suction conduit 13, heat exchanger 14, hot gas conduit 15, valves 16, 17, drain 18, and compressor inlet 19, correspond to the like parts in Fig. 1, and have the same reference numerals applied thereto.

The condenser is differently arranged and is marked 25. It is of the air-cooled type and has associated therewith a suction fan and motor unit denoted by 26. The hot gas conduit 27 from compressor discharge leads to the inlet of the condenser, while its outlet is connected to a receiver 28, by a conduit 29. Supply conduit 5 communicates with the receiver.

A branch conduit, here marked 30, is connected to suction conduit 13 at two points, and a flow controlling device 31, such as hold back valve 20 of Fig. 1, is interposed in conduit 13 between the points at which the

branch conduit communicates therewith. A reevaporator **32** is fitted in branch conduit **30**, as is also a pressure reducing device, e.g., capillary **33**, which latter may be substituted by any other suitable device as explained in connection with capillary **24** of Fig. 1.

The reevaporator **32** may be of low cost construction devoid of a fan and motor unit because, due to its juxtapositioning with respect to the condenser **25**, the suction fan of the latter will generate a flow of air through the reevaporator as indicated by the arrow.

The mode of operation of this form of the invention shown in Fig. 2 is so like that of the form shown in Fig. 1, that it is believed sufficient to say that, during refrigerating cycles, the refrigerant follows the normal course from compressor, through condenser, receiver, evaporator, and back to compressor through valve **31**. When a defrosting cycle is initiated and the effect of the hot gas in the evaporator **9** raises the pressure in suction conduit **13**, valve **31** closes and the liquid refrigerant from the evaporator is compelled to travel through capillary **33** and reevaporator **32** before reaching the compressor, thereby causing re-vaporizing of the returning refrigerant as in the case of the flow of refrigerant through the capillary **24** and reevaporator **22** of Fig. 1. The valve **31** also serves to throttle and meter out in small portions any residual liquid refrigerant in the suction conduit immediately after each defrosting cycle, as previously described in connection with valve **20** of Fig. 1, thereby avoiding injury to the compressor; following which the reduction of pressure in the suction conduit permits valve **31** to open fully and pass the refrigerant freely therethrough during the succeeding refrigerating cycle.

This system of Fig. 2 is, like that of Fig. 1, well suited to the use of a low temperature compressor, whether hermetically sealed or not; and, if the compressor is of the low temperature, hermetically sealed, suction-gas cooled type, the branch conduit **30** with its reevaporator **32** and capillary **33** may be omitted.

It will be seen that both forms of the invention are of simple and inexpensive construction, while lending themselves nicely to modern advances with particular reference to low temperature compressors, including those that are hermetically sealed; and that they attain all the objects hereinabove recited as well as others inherent in the invention.

I wish it to be understood that various changes may be resorted to in the form, construction, material and arrangement of the several parts without departing from the spirit or scope of the invention; and hence I do not intend to be limited to details herein shown or described except as the same may be included in the claim or be required by disclosures of the prior art.

What I claim is:

A refrigerating system comprising, an electrically motor driven compressor of the low temperature hermetically sealed suction gas cooled type, an evaporator, a condenser connected by conduit with the compressor discharge for supplying condensed refrigerant to the inlet of the evaporator, a hot gas defrosting conduit connecting the compressor discharge with the evaporator and bypassing the condenser, a suction conduit connecting the outlet of the evaporator with the inlet of the compressor, and a flow modulating device positioned in the suction conduit and operatively subject to pressure in the suction conduit between itself and the compressor adapted for permitting free passage of refrigerant therethrough during refrigerating cycles of the system, throttling the passage of refrigerant therethrough during defrosting cycles for reducing the pressure of the refrigerant and cooperating with the heat of the electric compressor motor assembly to reevaporate liquid refrigerant entering the compressor, and also for metering the flow to the compressor of liquid refrigerant remaining in the suction conduit for a short period following each defrosting cycle, the compressor being so constructed and arranged that the refrigerant passing thereinto from the suction conduit flows in heat exchange contact with the heat generated by the motor assembly to accomplish the reevaporation of the liquid portion of the refrigerant before recompression.

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