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DEFROSTING REFRIGERATING APPARATUS

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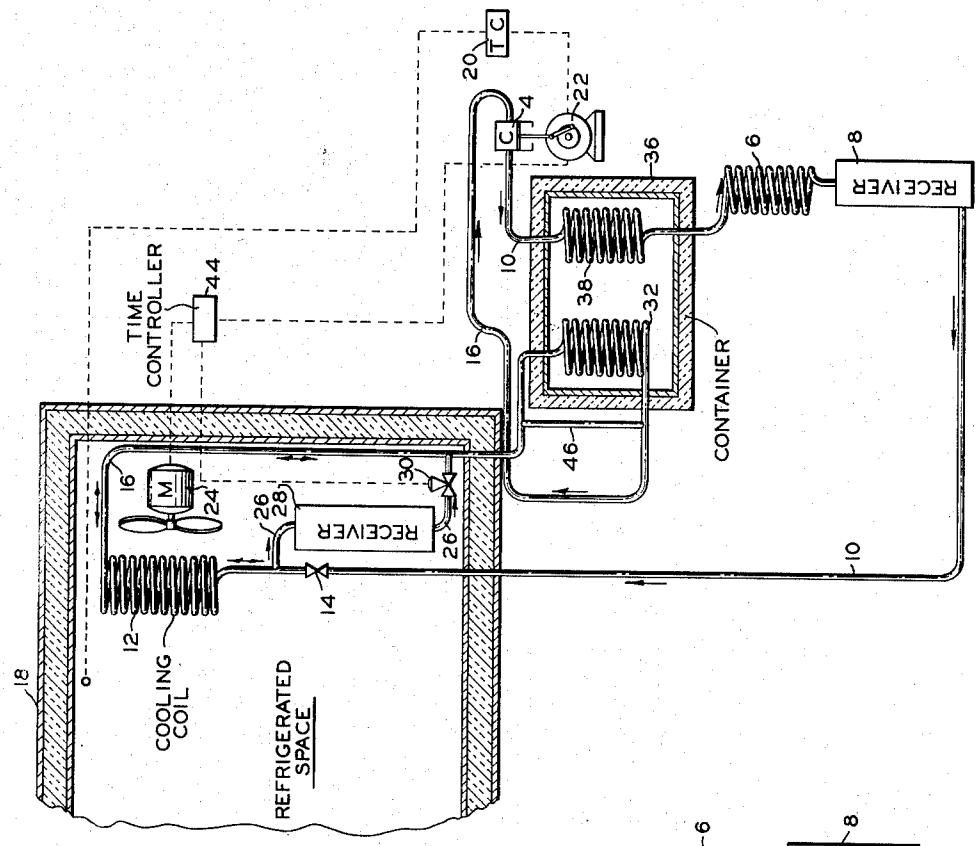


FIG. 2.

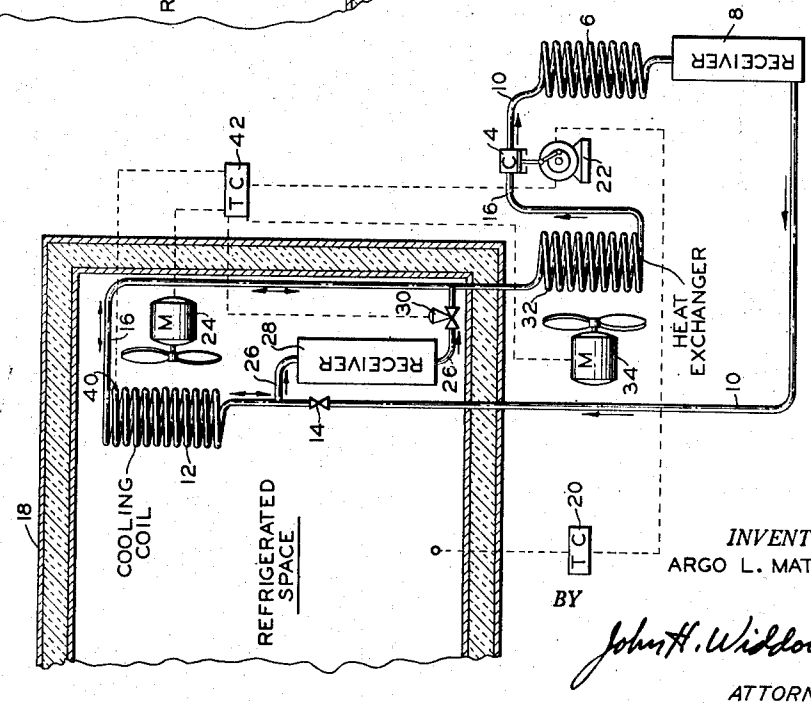


FIG. 1.

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DEFROSTING REFRIGERATING APPARATUS

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6 Claims. (Cl. 62—115)

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This invention relates to a defrosting method and apparatus. In a more specific aspect it relates to a method and apparatus for defrosting the cooling coil of a low temperature refrigeration system. In a still more specific aspect, it relates to a method and apparatus for defrosting the cooling coil of a low temperature refrigeration system, using heat available in the refrigerant liquefying operation and means.

The cooling coil of low temperature refrigeration systems, 34° F. and below, must be defrosted, since frost build up on the coil prevents good heat transfer, thus lowering the efficiency of the system and making it difficult or impossible to maintain the desired temperature in the refrigerated space. Defrosting methods and apparatus are known in the art, such methods as using heat furnished by electrical or other means to melt the frost, in compressor systems sending hot compressed refrigerant into the coil by operating the compressor during the defrosting cycle, and simply allowing the refrigerated space to warm up to a point where the frost will melt, and other methods. The methods known in the art are not satisfactory, being either expensive to operate or time consuming or both. Many commercial installations have to be defrosted several times daily and valuable refrigerated meat, vegetables, etc., have to be protected.

I have invented a new method and apparatus for defrosting the cooling coils of low temperature refrigeration systems, which defrosts rapidly and inexpensively. In carrying out the process of my invention, the refrigeration cycle operation is shut down and liquid refrigerant is withdrawn from the cooling coils when the coils are frosted and it is desired to defrost. The liquid refrigerant is vaporized and resulting vapors are passed into the cooling coil wherein they give up heat, the heat given up melting the frost. In carrying out one embodiment of my invention, heat from the refrigerant liquefying method and means, during refrigeration cycle operation, is stored up in a heat storage material and subsequently used to vaporize the liquid refrigerant withdrawn from the cooling coils during defrosting cycle operation.

The method and apparatus of my invention has many advantages. My method is easy and inexpensive to operate and the apparatus is cheaply and easily installed. The defrosting system of my invention can be built into existing refrigeration systems or incorporated in new installations. It can be used with compression refrigeration systems, using either a compressor

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with a positive displacement mechanism or an impeller, and it can be incorporated into absorption refrigeration systems. The new defrosting method and apparatus of my invention can be used on all types of refrigeration fixtures, such as, reach-in fixtures, walk-in fixtures, display cases (either open or closed), locker plants, sharp freezers, etc., and with all types of refrigerant metering devices, such as, expansion valve, capillary tube, float valve, restrictor, or any other type of refrigerant control. The cooling surface in the refrigerated space, usually referred to as the cooling coil, can be a single coil, a plurality of coils in parallel or series, etc., utilizing in cooling the refrigerated space, forced convection, natural convection, direct contact, a combination of such heat transfer methods, etc. Multiple coiling coils can be defrosted separately or simultaneously, as desired, using the process and apparatus of my invention. The defrosting method and apparatus of my invention can be operated manually, automatically or a combination of manual and automatic control. It can be operated by a time controller, preferably either refrigeration cycle running time or predetermined clock time, a pressure controller, preferably acting in response to cooling coil pressure, a temperature controller, preferably acting in response to cooling coil temperature or difference in temperature between refrigerated space temperature and cooling coil temperature, a combination of such controllers, or any other suitable control system. Heat used to vaporize liquid refrigerant from the cooling coil can be from an external source or it can come from available heat in the refrigeration system. If my defrosting method and means is used on a compressor type refrigeration system, the compressor is not subjected to high back pressures or liquid slugging, and use of suction valves, solenoid valves, etc., is not interfered with. Positive return of lubricating oil used in conjunction with the refrigerant is provided for in preferred embodiments of the method and apparatus of my invention. The defrosting method and apparatus of my invention is applicable to a very wide range of refrigeration system capacities, fills a need of long standing in the art, and is indeed, a great step forward in the art.

It is an object of my invention to provide new defrosting method and apparatus.

It is another object of my invention to provide rapid and economical method and apparatus for defrosting the cooling coil of a low temperature refrigeration system.

Still another object of my invention is to pro-

vide rapid and economical method and apparatus for defrosting the cooling coil of a low temperature refrigeration system, using heat available in the refrigerant liquefying operation and means.

Other objects and advantages of my invention will become apparent to one skilled in the art upon reading this disclosure.

In the drawings Fig. 1 is a schematic flow sheet showing a preferred embodiment of the defrosting process and apparatus of my invention, shown in use with a compressor refrigeration system. Fig. 2 is a schematic flow sheet depicting another preferred embodiment of the process and apparatus of my invention, shown in use with a compressor refrigeration system. Figs. 1 and 2 are schematic except that in the system shown in Fig. 1 it is preferred that the receiver be disposed below the cooling coil (as shown) and the heat exchanger be disposed below the receiver **28** (as shown) and, likewise, in the system shown in Fig. 2 it is preferred that the receiver be below the cooling coil and the container be below the receiver **28**, so that in either case liquid refrigerant from the cooling coil will flow by gravity into the receiver and thence into the heat exchanger or container as the case may be.

In the following discussion of the process and apparatus of my invention, reference is made to Figs. 1 and 2. The same reference numerals are used on Figs. 1 and 2 to indicate the same equipment. It is to be understood that the following discussion is not to unduly limit the scope of my invention.

Referring now to the drawings, compressor **4**, condensing coil **6**, receiver for condensed refrigerant **8**, line **10** for transfer of refrigerant to cooling coil **12**, refrigerant metering device shown as valve **14**, cooling coil **12** and suction line **16** comprise a usual refrigeration system. The temperature in the refrigerated space **18** is shown controlled in a usual manner by temperature controller **20**, which starts and stops motor **22** in response to the temperature in refrigerated space **18**. The refrigeration system shown in Figs. 1 and 2 utilizes forced convection and motor **24** turns the fan shown which moves air across cooling coil **12**.

In the embodiment of my defrosting method and apparatus shown in Figs. 1 and 2, the equipment added to or incorporated in the refrigeration system is conduit **26** with receiver **28** and control valve **30** therein. Receiver **28** can be dispensed with, if desired, depending on the type of cooling coil **12** used. If coil **12** is a type which operates with enough liquid refrigerant for the defrosting operation, receiver **28** need not be used. Heat exchange coil **32** to trap liquid refrigerant from receiver **28**, and in which same is vaporized, is added to suction line **16**. In the system shown in Fig. 1, motor **34** turns the fan shown, which blows air at room temperature over coil **32** to vaporize refrigerant therein. As will be apparent to those skilled in the art, other heating means can be used, such as heat from water, steam, electrical heat, etc. In the system shown in Fig. 2, coil **32** is placed inside an insulated container **36** which is filled with a heat storage material, preferably a material with melting point such that it will melt when heated by compressed refrigerant from compressor **4**, which passes through coil **38** inside container **36**, and will solidify giving up heat to vaporize refrigerant in coil **32**. Petroleum wax, and like materials of low vapor pressure at relatively high temperature, can be advantageously used. Dowtherm, which has a low vapor pressure at relatively high temperature, can be used, if desired.

In the defrosting method of my invention shown in Fig. 1, operation is as follows: Cooling coil **12** temperature at control point **40** will drop during the operation of the refrigeration cycle due to frost build-up on the coil. When coil temperature at point **40** drops to the point at which temperature controller **42** is set to operate on the low side, the controller shuts off motor **22**, discontinuing the refrigeration cycle, and motor **24**, stopping the passage of air over the cooling coil, and opens valve **30** and turns on motor **34**, starting the passage of air over coil **32**. Liquid refrigerant which is accumulated in receiver **28** during operation of the refrigeration cycle and liquid refrigerant in the cooling coil flows by gravity through conduit **26**, valve **30**, conduit **16** and into coil **32**, wherein it is vaporized. Resulting vapors pass back up line **16** into cooling coil **12**, wherein they are condensed. The heat given up is transferred through the walls of the coil and melts frost. Refrigerant condensed in coil **12**, then repeats the cycle until all the frost is melted. At the end of the defrosting operation, the coil temperature at point **40**, which will have risen during defrosting, will have reached the point at which temperature controller **42** is set to operate on the high side. The controller then acts to shut valve **30** and shut off motor **34**, and turns on motor **22**. The refrigeration cycle is then in operation. It is desirable to have controller **42** or another controller delay the starting of motor **24**, so that the coil **12** is cold before air is circulated across the coil.

The system shown in Fig. 2 operates substantially in the same manner as the system shown in Fig. 1 and discussed hereinbefore. During the refrigeration cycle in the system shown in Fig. 2, hot compressed refrigerant from compressor **4** is passed through coil **38** in insulated container **36** and gives up heat to the heat storage material therein. The heat stored up is used to vaporize liquid refrigerant from coil **12** and receiver **28**, trapped in coil **32**, during the defrosting cycle. Time controller **44** is set to start defrost cycle by shutting off motors **24** and **22** and opening valve **30**, preferably according to refrigeration cycle running time or predetermined clock time, and to close valve **30** and start motor **22**, preferably according to a set time for defrost operation. Delayed starting of motor **24** is desirable as set forth hereinbefore in regard to the system shown in Fig. 1. Bypass line **46** in Fig. 2 can be advantageously used to allow the liquid refrigerant to enter coil **32** from the bottom, if desired.

Lubricating oil normally used in conjunction with refrigerant causes no difficulty, and any entering coil **32** during defrost operation is picked up by refrigerant during refrigeration cycle operation. For this reason it is desirable that vapors from coil **12** during refrigeration cycle come into contact with a portion of coil **32** where such oil would collect during the defrosting cycle. If desired, suction line **16** can bypass coil **32**, and a separate conduit, tied into line **16** or directly into the coil, for vaporized refrigerant to cooling coil **12** can be used, with an oil return line from the bottom of coil **32** to compressor **4**.

Since coil **12** pressure during refrigeration cycle is effected by frost build-up, that is, as frost builds up, coil pressure goes down, the method and apparatus of my invention can be controlled by a pressure controller acting in response to coil **12** pressure. And, as will be apparent to those

skilled in the art, other control means can be used.

Following are examples of the process and apparatus of my invention in which a pressure controller was used, acting in response to cooling coil pressure, to stop refrigeration cycle and start defrosting operation, and to stop defrosting operation and start refrigeration cycle after the cooling coil was defrosted. The system used was the system shown in Fig. 1 with temperature controller **42** replaced with the pressure controller. It is to be understood that the conditions, etc., set forth in the examples are not to unduly limit the scope of my invention.

Example I

A run was made on a system like that shown in Fig. 1 of the drawings with a pressure controller used instead of temperature controller **42**. Compressor **4** was a positive displacement compressor, and motor **22** was a ⅓ H. P. electric motor. An electric motor driven fan was used to circulate air in the refrigerated space over coil **12**, and an electric motor driven fan was used to circulate air at room temperature over coil **32** during defrosting operation. The refrigerant was Freon 12, and the compressor was shut on and off during refrigeration cycle operation by a temperature controller, acting in response to the temperature in the refrigerated space. The pressure controller shut off motor **24** when defrost operation started, and the starting of motor **24** was delayed until coil **12** temperature had dropped to refrigeration cycle normal after starting refrigeration cycle operation when coil **12** was defrosted.

The pressure controller shut off motors **22** and **24**, opened valve **30** and started motor **34** when coil **12** pressure got down to 2 p. s. i. a. It closed valve **30**, started motor **22** and shut off motor **34** when coil **12** pressure reached 40 p. s. i. a.

On refrigeration cycle the refrigerated space was held at 0° F.

When coil **12** had no frost, the coil pressure ranged between 4 and 21 p. s. i. a. as refrigeration cycle was on and off. Gradually, as frost built up on coil **12**, over a period of 13½ hours, coil **12** pressure dropped to 2 p. s. i. a. when refrigeration cycle was on. At this time the pressure controller acted to switch the system to defrosting operation.

The coil was defrosted in the rapid time of 20 minutes, at which time coil **12** pressure had reached 40 p. s. i. a. The pressure controller then acted to start refrigeration cycle. During defrosting the temperature in the refrigerated space rose to 13° F. maximum, but in over ½ the time required from start of defrosting to 0° F. normal temperature operation, the temperature was not over 5° F. The temperature of the air passed over coil **32** was 55° F.

Example II

Another run was made on the same system with the temperature of the air passed over coil **32** at 68° F. As in the first run, defrost operation was started when coil **12** pressure reached 2 p. s. i. a. and refrigeration cycle was started when coil **12** pressure reached 40 p. s. i. a.

The coil was defrosted in 14 minutes. During defrosting, the temperature in the refrigerated space reached a maximum of 11° F., and again the temperature remained below 5° F., for over ½ the time from start of defrost to normal refrigeration cycle temperature of 0° F.

As will be evident to those skilled in the art, various modifications of this invention can be made, or followed, in the light of this disclosure and discussion, without departing from the spirit or scope of the disclosure or from the scope of the claims.

I claim:

1. In a refrigeration system, comprising, in combination, cooling coils, blower means to circulate air cooled by said coils, a compressor, a first conduit for refrigerant connecting the discharge of said compressor with the inlet of said cooling coils and having compressed refrigerant cooling means, refrigerant metering means adapted to meter refrigerant into said cooling coils, and a second conduit for refrigerant connecting the outlet of said cooling coils with the suction of said compressor, that defrosting apparatus which comprises, in combination, a third conduit connecting the inlet of said cooling coils and said second conduit, a receiver in said third conduit adapted to receive liquid refrigerant from said first conduit during refrigeration cycle and from said cooling coils by gravity flow, a control valve in said third conduit between said receiver and said second conduit, and heating means in said second conduit between said compressor and the point of connection between said second and third conduits adapted to receive liquid refrigerant from said receiver by gravity flow when said control valve is open during defrost cycle and to vaporize liquid refrigerant passed therein, and said defrosting apparatus being adapted on such defrost cycle to pass vaporized refrigerant from said heating means upwardly through said second conduit, third conduit, control valve and receiver into the inlet of said cooling coil and upwardly through said second conduit into the outlet of said cooling coil.

2. In a refrigeration system, comprising, in combination, a cooling coil, means to liquefy refrigerant, a first conduit for return of vaporized refrigerant from the outlet of said cooling coil to said refrigerant liquefying means, a second conduit for refrigerant from said refrigerant liquefying means to the inlet of said cooling coil, that defrosting apparatus comprising, in combination, a third conduit connecting the inlet of said cooling coils and said first conduit, a valve in said third conduit, and heating means in said first conduit between said refrigerant liquefying means and point of connection between said first and third conduits adapted to receive liquid refrigerant from said cooling coil by gravity flow when said valve is open during defrost and to vaporize refrigerant passed therein, and said defrosting apparatus being adapted on such defrost to pass vaporized refrigerant from said heating means upwardly through said first conduit, third conduit and valve into the inlet of said cooling coil and upwardly through said first conduit into the outlet of said cooling coil.

3. The apparatus of claim 2 wherein said third conduit has a receiver therein between said valve and point of connection between said third conduit and inlet of said cooling coil, said receiver being adapted to receive liquid refrigerant from said second conduit during refrigeration cycle operation and from said cooling coil by gravity flow.

4. The apparatus of claim 1 wherein said heating means comprises an insulated container having a first coil therein to receive liquid refrigerant from said receiver, and a second coil therein in flow relationship with said compressor and said

compressed refrigerant cooling means adapted to receive compressed refrigerant from said compressor, said container being filled with a heat storage material.

5. The apparatus of claim 2 wherein said heating means comprises a container filled with heat storage material, having a first coil therein in flow relationship in said first conduit with said outlet of said cooling coil and said refrigerant liquefying means adapted to receive liquid refrigerant from said cooling coil and a second coil in said container, said second coil in said container being a part of said refrigerant liquefying means and adapted to transmit heat given up during refrigerant liquefaction to said heat storage material.

6. In a refrigeration system, comprising, in combination, a cooling coil in a refrigerable space, a compressor, a conduit for refrigerant connecting the suction of said compressor with the outlet of said cooling coil, and a conduit for refrigerant connecting the inlet of said cooling coil with the discharge of said compressor and having compressed refrigerant cooling means, that apparatus for defrosting said coil which comprises, in combination, a receiver in said refrigerable space having an inlet and an outlet and being positioned below said cooling coil, said receiver inlet connected to said last-named conduit between said refrigerant cooling means and said inlet of said cooling coil, said receiver outlet being connected by a conduit with a valve therein to said first-named conduit, and said receiver adapted to receive liquid refrigerant from said cooling coil by gravity flow and to receive and hold liquid refrigerant during refrigeration operation with said valve closed, and a heat exchanger in said first-named conduit between said compressor and point of connection of said conduit from said receiver, said heat exchanger being positioned below said receiver and being adapted to receive liquid refrigerant from said receiver by gravity flow with said valve open and to vaporize liquid refrigerant passed therein, and said defrosting apparatus being adapted on defrost operation to pass vaporized refrigerant from said heat exchanger upwardly through a portion of said first-named conduit, valve and receiver into said cooling coil through its inlet and upwardly through a portion of said first-named conduit and into said cooling coil through its outlet.

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