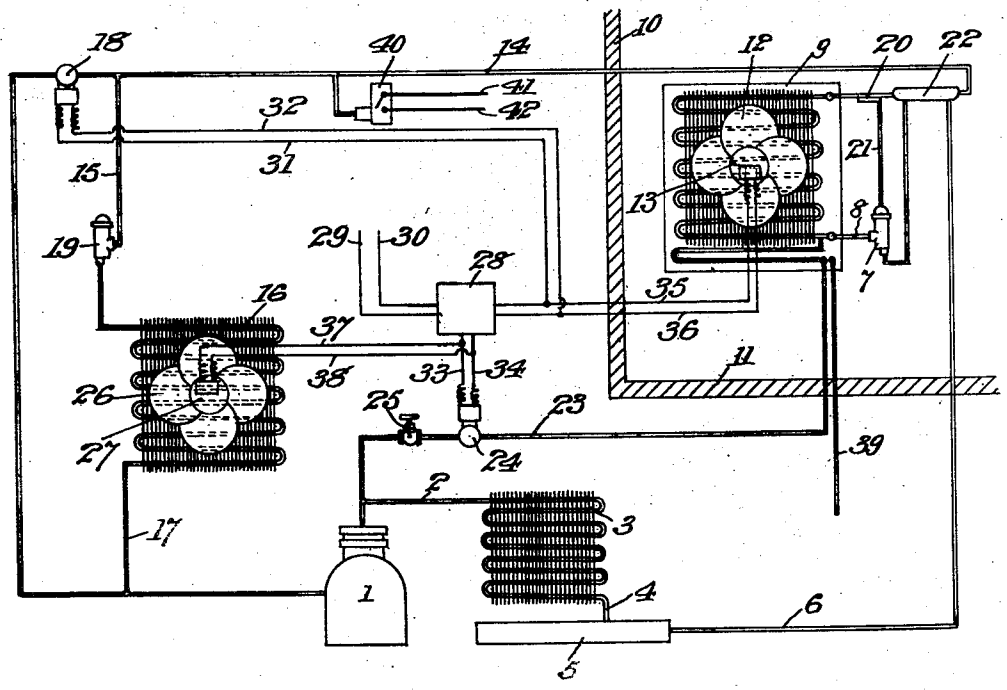
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DEFROSTING SYSTEM FOR REFRIGERATING APPARATUS

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INVENTOR
Otto J. Nussbaum
BY Brosius and Brosius
his ATTORNEYS

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DEFROSTING SYSTEM FOR REFRIGERATING APPARATUS

Otto J. Nussbaum, Trenton, N. J., assignor to Kramer Trenton Company, Trenton, N. J., a corporation of New Jersey

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This invention relates to refrigerating apparatus and, more particularly, to improved means for defrosting the evaporator within the refrigeration chamber.

An object of the invention is to provide an arrangement or system in which hot gas supplied from the compressor serves periodically to defrost the evaporator within the refrigeration chamber while a second evaporator, located without the said chamber and coupled with a pressure reducing means, such as an expansion valve, serves to revaporize the liquid flowing from the evaporator within the refrigeration chamber as a result of defrosting so that the said liquid reaches the inlet of the compressor in the form of gas.

Another object is to provide such an arrangement or system in which the defrosting step is efficiently and effectively accomplished even though the installation is one in which the compressor and condenser are located so as to be exposed to weather conditions and in spite of low ambient temperatures.

Another object is to provide such an arrangement or system in which conduits interconnecting the two evaporators and the compressor are provided with means for causing the fluid flowing from the evaporator located within the refrigeration chamber to the compressor to travel either directly to the compressor or through the other evaporator with its expansion valve before reaching the compressor.

Another object is to provide such an arrangement or system in which a hot gas line connects the outlet of the compressor with the inlet of the evaporator located in the refrigeration chamber, and in which valves are located in the said hot gas line and in the conduit running from said evaporator to the compressor, means being provided for periodically opening the one valve and closing the other and vice versa.

Another object is to provide such an arrangement or system in which each evaporator may be provided with a fan, and in which there is means for causing the fan connected with the evaporator located within the refrigeration chamber to be activated when the other fan is not activated and vice versa.

Another object is to provide such an arrangement or system in which, during normal operation, the evaporator located without the refrigeration chamber is by-passed by the fluid flowing from the evaporator within the said chamber to the compressor, and in which, during defrosting periods, the fluid flowing from the evaporator

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within the said chamber to the compressor passes through the evaporator located without the said chamber and through a pressure reducing device, such as an expansion valve, before entering the last named evaporator.

Another object is to provide such an arrangement or system which includes automatic means that may be set for predetermined periodical activity, which means controls the periods of normal operation and defrosting operation and likewise controls the activation and deactivation of the several elements during each of said periods.

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

In connection with the installation of refrigerating apparatus it is sometimes desirable, in view of building structure or arrangement, to locate the compressor unit, which commonly includes the condenser, out of doors which practice is feasible when the condenser is of the air-cooled type. However, at geographical points where the temperature is normally low or where winters are severe difficulty is often encountered, particularly in those systems employing hot gas defrosting, due to an insufficient supply of heat for the defrosting step. This difficulty is exaggerated when the water vapor load from substances in the refrigerating chamber is high while the temperature surrounding the compressor and condenser is low, because this condition causes ice to form rapidly on the evaporator in the refrigeration chamber while the low ambient temperature at the compressor and condenser unit reduces the supply of heat requisite for satisfactory defrosting. The present invention is calculated to overcome the difficulty just described and to impart additional advantages to the performance of the apparatus or system.

A practical embodiment of the invention is diagrammatically represented in the accompanying drawing, in which a compressor is denoted by 1 and is connected by pipe 2 with a condenser 3 which is, in turn, connected by pipe 4 with a receiver 5. These parts just mentioned may be of any well known or approved form and arrangement and they will not be further described as those skilled in this art are thoroughly familiar with them and their particular construction and arrangement constitute no part of the present invention. The receiver is connected by the usual supply pipe line 6 with a pressure reducing

device, such as an expansion valve 7, which may be of any well known or approved form and itself connected by pipe 8 with an evaporator 9, of any approved or desired construction, which is mounted or hung by suitable means (not shown) within the refrigeration chamber of which two walls are shown and marked 10, 11. The usual fan 12, and its motor 13, are mounted adjacent the evaporator to circulate the chilled air throughout the refrigeration chamber.

From the outlet of the evaporator 9 a suction pipe or conduit 14 leads to the intake port of the compressor 1; and a branch pipe or conduit 15 leads from pipe 14 to the inlet of a second evaporator 16 which is mounted or hung by any appropriate means at a point without the refrigeration chamber 10, 11. The outlet of evaporator 16 is connected by another pipe or conduit 17 with the suction pipe 14 at a point adjacent the compressor. It will be observed that the arrangement just described provides two paths or courses for the fluid traveling from the evaporator 9 that is within the refrigeration chamber to the compressor; one of the paths or courses being direct to the compressor and the other traversing the evaporator 16 that is positioned without the refrigeration chamber. A solenoid valve 18 is located in the suction pipe 14 at a position intermediate the compressor 1 and the point at which conduit 15 connects with pipe 14; and it will be clear that, when valve 18 is open, fluid from evaporator 9 may travel through pipe 14 directly to compressor 1 while, when valve 18 is closed, the said fluid must pass through pipe 15, evaporator 16 and pipe 17 to reach the compressor.

In the pipe or conduit 15 there is placed a pressure reducing means, such as an expansion valve 19, which may be of any well known or approved form, the function of the said valve 19 being to expand and reduce the pressure of the liquid flowing from evaporator 9 during periods in which the said evaporator is being defrosted. In other words, expansion valve 19 functions with respect to evaporator 16 in a manner similar to that in which expansion valve 7 functions with respect to evaporator 9.

A feeler tube 20, of any well known or approved form, is associated with suction pipe 14 at a point adjacent evaporator 9 and is connected by a small diameter pipe 21 with expansion valve 7 in order to regulate the action of the latter in a manner well understood by those skilled in this industry; and the refrigerant feed pipe 6 and suction pipe 14 both pass through a heat exchanger 22, which may be of well known or approved construction, for the purpose of regulating the temperature of the refrigerant fed to valve 7 as well as the relative temperature of the liquid refrigerant flowing into the evaporator 9 and the vaporized refrigerant outflowing therefrom, all of which is also well known and familiar practice in this industry.

The discharge of compressor 1 is connected by a pipe or conduit 23 with the evaporator 9 for the purpose of periodically supplying hot gas to defrost the latter, and a second solenoid valve 24 is located in pipe 23 for the automatic closing and opening thereof. A hand valve 25 is positioned in pipe 23 at a point intermediate compressor 1 and valve 24 for the purpose of manually shutting off the defrosting line during occasional servicing of the system. The evaporator 16 located without the refrigeration chamber 10, 11, is, like the evaporator 9, equipped with the usual fan 26 and fan motor 27 for the purpose of increasing its radiation and vaporizing effect, although this fan 26 and its motor may be omitted, if desired.

An electric timer, preferably of the self-starting type, various forms of which are well known and on the market, is indicated by 28 and is connected by wires 29, 30, with any suitable source of electric current, such, for instance, as a commercial supply line. This timer serves to control the solenoid valves 18 and 24 as well as the fan motors 13 and 27, the timer being in electric circuit with valve 18 through wires 31, 32; with valve 24 through wires 33, 34; with fan motor 13 through wires 35, 36; and with fan motor 27 through wires 37, 38. The timer 28 may be set by the installing engineer to initiate defrosting periods at predetermined intervals selected by him and to continue each defrosting operation for a predetermined duration also selected by him; the apparatus just described being so arranged that, when the timer initiates a defrosting period it actuates solenoid valve 18, which is normally open, so as to close the valve; and it actuates solenoid valve 24, which is normally closed, so as to open the valve. Simultaneously, the timer 28 interrupts the current flow to fan motor 13 which causes fan 12 that is normally operating to cease rotating; and completes the current circuit to fan motor 27 which causes fan 26, that is normally idle, to start rotating. At the end of the defrosting operation, timer 28 reverses its effects upon the parts just mentioned, thereby opening valve 18, closing valve 24, starting fan 12, and stopping fan 26.

It will be understood that the evaporator 9 is provided with the usual drip pan (not shown) which is defrosted with the evaporator, and a suitable pipe 39 serves to drain off the water resulting from defrosting to the sewer or any other suitable disposal provision.

In operation, valve 24 is normally closed while valve 25 is normally open, and the hot gas from the compressor 1 passes through pipe 2, condenser 3, pipe 4, receiver 5, pipe 6, expansion valve 7, and pipe 8 to evaporator 9 for the purpose of chilling the refrigeration chamber 10, 11, all as is usual, customary and well understood. As valve 18 is normally open, the refrigerant fluid passing out of evaporator 9 flows through suction pipe 14 and back to the intake of compressor 1, thus completing the cycle of fluid travel which continues during normal refrigerating operations.

The self-starting electric timer 28 has previously been set by the engineer to initiate at predetermined periods defrosting steps continuing for predetermined durations. When, now, a time for defrosting evaporator 9 arises, the said timer functions to close valve 18, open valve 24, stop fan 12 and start fan 26. With this setup the hot gas from the compressor flows through pipe 23 to evaporator 9 and melts the ice with which the latter and its drip pan are encrusted, the water resulting therefrom passing off through pipe 39. The hot gas in performing its defrosting function is in turn chilled by the ice on the evaporator 9 and drip pan so that, when it emerges from the said evaporator, it flows through pipe 14 as a liquid. Valve 18 being closed compels this liquid to pass through pipe 15 and expansion valve 19, to and through evaporator 16 and thence through pipe 17 to the intake of compressor 1. The effect of the expansion valve 19 is to reduce the pressure of the liquid and the effect of the evaporator 16, with its fan 26,

is to revaporize or reevaporate the liquid so that it passes to the compressor as a gas, thereby avoiding the slugging of liquid through the compressor intake which would seriously handicap the operation of the apparatus and reduce its capacity to supply heat for defrosting. When the predetermined duration of the defrosting period has expired, the timer 28 again functions to close valve 24, open valve 18, start fan 12 and stop fan 26. Whereupon the apparatus resumes its operation as a refrigerating system at full efficiency because of the defrosting of the refrigerating chamber evaporator 9 and its drip pan.

If desired, a pressure switch 40, of any well known or approved form, may be connected with pipe 14 at a point intermediate the evaporator 9 and the junction of pipes 14 and 15, for the usual purpose of starting and stopping the compressor motor (not shown) in response to the pressure existing in pipe 14. The switch 40 is connected to the compressor motor by wires 41, 42, in any customary manner, the same being so well understood in this industry as to call for no illustration or description.

From the foregoing it will be seen that, during normal operation, evaporator 9 acts as an evaporator and condenser 3 is performing its usual function of condensing the hot gas received from the compressor; while, during the defrosting periods, evaporator 9 acts as a condenser, evaporator 16 acts as an evaporator and condenser 3 is practically inactive.

The functioning of evaporator 16, especially in conjunction with its expansion valve 19, is such that the liquid returning from evaporator 9 is thoroughly vaporized even though evaporator 16 is located out of doors and subject to very low temperatures. This greatly assists the functioning of compressor 1 and condenser 3 and causes adequate heat to be provided for each defrosting of evaporator 9, even though the compressor and condenser may likewise be located out of doors and exposed to low ambient temperatures. Another operational advantage resides in the fact that this structure and arrangement eliminates objectionably heavy loads upon the compressor motor either during defrosting periods or immediately after the resumption of normal operations. Again, the evaporator 16 may be of considerably less heat transfer surface than evaporator 9 and yet serve its purpose adequately and satisfactorily. Finally, the apparatus, arrangement or system is comparatively simple, may be composed of standard parts, adapts itself to many different installation requirements, and will function with complete satisfaction regardless of climatic conditions. All the objects hereinabove mentioned are attained to a full degree, and the user also receives the advantage of numerous other desirable features inherent in the construction and arrangement.

While the utility of this invention has been emphasized under conditions in which the compressor, condenser and evaporator are subject to low ambient temperatures, it should be noted that it is also well adapted to situations in which the said parts are subject to moderate or warm temperatures, and the pressure reducing device 19 may even be omitted if the surrounding temperature is fairly high, e. g., 60° F. or higher.

When, in the claims, I use the expression "a refrigeration chamber," I intend to include, not only a normally closed chamber, but also other forms of refrigeration spaces, compartments or sections even though they normally be partly open, such, for instance, as the refrigeration spaces in self-service display cases.

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

What I claim is:

1. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, conduits interconnecting the two evaporators and the compressor, pressure reducing means in the conduit which connects the two evaporators, means for controlling said conduits to permit fluid to flow from the outlet of said first evaporator either directly to the inlet of the compressor or by a course passing through the pressure reducing means and said second evaporator, and a hot gas line connecting the outlet of the compressor with the inlet of said first evaporator without passing through the condenser.

2. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, conduits interconnecting the two evaporators and the compressor, pressure reducing means in the conduit which connects the two evaporators, said conducts being arranged so as to permit fluid to flow from the outlet of said first evaporator either directly to the inlet of the compressor or by a course passing through the pressure reducing means and said second evaporator, a hot gas line connecting the outlet of the compressor with the inlet of said first evaporator without passing through the condenser, and automatic means for closing the conduit leading directly from the outlet of said first evaporator to the inlet of the compressor and opening said hot gas line.

3. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, conduits interconnecting the two evaporators and the compressor, pressure reducing means in the conduit which connects the two evaporators, said conduits being arranged so as to permit fluid to flow from the outlet of said first evaporator either directly to the inlet of the compressor or by a course passing through the pressure reducing means and said second evaporator, a hot gas line connecting the outlet of the compressor with the inlet of said first evaporator without passing through the condenser, and automatic means for simultaneously closing the conduit leading directly from the outlet of said first evaporator to the inlet of the compressor and opening said hot gas line.

4. Apparatus of the character described comprising, a compressor, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, conduits interconnecting the two evaporators and the compressor, pressure reducing means in the conduit which connects the two evaporators, said conduits being arranged so as to permit fluid to flow from the outlet of said first evaporator either

directly to the inlet of the compressor or by a course passing through the pressure reducing means and said second evaporator, a hot gas line connecting the outlet of the compressor with the inlet of said first evaporator, automatic means for simultaneously closing the conduit leading directly from the outlet of said first evaporator to the inlet of the compressor and opening said hot gas line, a fan associated with each of said evaporators, means for driving said fans, and automatic means for stopping the fan associated with said first evaporator and starting the fan associated with said second evaporator when the conduit leading directly from the outlet of said first evaporator to the inlet of the compressor is closed.

5. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, a conduit connecting the outlet of said first evaporator with the inlet of the compressor, a second conduit connecting said first conduit with the inlet of said second evaporator, a third conduit connecting the outlet of said second evaporator with the inlet of the compressor, a valve in said first conduit for closing it and causing the fluid from the said first evaporator to pass through said second conduit, second evaporator and third conduit, and a hot gas line connecting the outlet of the compressor with the inlet of the said first evaporator without passing through the condenser.

6. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, a conduit connecting the outlet of said first evaporator with the inlet of the compressor, a second conduit connecting said first conduit with the inlet of said second evaporator, a third conduit connecting the outlet of said second evaporator with the inlet of the compressor, pressure reducing means in said second conduit, a valve in said first conduit for closing it and causing the fluid from the said first evaporator to pass through said second conduit, pressure reducing means, second evaporator and third conduit, and a hot gas line connecting the outlet of the compressor with the inlet of the said first evaporator without passing through the condenser.

7. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, a conduit connecting the outlet of said first evaporator with the inlet of the compressor, a second conduit connecting said first conduit with the inlet of said second evaporator, a third conduit connecting the outlet of said second evaporator with the inlet of the compressor, pressure reducing means in said second conduit, a valve in said first conduit for closing it and causing the fluid from the said first evaporator to pass through said second conduit, pressure reducing means, second evaporator and third conduit, a hot gas line connecting the outlet of the compressor with the inlet of said first evaporator without passing through the condenser, a second valve in said hot gas line, and means for periodically closing said first valve and opening said second valve and for opening said first valve and closing said second valve.

8. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, a conduit connecting the outlet of said first evaporator with the inlet of the compressor, a second conduit connecting said first conduit with the inlet of said second evaporator, a third conduit connecting the outlet of said second evaporator with the inlet of the compressor, pressure reducing means in said second conduit, an automatic valve in said first conduit for closing it and causing the fluid from the said first evaporator to pass through said second conduit, pressure reducing means, second evaporator and third conduit, and a hot gas line connecting the outlet of the compressor with the inlet of said first evaporator without passing through the condenser.

9. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber, a second evaporator located without said chamber, a conduit connecting the outlet of said first evaporator with the inlet of the compressor, a second conduit connecting said first conduit with the inlet of said second evaporator, a third conduit connecting the outlet of said second evaporator with the inlet of the compressor, pressure reducing means in said second conduit, a valve in said first conduit for closing it and causing the fluid from the said first evaporator to pass through said second conduit, pressure reducing means, second evaporator and third conduit, a hot gas line connecting the outlet of the compressor with the inlet of said first evaporator without passing through the condenser, a second valve in said hot gas line, and automatic means for periodically closing said first valve and opening said second valve and for opening said first valve and closing said second valve.

10. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber and having an inlet and an outlet, the inlet of said evaporator being in operative connection through the condenser with the discharge of the compressor, a hot gas line connecting the outlet of the compressor with the inlet of said evaporator without passing through the condenser, an evaporating coil located without said chamber and having an inlet and an outlet, a fluid conducting conduit connecting the outlet of the evaporator that is within the chamber with the inlet of the evaporating coil that is without the chamber, a fluid conducting conduit connecting the outlet of the evaporating coil that is without the chamber with the inlet of the compressor, and pressure reducing means in the said conduit which connects the outlet of the evaporator that is within the chamber with the inlet of the coil that is without the chamber, the parts being so constructed and arranged that the surrounding air may be circulated in contact with the outer surface of the coil that is located without the chamber to augment its effect upon the fluid passing therethrough.

11. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber and having an inlet and an outlet, the inlet of said evaporator being in operative connection through the condenser with the discharge of the compressor, a hot gas line connecting the outlet of the compressor with the inlet of said

evaporator without passing through the condenser, an evaporating coil located without said chamber and having an inlet and an outlet, a fluid conducting conduit connecting the outlet of the evaporator that is within the chamber with the inlet of the evaporating coil that is without the chamber, a fluid conducting conduit connecting the outlet of the evaporating coil that is without the chamber with the inlet of the compressor, pressure reducing means in the said conduit which connects the outlet of the evaporator that is within the chamber with the inlet of the coil that is without the chamber, and air circulating means associated with the evaporating coil that is without the chamber to augment its effect upon the fluid passing therethrough.

12. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration chamber, an evaporator located within said chamber and having an inlet and an outlet, the inlet of said evaporator being in operative connection through the condenser with the discharge of the compressor, a hot gas line connecting the outlet of the compressor with the inlet of said evaporator without passing through the condenser, a second evaporator located without said chamber and having an inlet and an outlet, a fluid conducting conduit connecting the outlet of the evaporator that is within the chamber with the inlet of the said second evaporator, a fluid conducting conduit connecting the outlet of the said second evaporator with the inlet of the compressor, pressure reducing means in the said conduit which connects the outlet of the evaporator that is within the chamber with the inlet of said second evaporator, and automatic means for opening and closing said hot gas line.

13. Apparatus of the character described comprising, a compressor, a condenser, a refrigeration

chamber, an evaporator located within said chamber and having an inlet and an outlet, the inlet of said evaporator being in operative connection through the condenser with the discharge of the compressor, a hot gas line connecting the outlet of the compressor with the inlet of said evaporator without passing through the condenser, a second unenclosed evaporator located without said chamber so as to be surrounded by circumambient atmosphere and having an inlet and an outlet, a fluid conducting conduit connecting the outlet of the evaporator that is within the chamber with the inlet of said second evaporator, a fluid conducting conduit connecting the outlet of the said second evaporator with the inlet of the compressor, pressure reducing means in the said conduit which connects the outlet of the evaporator that is within the chamber with the inlet of said second evaporator, and automatic means for opening and closing said hot gas line.

OTTO J. NUSSBAUM.

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