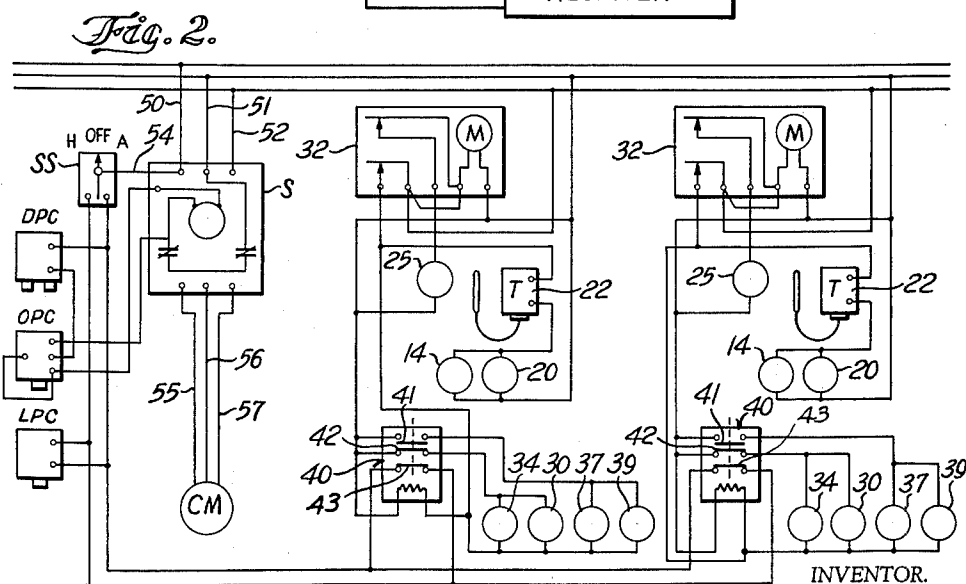
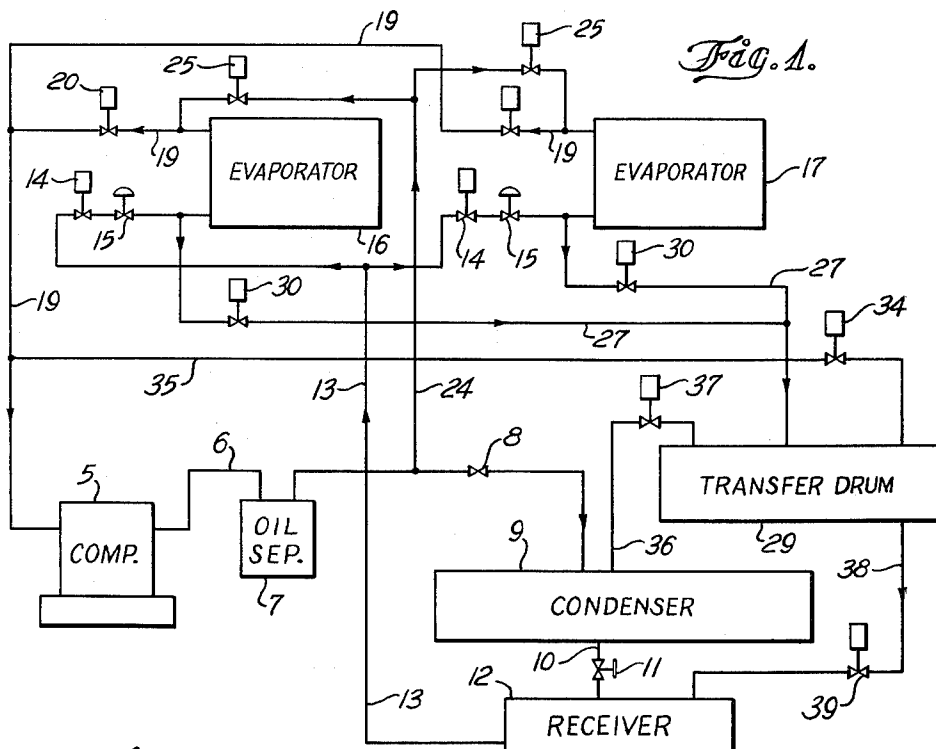


April 11, 1961

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RETURN FOR REFRIGERATION SYSTEMS
Filed Aug. 4, 1958

2,978,877



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HOT GAS DEFROSTING SYSTEM WITH GRAVITY LIQUID RETURN FOR REFRIGERATION SYSTEMS

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Filed Aug. 4, 1958, Ser. No. 752,739

5 Claims. (Cl. 62—155)

This invention relates generally to refrigeration systems and more particularly to an improved system of hot gas defrosting for the evaporators.

In refrigeration systems, a considerable amount of ice builds up on the evaporator units and prevents proper heat transfer, and to insure efficient operation of the evaporators, this ice build-up must be removed periodically.

The principle of using hot gas from the compressor to defrost the evaporators is well-known and has been used with considerable success. Serious problems have arisen in such defrosting systems, however, the principal one of which is efficiently disposing of the large quantity of liquid formed in the evaporators by condensation of the hot gas. Stated otherwise, the heat given off by the gaseous refrigerant in the storage room causes the refrigerant to condense, and although the evaporator coil or air units have thus been defrosted, a considerable quantity of liquid refrigerant is formed in the evaporator, which is highly undesirable.

The problem of liquid formation in the evaporators has been a troublesome one to the refrigeration industry for many years. Various attempts have been made, both from experimental and commercially useful viewpoints, to dispose of this liquid in an efficient manner. The liquid cannot be returned to the suction line because of consequent damage to the compressor.

In accordance with the present invention, a refrigeration system is provided having a hot gas defrosting system in which the liquid that is condensed in the evaporator unit during the defrosting period is returned through a transfer drum and then directly to the receiver by gravity. By means of this invention, the necessity of re-evaporating the liquid as it comes from the evaporators and returning it to the compressor is eliminated. Instead, the liquid is returned more directly to the receiver and in its useful liquid state. As a result, a hot gas defrosting arrangement for a refrigerating system is provided which is more economical both to produce and to operate than are conventional systems.

More specifically, the invention provides a defrosting system of the above type for use with a plurality of evaporator units and wherein an automatic timer is used to determine the defrost time for each evaporator unit or load, so that the defrosting thereof is accomplished in sequence, one load at a time.

Another more specific object of the present invention is to provide a novel electrical control circuit for a defrost system of the above type in which the operation of the evaporator unit or units is controlled by their respective temperature controller to maintain room temperature under normal operations. The defrosting operation is initiated by an automatic timer which takes over control of its evaporator from the temperature controller during the defrosting operation. This automatic timer actuates other valves to cause defrosting of the evaporator and in sequence if a plurality of evaporators are used in the system.

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These and other objects and advantages of the present invention will appear later as this disclosure progresses, reference being had to the accompanying drawings, in which:

Figure 1 is a schematic diagram of one typical refrigeration system embodying the improved hot gas defrosting system in accordance with the present invention; and

Figure 2 is an electrical wiring diagram showing the electrical apparatus and connections involved in the system of Figure 1, the components being in the normal position as when not energized.

While the invention has been illustrated and described herein as being advantageously applicable to a system utilizing two evaporator units, it is not desired or intended to thereby limit the scope or utility of the invention to any particular number or type of evaporators. Conventional air units or pipe gravity coils may be used, for example, as well as any combination thereof. It is also contemplated that descriptive terms employed herein will be given the broadest possible interpretation consistent with the disclosure.

Referring in greater detail to the drawings, the improved refrigeration system includes a conventional compressor 5 having a discharge line 6 which conducts the hot vaporized refrigerant through the oil separator 7, check valve 8 and into the condenser 9. The liquid refrigerant then leaves the condenser via conduit 10 which contains a hand valve 11 and enters the high pressure liquid receiver 12. The high pressure liquid then is discharged from the receiver through conduit 13, solenoid valves 14 and through the conventional thermostatic expansion valves 15 where it expands into the evaporators 16 and 17. The compressor, oil separator, condenser, receiver and evaporators are conventional and it will be understood certain conventional check valves and shut-off valves have been omitted, such as hand valves on each side of the compressor, for the sake of clarity and as their use is well-known to those skilled in the art.

As the control valves and switches are the same for each evaporator unit, only one set will be specifically referred to but similar reference numerals will be used for similar elements.

During normal operation, liquid refrigerant is admitted to the evaporators when solenoid valves 14 are opened. After the liquid refrigerant expands in the evaporator to thereby create the desired cooling effect in the area where it is located, the vaporized refrigerant is then permitted to leave the evaporators via the suction line 19, when the solenoid valves 20 therein are opened, and is returned to the compressor 5.

Solenoid valves 14 and 20 are thus normally operated by the conventional thermostat temperature controller 22 (Fig. 2) to open and close the liquid line 13 and suction line 19 to maintain a predetermined temperature of the refrigerated area.

During this normal operation of the refrigeration system, a considerable amount of ice will build up on the evaporator units and this ice must be periodically removed to insure good heat transfer and efficient operation of the units. Prior practice has involved the periodic passing of the hot gas from the compressor directly into the evaporators for the purpose of melting the ice formed thereon. This practice, however, while serving to effectively melt the ice, resulted in a large amount of liquid refrigerant being formed in the evaporators, and the efficient disposal of this liquid refrigerant has been a source of concern to this industry for many years. It has been a widespread practice to re-evaporate this liquid in one manner or another, as by means of various heat exchangers, and then ultimately return the vaporized refrigerant to the compressor for re-use.

In accordance with the present invention, to initiate a defrost cycle, the hot vaporized refrigerant, or "gas," is introduced through conduit 24, which is connected to the compressor discharge line 6, into the evaporators when the solenoid valve 25 in line 24 is opened. At the time this hot gas valve 25 is opened, the supply line valve 15 and suction line valve 19 are closed.

A liquid return line 27 places the evaporator in communication with a transfer drum or tank 29 when the combination relief and solenoid stop valve 30 in line 27 is open. Valve 30 is set to open at a predetermined pressure in the evaporators, such as for example, 60 p.s.i.

The valve 30 remains closed during the defrosting period until the hot gas in the evaporators causes the pressure therein to rise above the predetermined pressure relief setting of the valve. The normal pressure setting (say about 60 p.s.i.) for valve 30 is sufficient to maintain enough heat in the evaporator to cause defrosting. After approximately 60 pounds of pressure has developed in the evaporator, the relief valve 30 opens and this pressure is sufficient to force the liquid into the transfer drum, even if the latter is installed in a location above the level of the evaporator.

Venting means are provided for the drum 29 through solenoid valve 34 in conduit 35, which conduit connects the upper portion of the drum to the suction line 19.

During the defrosting cycle, the solenoid valves 14, 20 are controlled by the defrosting timer 32 rather than by the temperature controller 22. Valves 25 and 34 are controlled by the timer only and are both open during the defrosting period as will appear more fully later.

An equalizer line 36 has a solenoid valve 37 therein and places the upper portion of the drum in communication with the condenser. A drain line 38 places the lower portion of the transfer drum in communication with the receiver and has a solenoid valve 39 therein. Both valves 37 and 39 are closed during the defrosting cycle, thereby separating the drum from the high pressure side of the system and the drum is placed under suction line pressure by line 35 and open valve 34. Valves 37 and 39 are also controlled only by the defrosting timer 32, as will appear.

After the defrost period has elapsed, as determined by the timer 32, the latter returns all of the solenoid valves to their normal position. In other words, the liquid valve 15 and suction valve 19 revert back to control by the thermostat controller 22; hot gas valve 25 and the drain-relief valve 30 are both closed; equalizing valve 34 to suction is closed; drain valve 39 and equalizing valve 37 are opened. Under these conditions, the drum is isolated from the low pressure side of the system and communicates with the high pressure side through valves 37 and 39. As a result, the pressure then builds up in the drum to that of the receiver, and the liquid in the drum then drains by gravity to the receiver via line 38.

In reference to Figure 2, the magnetic relays 40 are of conventional type and are actuated by their timer 32. These relays have the normally open switch 41 which, when closed, energizes valves 37 and 39. The normally closed switch 42, when closed, causes valves 30 and 34 to be energized and open. The normally closed switch 43 is connected to the compressor circuit so that when a unit is to be defrosted and its corresponding compressor is not operating, the relay cuts the compressor back into the circuit to furnish hot gas for the defrosting process.

The defrost timers 32 actuate their respective relays 40, control the valves 25, 34, 37 and 39, and in addition, during the defrost cycle only, control the solenoid valves 14 and 20. These are conventional two-circuit defrosting timers having an electric clock motor M, and these timers serve to shut off the refrigeration and open up the hot gas line to the evaporator, as previously described.

Other conventional controlling devices are shown in Figure 2 and include a dual pressure control DPC which

is a combination control that opens the circuit to shut down the system in the event the system pressure either exceeds or falls below the predetermined operating range. The oil pressure control OPC acts to stop the compressor if its oil pressure fails. The low pressure control LPC is an automatic control that cuts the compressor in and out depending on the suction pressure.

A manually operated selector switch SS when moved to the H position acts to bypass the LPC switch and the system can then be operated by hand or manually. When the selector switch is moved to the A position, the system operates automatically under the influence of the LPC which turns the compressor on and off in accordance with the suction pressure.

The conventional automatic starter S is connected to the three-phase supply lines by wires 50, 51 and 53; to the selector switch SS by wire 54 and to the compressor motor CM by wires 55, 56 and 57.

By means of the present invention, the evaporator units are periodically and alternately defrosted by hot gas from the compressor. During the defrost period for one of the units, all of the various solenoid valves for that unit are controlled by their defrost timer rather than some of them being controlled by the thermostat control. The liquid formed in the evaporators is released therefrom by the relief valve, and this liquid is forced under pressure into the transfer drum, which drum is at that time blocked from the high pressure side of the system and is vented to the suction line thereof.

After the defrost period is finished, the timer returns the solenoid valves to their normal position; that is, the hot gas is shut off from the evaporator; the liquid and suction valves revert back to control by the thermostat controller; the transfer drum is placed in communication with the high pressure side of the system, more specifically, with the condenser and receiver; and the drum is closed to the low pressure or suction side of the system.

The transfer drum is then pressurized and the liquid refrigerant therein drains by gravity into the high pressure receiver, ready for reuse.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. A refrigeration system comprising a compressor having a high pressure refrigerant line for passing refrigerant through a condenser and receiver and into an evaporator, and also having a suction line for returning evaporated refrigerant back to the compressor, a liquid transfer drum connected between said evaporator and said receiver for returning liquid refrigerant to said receiver, a hot gas line between the compressor and said evaporator, and temperature responsive electrical control means including a defrost timer and valves for regulating refrigerant flow in said system and adapted to close said pressure and suction lines and open said hot gas line to thereby permit hot gas to enter and defrost said evaporator, said control means also adapted to block communication between said drum and receiver and permit liquid refrigerant to pass under pressure from said evaporator to said drum when pressure in said evaporator exceeds a predetermined amount, and at the end of the defrost cycle said control means being adapted to place said drum in communication with said receiver and isolate said drum from the suction side of said system whereby liquid refrigerant can drain by gravity from the drum to the receiver.

2. A refrigeration system comprising a compressor having a high pressure refrigerant line for passing refrigerant through a condenser and receiver and into an evaporator, and also having a suction line for returning evaporated refrigerant back to the compressor, a liquid transfer drum connected between said evaporator and said receiver for

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returning liquid refrigerant to said receiver, a vent conduit placing said drum in communication with the suction side of the system, a hot gas line between the compressor and said evaporator, and temperature responsive electrical control means including a defrost timer and valves for regulating refrigerant flow in said system and adapted to (1) close said pressure and suction lines and open said hot gas line to thereby permit hot gas to enter and defrost said evaporator, (2) block communication between said drum and receiver and open said vent line, (3) permit liquid refrigerant to pass from said evaporator to said drum when pressure in said evaporator exceeds a predetermined amount, and at the end of the defrost cycle said control being adapted to close said vent line and place said drum in communication with said receiver whereby liquid refrigerant can drain by gravity from the drum to the receiver.

3. In a refrigeration system, the combination comprising a compressor, a condenser, a liquid receiver, an evaporator, a liquid conduit for connecting said compressor to said evaporator through said condenser and receiver, a suction conduit connecting said evaporator to said compressor for returning refrigerant to said compressor, a valve in each of said liquid and suction conduits, a liquid transfer drum, conduit means between said evaporator and said drum and having a combination electrically operated and pressure relief valve therein, a drain conduit between said drum and said receiver and including a valve therein, a vent conduit between said drum and the suction side of the system and having a valve therein, a hot gas line between the compressor and said evaporator and having a valve therein, and electrical control means adapted at the beginning of a defrosting cycle to close said liquid, suction and drain conduit valves, and open said hot gas line valve to thereby permit hot gas to enter and defrost said evaporator, said relief valve being adapted to open when pressure in said evaporator exceeds a predetermined amount to thereby permit liquid refrigerant to pass from said evaporator to said drum, said control means also adapted at the end of the defrost cycle to place said drum in communication with said receiver whereby liquid refrigerant can drain by gravity from the drum to the receiver.

4. A refrigeration system comprising a compressor, a condenser, a liquid receiver, an evaporator, a liquid conduit for connecting said compressor to said evaporator through said condenser and receiver, a suction conduit connecting said evaporator to said compressor for returning refrigerant to said compressor, a valve in each of said liquid and suction conduits, a temperature controller for actuating said liquid and suction conduit valves to thereby control said evaporator during normal operation, a liquid transfer drum, conduit means between said evaporator and said drum and having a combination electrically operated and pressure relief valve therein, a drain conduit between said drum and said receiver, an equalizer conduit between said drum and said condenser, said drain and equalizer conduits each having a valve therein, a vent conduit between said drum and the suction side of the system and having a valve therein, a hot gas line

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between the compressor and said evaporator and having a valve therein, and electrical control means for actuating said valves and adapted to initiate a defrosting cycle by (1) closing said liquid and suction conduit valves, (2) closing said drain and equalizer conduit valves, and (3) opening said hot gas line valve to thereby permit hot gas to enter and defrost said evaporator, said relief valve being adapted to open when pressure in said evaporator exceeds a predetermined amount to thereby permit liquid refrigerant to pass from said evaporator to said drum, said control means also being adapted at the end of the defrost cycle to isolate said drum from the suction side of the system and place said drum in communication with said receiver whereby liquid refrigerant can drain by gravity from the drum to the receiver.

5. A refrigeration system comprising a compressor, a condenser, a liquid receiver, an evaporator, a liquid conduit for connecting said compressor to said evaporator through said condenser and receiver, a suction conduit connecting said evaporator to said compressor for returning refrigerant to said compressor, a valve in each of said liquid and suction conduits, a temperature controller for actuating said liquid and suction conduit valves to thereby control said evaporator during normal refrigerating operation, a liquid transfer drum, conduit means between said evaporator and said drum and having a combination electrically operated and pressure relief valve therein, a drain conduit between said drum and said receiver, an equalizer conduit between said drum and said condenser, said drain and equalizer conduits each having a valve therein, a vent conduit between said drum and the suction side of the system and having a valve therein, a hot gas line between the compressor and said evaporator and having a valve therein, and electrical control means for actuating said valves for a defrosting cycle and adapted to (1) close said liquid and suction conduit valves, (2) close said drain and equalizer conduit valves, (3) open said vent conduit valve and (4) open said hot gas line valve to thereby permit hot gas to enter and defrost said evaporator and place said drum in communication with the suction side of the system, said relief valve being adapted to open when pressure in said evaporator exceeds a predetermined amount to thereby permit liquid refrigerant to pass from said evaporator to said drum, said control means also adapted at the end of the defrost cycle to close said vent conduit valve and open said valves in said drain and equalizer conduits, to thereby place said drum in communication with said condenser and receiver and isolate said drum from the suction side of said system whereby liquid refrigerant can drain by gravity from the drum to the receiver.

References Cited in the file of this patent

UNITED STATES PATENTS

2,525,560	Pabst	Oct. 10, 1950
2,729,950	Toothman	Jan. 10, 1956
2,770,104	Sweynor	Nov. 13, 1956
2,778,195	Christensen	Jan. 22, 1956
2,841,962	Richards	July 8, 1958