Sept. 18, 1956 R. M. HENDERSON 2,763,130

HOT GAS DEFROSTING SYSTEM

Filed April 28, 1952 2 Sheets-Sheet 1

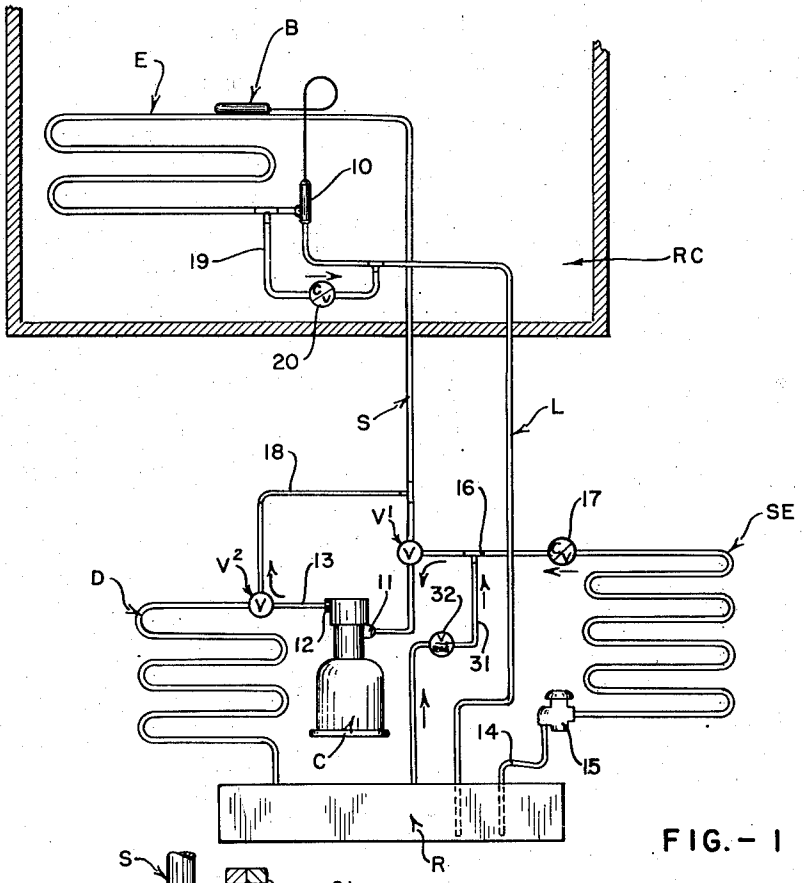


FIG. - 1

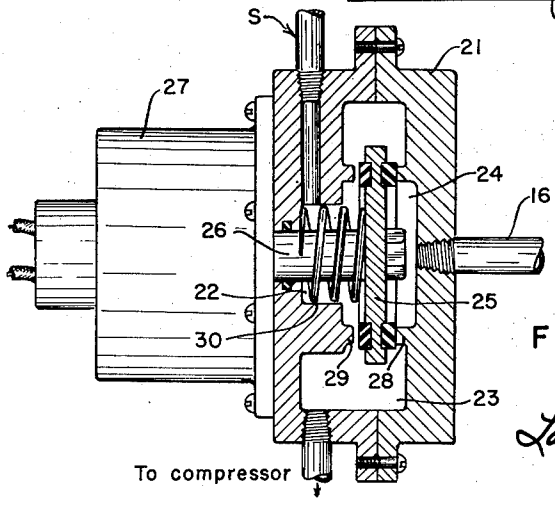


FIG. - 2

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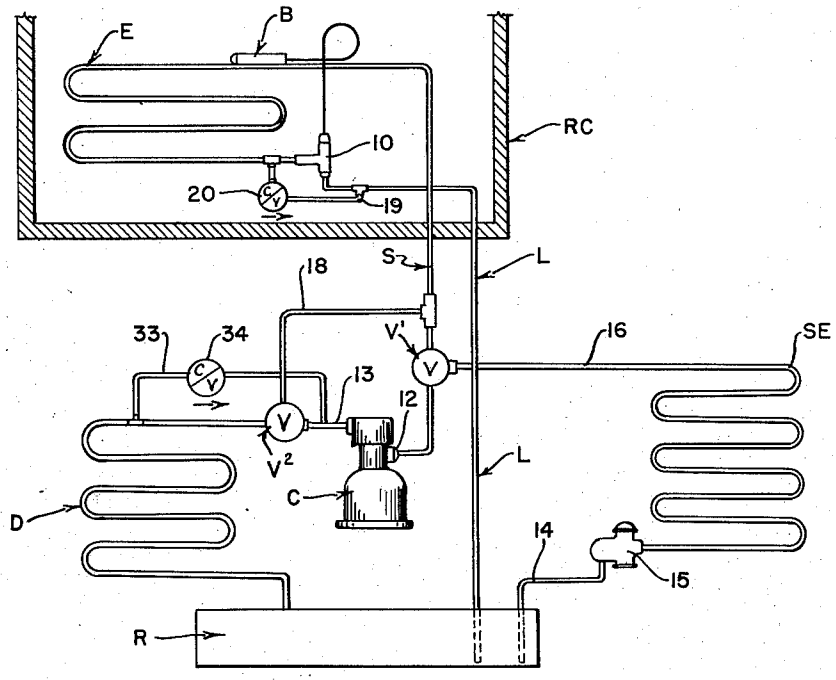


FIG.— 3

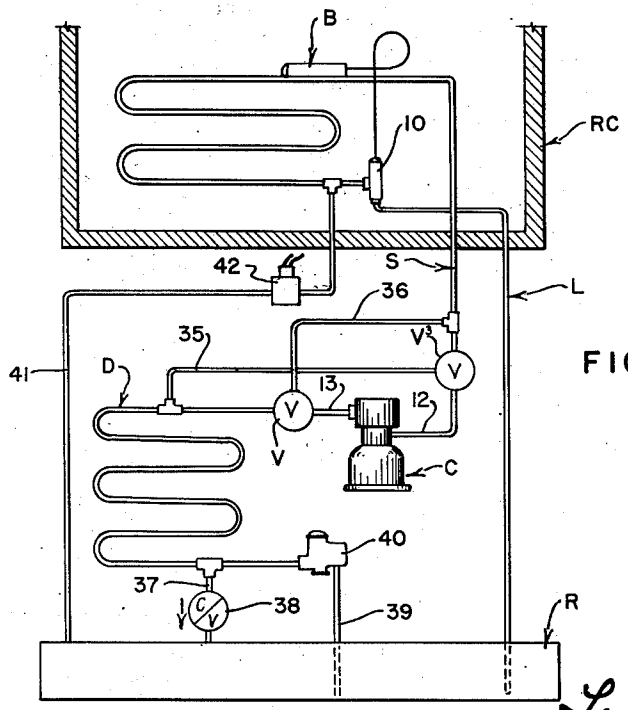


FIG.— 4

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HOT GAS DEFROSTING SYSTEM

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Application April 28, 1952, Serial No. 284,730
12 Claims. (Cl. 62—3)

This invention relates to refrigeration apparatus and more particularly to improved means and method for hot gas defrosting of refrigeration evaporators, especially those which are used in low temperature refrigerators.

There are many and various defrosting systems in use which are designed to use hot refrigerant gas to defrost refrigeration evaporators. Most of such systems are arranged to divert hot gas from the compressor discharge line into the evaporator to thereby utilize the heat carried by the gas for defrosting.

In the operation of these systems it has been found that when this hot gas enters a low temperature evaporator, it is immediately condensed into a liquid. It has also been found in the operation of most of these systems that the entrance of hot gas into the evaporator causes the expansion valve to stand open during the defrosting cycle to permit unrestricted flow of liquid refrigerant from the receiver through the orifice of the expansion valve into the evaporator. Therefore, from these two sources, an excessive amount of liquid is accumulated in the evaporator or the low side of the refrigeration system during the defrosting cycle.

Because of the fact that conventional refrigeration compressors are not designed to pump liquid, this accumulated liquid must be evacuated from the low side of the refrigeration system, either during the defrosting cycle or at the end of the cycle and before the regular refrigeration cycle is again started in order to thereby avoid damage to the compressor.

In one type of defrosting system which is commonly known as "reverse cycle defrosting," a by-pass line and check valve are arranged to permit this accumulated liquid to bypass the expansion valve and flow into the liquid line or the high side of the system. This method of liquid return to the high side of the system is fairly successful in applications wherein comparatively high temperatures are maintained because the condensation of hot gas in a relatively warm evaporator is rather slow and continued pumping of hot gas into the evaporator soon builds up enough pressure in the evaporator or the low side of the system to overcome the pressure in the receiver side of the system to thereby cause the liquid, which is accumulated in the evaporator, to flow toward the receiver side of the system. However, this system is inadequate when the refrigerator or evaporator section is held at sub-freezing temperatures. In such installations the condensation of hot gas is very rapid and the process of building up sufficient pressure in the evaporator to cause the liquid to flow against the pressure in the receiver side of the system is very slow, and usually consumes so much time that most of the liquid in the entire system is accumulated in the low side of the system before sufficient pressure is built up in the evaporator to force it into the receiver side.

This accumulation of liquid in the evaporator by condensation of pressure and reverse flow of liquid through the expansion valve orifice not only depletes the supply of liquid in the receiver, but also forms a high liquid level

in the evaporator being defrosted which forms a liquid seal or a barrier against the flow of vapor through the bottom of the evaporator which is filled with liquid and, therefore, a portion of the evaporator will defrost and another part that is filled with liquid which has been cooled to sub-freezing temperature will remain frosted until sufficient pressure can be built up in the evaporator to overcome the receiver pressure.

In these so-called reverse cycle applications, an expansion valve with a by-pass and check valve arrangement is usually positioned between the condenser and the receiver to thereby cause the condenser to become an evaporator when the flow of refrigerant is reversed. This arrangement, by necessity, forms a liquid seal between the condenser and the receiver which prevents the escape of gas from the receiver to the condenser and because of the fact that all other connections to the receiver in a conventional refrigeration system are liquid sealed, the escape of vaporized refrigerant from the receiver is prevented. Therefore, a gas pressure sufficiently high to hold the refrigerant in a liquid state at a temperature equal to the ambient temperature of the receiver is maintained during the defrosting cycle, and because of the usual high temperature of the receiver, this pressure remains comparatively high. To cause the liquid, which accumulates in the evaporator as a result of defrosting, to flow into the receiver from the evaporator through the means provided, the pressure in the evaporator must be raised at least slightly above the pressure in the receiver and because of the low ambient temperature of an evaporator in a sub-freezing refrigerator, the accumulation of this pressure in the evaporator by the introduction of hot gas is impractical because the introduction of a sufficient amount of heat into the evaporator of the refrigerated chamber to build up this amount of pressure would not only heat the evaporator, but would also heat the refrigerated chamber to a point where the product load would be damaged.

Because of the above outlined difficulties which have been encountered in reverse cycle defrosting, this method of defrosting has practically been abandoned for low temperature or sub-freezing refrigeration systems, and various other means and methods have been employed. The most common of these systems is what is generally known as "re-evaporation." In this type of defrosting system, the liquid which is accumulated in the refrigeration evaporator as a result of defrosting is passed through a second evaporator or other heating means, which is positioned in the suction line or a suction line by-pass, to thereby evaporate the liquid before it reaches the compressor. In such a system, because of the fact that there is usually a larger accumulation of liquid by the evaporator than the amount required for re-evaporation for the purpose of absorbing heat to complete the defrosting cycle, it requires more heat and more running time of the condensing unit to re-evaporate and recondense this liquid to return it to the receiver than it does to completely defrost the evaporator. Therefore, a considerable amount of energy is wasted and an excessive period of time is consumed in the operation, which in turn creates an excessive warm-up period for the frozen product load in the refrigerator.

It is in view of the discussed shortcomings of the prior defrosting systems that a primary object of my invention is to provide means and method to facilitate the return of liquid refrigerant, which accumulates in the evaporator section of a refrigeration system as a result of hot gas defrosting, to the liquid receiving means of said system during the defrosting operation.

Another object is to provide, in combination with a hot gas defrosting system, a means and a method to reduce the pressure difference, which is created at the beginning of and as a result of the defrosting, between

the evaporator means which is being defrosted and the liquid receiving means of the refrigeration system, to thereby facilitate the return of liquid refrigerant from said evaporator section to the said liquid receiving means during the defrosting operation.

Another object is to provide a means of reducing the gas pressure in the liquid receiving means of a refrigeration system during a hot gas defrosting operation of said system, and additionally a means to regulate and control such pressure reduction during said defrosting operation.

Other objects of my invention will become apparent from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a schematic view of a refrigeration and defrosting system shown, by way of example, as embodying the invention;

Figure 2 is a sectional view of the type of three-way control valves which can be used in the system of Figure 1;

Figure 3 is a view showing another manner in which my invention can be embodied in a refrigeration and defrosting system of the type shown in Figure 1; and

Figure 4 is a view showing a manner in which my invention can be embodied in a system having a so-called reverse cycle refrigeration defrosting system to obtain the desired results.

Referring to Figure 1 in detail, a conventional low temperature refrigerating system is shown with which is to be associated a hot gas defrosting system embodying my invention. This low temperature refrigeration system comprises an evaporator E of the coil type forming the evaporator section of the system (there may be more evaporators but only one is shown for simplicity). The evaporator is positioned in a space or chamber to be refrigerated which is indicated by the letters RC. Also forming part of the conventional system is the compressor C, the condenser D and the liquid receiver R. The receiver is connected to one end of the evaporator by a liquid conduit line L with which is associated the expansion valve **10**. There is also a suction conduit line S connected to the low side **11** of the compressor and to the other end of the evaporator. To this suction line is clamped the bulb B which controls the expansion valve **10** in a known manner. The high side **12** of the compressor is connected by a conduit **13** with one end of the condenser D, said other end being connected into the receiver R as shown.

With this conventional refrigeration system, the refrigerant in the evaporator absorbs heat from the space RC being cooled because it is held under a pressure at which the liquid's boiling temperature is below the temperature of the surrounding air or material in the chamber. The heat flowing into the refrigerant causes it to boil and be converted into a vapor. This vapor then passes through the suction line to the compressor C where it will be compressed to a pressure at which the temperature of the refrigerant is somewhat higher than the cooling medium (generally air or water) in the condenser D. At the condenser, when the heat is transferred from the compressed vapor to the cooling medium of the condenser, the refrigerant condenses into a liquid. The liquid refrigerant then passes into the receiver R and subsequently through the liquid line L to the evaporator E through the expansion valve. This expansion valve is designed to keep the line as full of refrigerant as possible and prevent any return. In the evaporator the pressure of the refrigerant becomes reduced, where it again boils and extracts more heat from the chamber RC with the result that it is again changed to a vapor.

The hot gas defrosting system which is shown as associated with the conventional low pressure refrigeration system comprises a secondary evaporator or heat exchanger SE positioned outside of the refrigerated chamber RC in which the refrigeration evaporator E is placed to refrigerate said chamber. The hot gas employed for

defrosting is produced from the liquid refrigerant of the refrigerating system and this is accomplished by connecting the secondary evaporator SE to the receiver by a conduit **14**, together with a restricting means which, as shown, is in the form of an expansion valve **15**, whereby the liquid refrigerant coming from the receiver is expanded and becomes a vapor as the liquid boils, due to the heat surrounding the secondary evaporator being absorbed. No special source of heat is shown for the secondary evaporator, but it can be supplied by providing a surrounding tank through which a heated gas or liquid can flow. This supplied heat in the tank can be controlled in a manner similar to that disclosed in my copending application Serial No. 280,263 filed April 3, 1952, for "Defrosting System for Refrigeration Evaporators." The secondary evaporator SE will be connected into the suction line refrigerating system by means of a conduit **16** having a check valve **17** arranged to prevent any return of heat laden gas to the secondary evaporator.

In transmitting the hot gas to defrost the evaporator E in the refrigerated chamber, I employ the compressor C of the refrigeration system and arrange for the condenser D to be by-passed. To connect the secondary evaporator to the low side of the compressor there is employed a 3-way valve V^1 in the suction line S of the refrigeration system where the conduit **16** coming from the secondary evaporator is connected. This 3-way valve V^1 may be of any type, manually or electrically controlled as desired. Preferably, I control it by means of a solenoid which will be placed in a suitable time control circuit so the valve will be automatically operated. A suitable 3-way valve which could be employed is shown in Figure 2.

In order to by-pass the condenser of the refrigeration system, the high side **12** of the compressor will be arranged to be connected into the suction line S of the refrigerating system between the valve V^1 and the evaporator E. This is accomplished by means of another 3-way valve V^2 (can be similar to the structure of valve V^1) positioned in the line **13** between the condenser and the compressor. This valve V^2 also has connected to one of its outlet ports a conduit **17** which will be connected into the suction line by a **T** connection as shown. Also a part of the defrosting system will be the by-pass line **19** which will be connected around the expansion valve **10** for the evaporator E so that liquid which accumulates in the evaporator E during defrosting can freely move back to the receiver R. In this by-pass line **19** there will be a check valve **20** so as to prevent any return of liquid from the receiver to the evaporator E.

As disclosed in Figure 2, the valve V^1 (valve V^2 also being the same) has a casing **21** and within this are chambers **22**, **23** and **24** with chamber **22** connected to the suction line S, the chamber **23** to the compressor and the chamber **24** to the conduit **16** coming from the secondary evaporator. A valve element **25** is carried on the end of a shaft **26** and this is controlled by a solenoid **27**. The valve element is in chamber **23** and can alternately engage seats **28** and **29**. A spring **30** normally biases the valve element onto seat **28**, thus closing off the conduit **16** and allowing the suction line S to be directly connected to the compressor, which will be the condition during refrigeration. When solenoid **27** is energized, valve element **25** will be moved off seat **28** and to seat **29**. This will be the defrosting condition. Consequently, the evaporator E will be cut off from the compressor and the secondary evaporator will be connected to the compressor so that heat laden vapor can be transmitted to the evaporator E being defrosted by way of the 3-way valve V^2, conduit **18** and the suction line. The solenoid of the valve V^2 will be in the same time controlled circuit as the solenoid of the valve V^1 and so simultaneously operated that the high side of the compressor, during defrosting, will be connected to the evaporator E and disconnected from the condenser D.

In the functioning of the hot gas defrosting system just described, the heat laden vapor coming from the secondary evaporator SE will, after proper control of the two 3-way valves V^1 and V^2, pass to the compressor C and then be transmitted by said compressor through the conduit **18** to the suction line and then to the evaporator E where this heat laden vapor will cause the accumulated frost on the coils of the evaporator E to melt. When heat is transferred to accomplish the melting, the gas will condense and again become a liquid and this liquid will then flow back through the by-pass line **19** and the liquid line L of the refrigerating system to the receiver R. In refrigerating systems of the low pressure type, particularly where the evaporator E in the refrigerated chamber is maintained at a comparatively high average temperature above freezing, the defrosting system just described usually operates in an adequate manner to accomplish defrosting. However, when the evaporator E, during refrigeration, is maintained at sub-freezing temperatures, the absorption of heat from the heat laden vapor employed during defrosting will be so rapid that sufficient pressure to overcome the normal pressure in the receiver R to allow for flow of liquid from the evaporator to the receiver cannot be built up in a short enough period of time to prevent excessive accumulation of liquid in the evaporator. Consequently, there will be a high liquid level in the evaporator and also a possible exhaustion of the liquid in the receiver and the defrosting will not be accomplished in the desired manner or in the desired short period of time.

I have discovered that this problem as to exhaustion of the supply of liquid in the receiver and the accumulation of too much liquid in the evaporator during defrosting can be solved by reducing the gas pressure in the receiver. When this is done there will then result a proper flow of liquid from the evaporator being defrosted to the receiver and such will take place in a comparatively short period of time after the initiation of the defrosting cycle. To accomplish the reduction of gas pressure in the receiver, I connect what I term as the "receiver side" of the refrigeration system to the "opposite side" of said refrigeration system. By "receiver side," as I use it in this description of my invention and also in the claims, is meant that side of the refrigeration system which includes the liquid receiver and/or any other portion of said system which is in unrestricted connection with the reeciver and which has substantially the same pressure as is being maintained in the receiver during the defrosting operation. By the expression "opposite side" of the system used in connection with the selected expression "receiver side," is meant any other portion or portions of the refrigeration or defrosting system other than the receiver and/or the unrestricted connections to the receiver.

As shown in Figure 1, the connection between the receiver side and the opposite side of the system is a conduit line **31** which is connected into the receiver side at the top of the receiver R at one end and into the conduit **16** between the 3-way valve V^1 and the check valve **17**, it being recalled that this conduit **16** connects the secondary evaporator SE to the suction line S so that by means of the 3-way valve V^1 heat laden vapor can pass to the compressor and be transmitted thereby to the evaporator E which is being defrosted. With this conduit **31** connected as shown, it will be seen that the gas pressure in the receiver can be lowered and with the lowering thereof liquid will then be permitted to flow back to the receiver R from the evaporator E by way of the by-pass line **19** and the liquid return line L on the receiver side of the expansion valve **10**. The reason that there will be a lowering of the gas pressure in the receiver is that the portion of the system to which the conduit **31** connects the receiver is at a lower pressure than the gas pressure in the receiver.

To better insure, during the entire defrosting cycle, a proper functioning of the escape conduit **31** for lowering the gas pressure on the "receiver side" of the system, it is desirable that certain pressure conditions be maintained. In the first place the pressure in the receiver R should always be maintained slightly above the pressure in the secondary evaporator SE so there will be an adequate flow of liquid into this evaporator through the expansion valve **15** in order that heat will be absorbed and heat laden vapors supplied in an adequate amount to accomplish the defrosting. In the second place, the pressure in the receiver R must be always maintained at a value sufficiently low as to permit the pressure in the evaporator E being defrosted to quickly exceed the pressure in the receiver and thereby assure a rapid evacuation of the liquid from the evaporator E back to the reeciver.

To accomplish this proper functioning, I employ in the escape conduit **31** a suitable pressure relief valve, or what may also be called a pressure regulating valve and this valve indicated at **32** may be of some known construction if it is capable of functioning as desired, or may be of a special design to assure the obtaining of the best desired results. This valve will be adjusted to hold a slightly higher pressure in the receiver R than that in the secondary evaporator. When this is done there will be assured an even and adequate flow of liquid through the expansion valve **15** to the evaporator during defrosting. There will also be proper adjustment of the expansion valve **15** so that the results will be obtained and the desired pressures maintained.

With this connection between the "receiver side" of the system and the "opposite side" of the system, together with proper control of the gas pressure in the "receiver side," it will be apparent that means will then be provided to effect a rapid return of liquid refrigerant from the evaporator E to the receiver during defrosting and without any necessity of re-evaporation of such liquid before its return to the receiver, as has been the already indicated prior practice. With check valve **17** positioned as shown, then vapor from the receiver, during refrigeration, cannot pass to the secondary evaporator through conduit **31** and the valve **32**.

It is not intended to confine my invention solely to the use of a conduit **31** located in the manner shown and described and also having associated therewith a pressure regulating valve. The same results which are obtained by the arrangement described can also be obtained by other arrangements, not only in the type of defrosting system already described but in refrigeration systems using the so-called reverse cycle defrosting.

In Figure 3 I have shown another defrosting system similar to the one shown in Figure 1 wherein a secondary evaporator is also employed for the heat source or heat exchanger and during defrosting 3-way valve means will be employed to connect the secondary evaporator into the compressor and the suction line in a manner already described. In Figure 3 all structure shown and previously described in detail in connection with Figure 1 is indicated by the same reference characters. Instead of employing a by-pass conduit between the receiver and the conduit **16** coming from the secondary evaporator to the 3-way valve V^1, I employ a by-pass together with a check valve between the high side of the compressor and ahead of the 3-way valve V^2 to the condenser. This by-pass line in Figure 3 is indicated by the numeral **33** and the check valve by the numeral **34**, said check valve being operable to prevent flow from the high side of the compressor to the condenser when there is a greater pressure on the high side.

In operation of this defrosting system the valves V^1 and V^2 will be substantially simultaneously operated when defrosting is desired, thus causing the secondary evaporator SE to be connected to the low side of the compressor and the high side of the compressor to be connected to the suction line through the conduit **18**.

When the valve V^2 is controlled during defrosting it will functionally isolate the condenser and cause it to be on the "receiver side" of the defrosting system. Upon initial closing of the valves V^1 and V^2 to accomplish the defrosting, the "receiver side" will be at a relatively high pressure say, for example, around 100 pounds per square inch. Liquid from the receiver will then pass through the expansion valve or restricting means **15** to the secondary evaporator and become heat laden vapor in a manner already described. From here the vapor will be transmitted by the compressor through the valve V^2 into the suction line and to the evaporator E in the refrigerated chamber. This heat laden vapor entering the evaporator E will begin to defrost the evaporator and, as already explained, it will return to liquid form as heat is given up and then pass back into the receiver through the by-pass **19** and check valve around the expansion valve **10**. With high pressure in the receiver and also in the condenser, because the condenser has now been functionally isolated and placed on the receiver side of the defrosting system, then if there were no way of relieving such, there will be insufficient operating pressure developed in the evaporator E to force liquid back into the receiver, and consequently liquid will accumulate in the evaporator and defrosting operations cannot be carried out in the manner described. With my by-pass line **33** and check valve **34**, I am able to lower the pressure in the receiver side of the system. When the defrosting cycle initially begins, the rapid accumulation of liquid in the evaporator being defrosted will result in the pressure at the high side of the compressor dropping very rapidly due to condensation in the evaporator because of the presence of the operating low temperature of the refrigeration system. Consequently the pressure at the high side of the compressor will be considerably lower than the pressure which is retained on the "receiver side" at the beginning of the defrosting cycle. Because of the check valve **34** and by-pass line around the valve V^2 between the high side of the compressor and the condenser, the pressure on the "receiver side" will be relieved and there will be a temporary equalization between the two sides, the check valve acting in no manner to restrict the flow of vapor from the condenser to the high side of the compressor. After this initial equalization there will be an increased pressure acting on the accumulated liquid in the evaporator being defrosted as the compressor operates and the liquid will then be forced back into the receiver in which the pressure has been reduced. Defrosting can then take place in a very short time because the heat laden vapor forced into the evaporator E being defrosted can give up its heat to cause melting and the liquid resulting therefrom can move quickly back to the receiver because there is not a high pressure in the receiver preventing such return.

The check valve **34** in the particular defrosting system shown in Figure 3 can be replaced by a different valve if it is desired to control the receiver pressure. A pressure regulating valve, such as the type shown at **32** in Figure 1, could be used in making a control of the receiver pressure.

In Figure 4 I have embodied my invention in a so-called reverse cycle defrosting system so that upon initiating the defrosting cycle there will be means embodied in the system for so reducing the gas pressure in the "receiver side" of the refrigeration system that such pressure will have such relation to the operating pressure in the "opposite side" of said system that accumulating pressure on the operating side can rapidly overcome the opposing pressure at the receiver side and thereby result in liquid refrigerant in the evaporator being defrosted to flow into the receiver. The reverse cycle defrosting system selected to embody my invention is associated with the usual refrigeration system already described. This system includes the evaporator E in the refrigerated chamber RC, the compressor C, the condenser D and the receiver R. There is the usual suction line S and the liquid line L having associated with it the expansion valve **10** controlled by the bulb B.

In the defrosting system shown I employ two 3-way valves V^3 and V^4 (similar to that of Figure 2), with the valve V^3 being connected in the suction line and arranged, when operated, to connect the suction line ahead of the compressor directly with the condenser D by way of a conduit **35**. The 3-way valve V^4 connects the high side **13** of the compressor to the suction line ahead of the valve V^3 by way of a conduit **36**. Since the defrosting system disclosed is to be a reverse cycle defrosting system, the condenser D is employed as the secondary evaporator heat exchanger as the means for creating the heat laden expanded refrigerant. In order to use the condenser for the heat exchanger, the usual condenser discharge line **37** will be provided with a check valve **38** so as to prevent any flow therethrough from the receiver to the condenser. To get liquid to the condenser during defrosting, there is provided a receiver liquid outlet line **39**. In order to provide restricted passage means for limiting the amount of refrigerant passing through the condenser during the defrosting, there is installed in line **39** a refrigeration expansion valve **40**. In place of this particular valve, other means could be employed if desired.

To complete the reverse cycle defrosting system embodying my invention, I employ a conduit **41** between the top of the receiver and the evaporator E to be defrosted, this line being connected to the evaporator behind the expansion valve **10**. This line is to be open only during defrosting and in order to accomplish this there is provided in the line a shut-off valve **42**. Preferably to provide for automatic control, the shut-off valve **42** will be solenoid controlled so that upon energization of the solenoid the valve will be opened.

With this defrosting system, defrosting will be initiated by controlling of the valves V^3 and V^4, together with the opening of the shut-off valve **42**. Upon the initial control of the valves there will be a rapid equalization of pressures between the "receiver side" and the "opposite side" of the system, due to the conduit **41** and the open condition of the valve **42**. Vapor pressure in the receiver will be relieved and it will pass into the evaporator, with the result that the receiver pressure will be lowered until the equalization takes place. As equalization occurs, liquid will begin to flow from the evaporator E to the receiver through the conduit **41**. This will be aided by continuous operation of the compressor which, it will be noted, has its high side connected to the suction line and the evaporator by way of valve V^4 during the defrosting. Upon the defrosting operation occurring, it will also be noted that the compressor will have its low side connected to the condenser through the valve V^3 and conduit **35**. The pressure in the condenser will thus be lowered and liquid from the receiver can flow through the restricted passage means in the form of the disclosed expansion valve **40** into the condenser and as a result expansion will take place. The check valve **38** in the normal condenser discharge line will be effective to assure that all refrigerant passing to the condenser will go through the expansion valve **40** and become expanded. As heat laden vapors are created in the condenser acting as a heat exchanger, they will be transmitted to the evaporator E by the compressor. After the pressure between both sides of the system have been equalized, the pressure of the "opposite side" becomes greater, due to the build-up by the compressor. Consequently the heat laden vapors entering the evaporator E to be defrosted will readily force the liquid in the lower part of the evaporator back into the receiver and defrosting will occur in a very short time.

It will be noted in all three defrosting systems illustrated, by way of example as embodying my invention, that there is provided means for rapidly reducing the gas pressure in the "receiver side" of the system. In so doing this soon after initiating the defrosting cycle, the opposing pressure on the "receiver side" can then be rapidly over-

come to permit complete evacuation of liquid from the evaporator in a short period of time and thus accomplish efficient defrosting of the evaporator in the refrigerated chamber. All of the disadvantages of prior defrosting systems, already pointed out, are overcome. With my invention there will be no necessity for building up high pressures and high heat over a long period of time in the part of the evaporator being defrosted so that the refrigerated chamber and the product load thereof might become damaged.

In all of the systems disclosed, regardless of whether a secondary evaporator is employed as a heat exchanger or the condenser becomes the secondary evaporator during the reverse cycle of operations to accomplish defrosting, the addition of means embodying my invention accomplishes the same result. In the claims broad terminology is intended to be used in connection with the means for producing the heat laden expanded refrigerant during the defrosting so as to include both a separate secondary evaporator or use of the condenser as the secondary evaporator. Also, in the systems illustrated, individual 3-way valves are employed in making certain conduit connections, but it is to be understood that the illustration of these is purely for the purpose of simplicity as these valves could be combined into a single valve structure with proper passage and connections for conduits so that the same result can be obtained as is obtained by the illustrated separate 3-way valve structures.

Thus, being aware of the possibility of modifications in the particular structure and arrangements shown in order to carry out the fundamental principles of my invention in a hot gas defrosting system for a low temperature refrigeration system, I desire it to be understood that the scope of the invention is not to be limited in any manner except in accordance with the appended claims.

What is claimed is:

1. In combination with a refrigeration system having the usual heat absorbing evaporator, compressor, receiver and condenser with connecting conduits and control devices, a hot gas defrosting system therefor comprising a heat exchanger connected to the receiver and means operable during defrosting operation for restricting the flow of liquid refrigerant from the receiver to the heat exchanger for producing a heat laden expanded refrigerant therefrom, means including suitable conduits and control valve means for transmitting the heat laden refrigerant to the suction side of said compressor and from the high side of said compressor to the refrigeration evaporator and returning the resulting liquid to the receiver as it accomplishes defrosting, means connecting the receiver with the system downstream of the restricting means during the defrost cycle for reducing the gas pressure in the receiver at the beginning of the defrosting operation so that accumulated pressure in the evaporator can rapidly overcome the opposing pressure in the receiver and cause liquid refrigerant in the evaporator being defrosted to flow into the receiver, and means controlling flow through said connecting means.

2. A reverse cycle refrigeration system comprising, a receiver for refrigerant, an evaporator connected to the receiver through an expansion valve, a condenser connected to the receiver, a compressor having its high side connected to the condenser and its low side connected to the evaporator during the refrigeration cycle to circulate refrigerant from the compressor to the condenser to the receiver, to the evaporator and return to the compressor, valve means connecting the low side of the compressor to the condenser and the high side of the compressor to the evaporator during the defrost cycle, means controlling flow of refrigerant from the receiver to the condenser during defrost cycle to permit the condenser to generate hot gas for defrosting, a separate conduit means connecting the evaporator with the receiver for bleeding off excess receiver pressure at the beginning of the defrost cycle, and means controlling flow through said separate conduit means.

3. In combination with a refrigeration system having the usual heat absorbing evaporator, compressor, receiver and condenser with connecting conduits and control devices, a hot gas defrosting system therefor comprising a secondary evaporator means for producing a heat laden vapor from the liquid refrigerant, means for conducting liquid from the receiver of the refrigeration system to the secondary evaporator, means including the refrigeration compressor and control valve means in the conduits leading to and from the compressor for transmitting the heat laden vapor to the refrigeration evaporator and returning the resulting liquid to the receiver as it accomplishes defrosting all without passage through the refrigeration condenser, conduit means connecting the receiver to the suction side of the compressor during defrost cycle and downstream of the secondary evaporator and operable during defrosting for reducing the gas pressure in the receiver to thereby allow liquid refrigerant accumulated in the evaporator being defrosted to flow directly to the receiver without any re-evaporation, and valve means in the connecting means regulating the amount to which the pressure in the receiver is reduced.

4. In combination with a refrigeration system having the usual heat absorbing evaporator, compressor, receiver and condenser with connecting conduits and control devices, a hot gas defrosting system therefor comprising a secondary evaporator for producing a heat laden vapor from liquid refrigerant in the receiver, means connecting the receiver to the secondary evaporator to supply it with liquid, means including control valve means in the conduits leading to and from the compressor for transmitting the heat laden vapor from the secondary evaporator to the refrigeration evaporator and returning the resulting liquid to the receiver as it accomplishes defrosting all without passage through the condenser, conduit means connecting the receiver to the suction side of the compressor during defrost cycle downstream of the secondary evaporator and providing for release of excess pressure in the receiver during initial defrosting operations, and a back pressure regulating valve in the said last named conduit for maintaining a pressure differential across the regulating valve and holding the pressure in the receiver at a valve slightly higher than that in the evaporator which produces the said heat laden vapor.

5. In a refrigeration apparatus having a receiver for refrigerant, a first evaporator connected to the receiver through an expansion valve, and a compressor having its high side connected to the receiver and its low side connected to the evaporator during the refrigeration cycle, the combination therewith of a defrost system comprising a second evaporator connected to the receiver and obtaining liquid refrigerant therefrom during the defrost cycle, means regulating flow from the receiver into the second evaporator, valve means connecting the low side of the compressor to the outlet of the second evaporator and connecting the high side of the compressor to the first evaporator during the defrost cycle, means connecting the receiver to the system downstream of said means regulating flow from the receiver into the second evaporator during the defrost cycle to bleed down the pressure in the receiver at the beginning of the defrost cycle, and valve means controlling flow through said connecting means.

6. The apparatus of claim 5 wherein said valve means controlling flow through the connecting means is a pressure regulating valve for bleeding off excessive pressure from the receiver at the beginning of the defrost cycle and after such excess pressure has been bled off maintaining a pressure differential across the regulating valve to maintain a pressure in the receiver slightly in excess of the pressure in said second evaporator.

7. The apparatus of claim 5 wherein said connecting means establishes fluid communication between the top

of the receiver and the first evaporator whereby gas in the top of the receiver may be conducted from the receiver to the first evaporator where it is liquefied and rapidly lowers the pressure in the receiver.

8. The apparatus of claim 5 wherein said valve means controlling flow through the connecting means is a check valve permitting flow from the receiver through the connecting means but preventing reverse flow through the connecting means.

9. In a refrigeration apparatus having a receiver for refrigerant, a first evaporator connected to the receiver through an expansion valve, a by-pass around said expansion valve, a check valve permitting flow from the evaporator to the receiver through the by-pass and preventing flow from the receiver to the evaporator through the by-pass, and a compressor having its high side connected to the receiver and its low side connected to the evaporator during the refrigeration cycle, the combination therewith of a defrost system comprising a second evaporator connected to the receiver and obtaining liquid refrigerant therefrom, means regulating flow from the receiver into the second evaporator, valve means connecting the low side of the compressor to the outlet of the second evaporator and connecting the high side of the compressor to the first evaporator during the defrost cycle, means connecting the receiver to the system downstream during the defrost cycle of said means regulating flow from the receiver into the second evaporator to bleed down the pressure in the receiver at the beginning of the defrost cycle and relieve the back pressure on said check valve to permit flow of refrigerant from the evaporator through the check valve, and valve means controlling flow through said connecting means.

10. The apparatus of claim 9 wherein said connecting means establishes flow communication between the top of the receiver and the low side of the compressor and said valve means controlling flow through the connecting means is a pressure regulating valve for bleeding off excessive pressure from the receiver at the beginning of the defrost cycle and after such excess pressure has been bled off maintaining a pressure differential across the regulating valve to maintain a pressure in the receiver slightly in excess of the pressure in said second evaporator.

11. In a refrigeration apparatus having a receiver for refrigerant, a first evaporator connected to the receiver through an expansion valve, and a compressor having its high side connected to the receiver and its low side connected to the evaporator during the refrigeration cycle, the combination therewith of a defrost system comprising a second evaporator connected to the receiver and obtaining liquid refrigerant therefrom during the defrost cycle, means regulating flow from the receiver into the second evaporator, valve means connecting the low side of the compressor to the outlet of the second evaporator and connecting the high side of the compressor to the first evaporator during the defrost cycle, means connecting the receiver to the system downstream of the second evaporator to bleed down pressure in the receiver at the beginning of the defrost cycle, and valve means controlling flow through said connecting means.

12. In a refrigerating apparatus having a receiver for refrigerant, a first evaporator connected to the receiver through an expansion valve, and a compressor having its high side connected to the receiver and its low side connected to the evaporator during the refrigeration cycle, the combination therewith of a defrost system comprising a second evaporator connected to the receiver and obtaining liquid refrigerant therefrom during the defrost cycle, valve means connecting the low side of the compressor to the outlet of the second evaporator and connecting the high side of the compressor to the first evaporator during the defrost cycle, means for transferring liquid refrigerant from the receiver to the second evaporator and for transferring gaseous refrigerant from the receiver to the low side of the compressor, and means regulating flow of gaseous refrigerant through said transfer means.

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