Oct. 29, 1940. H. H. McADAM 2,219,393

DEFROSTING DEVICE

Filed Sept. 19, 1938

Fig. 1.

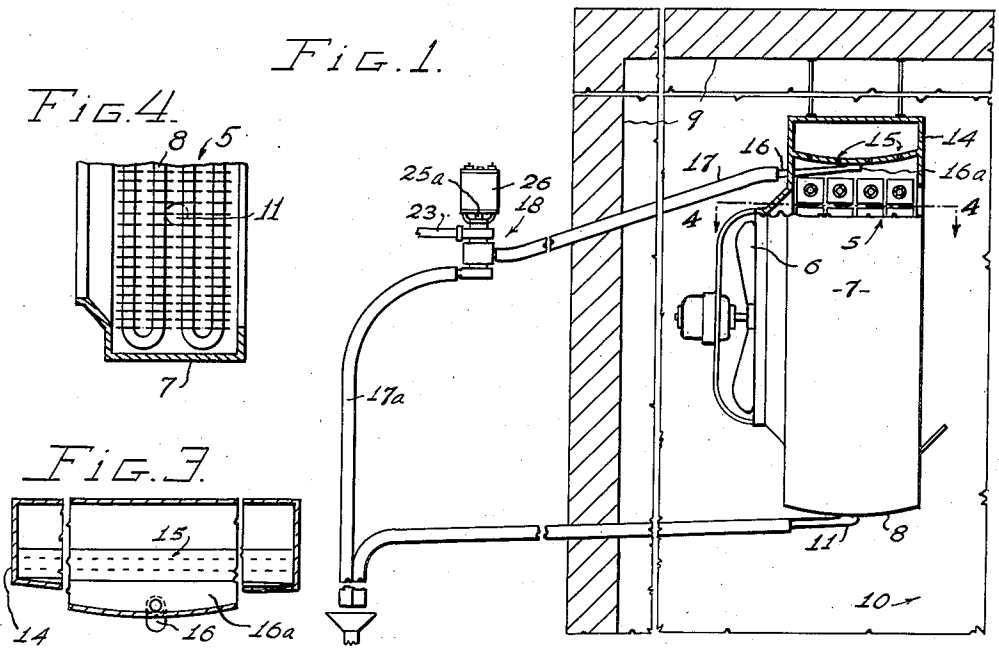


Fig. 4.

Fig. 3.

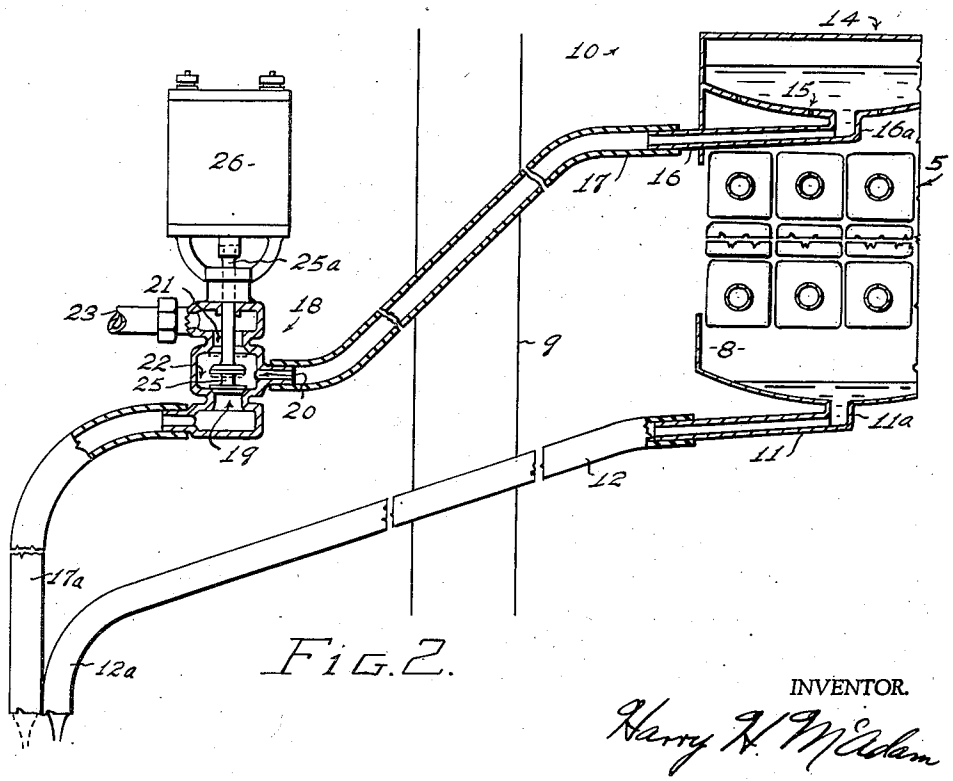


Fig. 2.

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2,219,393

DEFROSTING DEVICE

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14 Claims. (Cl. 62—1)

My invention relates to low temperature refrigeration where a space is required to be constantly maintained at temperatures below the freezing point of water, and the invention relates more particularly to methods and devices for defrosting the coils or heat transfer surfaces used in maintaining such conditions.

Where the air which is being recirculated over these low temperature surfaces never rises above the freezing point of water periodic defrosting under maintained low temperature conditions has presented many problems. It is an object of this invention to provide simple and highly effective means for so defrosting.

One class of defrosting methods and devices involves the application of heat internally of the coil by high pressure vapor either generated by extraneous heat or obtained direct from the high side of the refrigeration system; this high pressure vapor actually converting the coil into a heating element. The pressures and temperatures used are higher than those for which the coils, expansion valves, floats, control diaphragms and the like are designed, and particularly where vapor is generated by an electric heating element there is always the possibility of rupture or serious damage. Still another difficulty with this method of defrosting is the relatively large amount of sensible heat thereby added to the coil. This heat, if not carefully absorbed at the expense of refrigeration may produce warm air currents over products which are to be maintained at constant low temperature.

Now it is a particular object of this invention to defrost without relying on temperatures higher than that of ordinary tap water, and without internally applied heat, and without adding undue sensible heat to the coil. It will be apparent hereinafter that while I do employ a form of thermal energy for defrosting, this is applied in a novel manner which is highly effective at very moderate temperatures and produces quite unexpected results while employing natural phenomena which have not heretofore been put to practical use for efficient defrosting at low temperature.

The application of heat internally of a coil first acts to melt ice immediately in contact with metal surfaces and thus results in large flakes of unmelted ice becoming detached. Such unmelted flakes are difficult to dispose of under low temperature conditions and to prevent them from clogging drip-pans, drains and the like the balance of defrosting must be carried on at such internal temperature that some of the melted ice will actually reach the drains in the form of warm water. This also leaves a moist warm coil from which unduly humid air will flow immediately air is again set in motion. It is another object of this invention to provide for defrosting under such conditions that all ice is definitely melted and carried away as water to points remote from the low temperature region. It is another and highly important object of the invention that practically all water shall be removed from the low temperature regions so that neither re-evaporation thereof, or re-freezing thereof will take place in any appreciable quantity and whereby a low temperature condition may be maintained in a given space over a period of weeks or months.

Another defrosting method for low temperature work is to provide and periodically operate a system of doors or dampers around the coil which act to temporarily isolate the coil from low temperature air and bring it in contact with a flow of extraneous warm air. This requires locating the coil near one wall of the refrigerated compartmnet and is also slow and tedious by reason of the low rate of heat transfer from air to ice. Also this method finally brings the coil or heat transfer surfaces to many degrees above freezing, and unless warm air continues to move over the surfaces until they are quite dry the coil will give off warm humid air when again brought into contact with the cold air of the refrigerated space.

It is an object of this invention, realizing as I do the disadvantages of the too violent effects of internally applied heat, and the too slow application of external heat from warm air currents, to provide a new method which has the advantages of the other methods without the disadvantages thereof. It is a specific object of this invention to apply a lower order of thermal energy more effectively and more uniformly thruout the mass of ice to not only melt it more rapidly and more uniformly thruout its entire mass but to encourage this ice to leave the cold regions as water and to travel to remote points where it can do no harm. Also my invention provides for locating the coil or coils at any suitable point within a refrigerated space without regard for the distance to the nearest wall.

In very low temperature work where the refrigeration plant is usually taxed to the limit to maintain required low temperatures, efficient and more frequent defrosting is to be desired. Where it is advisable to defrost after a rather light frost has formed it has been found that little or no melted ice will drip from the surfaces and when refrigeration is again effective the coil surfaces will be found to have practically the same coating as

before altho more in the form of ice than frost. This is due to the fact that the light frost will melt in place and will remain as a dew on the surfaces thru surface attraction. Whereas dew or slowly precipitated moisture will adhere to coil surfaces to an appreciable depth, I have observed that water applied to these surfaces in any other manner will largely drain away by gravity and will leave only a few widely spaced drops of coalesced water. It is therefore another object of this invention to provide for removing light frost accumulations such as are not effectively removed by prior methods.

In carrying out defrosting it is the custom to discontinue refrigeration during defrosting. While this appears as an obvious conclusion, and while it is preferable with my method as well as with prior methods, it is a fact that my defrosting method applies thermal energy to the coils so rapidly that much frost or ice can be removed even if the supply of the particular refrigerant is continued. Also the present invention is directed to all manner of coils both gravity and blower types as well as those which are operated as flooded coils, or as expansion-valve-controlled coils, or as brine coils. While I have the blower type, fin-and-tube coil more in mind the invention does not depend in any way upon the fan or blower to remove ice or moisture.

It is another object of the invention to provide for employing any of the well known timing devices for operating the defrosting device peculiar to this invention and whereas certain of these timing or defrosting control devices provide a necessary lapse of a minute or so between the end of the heat application and the starting of refrigeration and air motion over the coils, I, by this invention take particular advantage of this lapse of time. It has also been proposed, with some defrosting devices, to begin refrigeration and to continue same for a short interval before the fan or blower is started, and some timing devices are so arranged. This, in the case particularly of internal heat application is a necessary evil in order that the hot coil shall not throw heated air. This invention, while leaving a still relatively cool coil after defrosting, provides that this interval will more rapidly lower the coil temperature so that no free water remains on the surfaces when the fan starts.

One practical device for carrying out this invention is illustrated by the accompanying drawing in which:

Figure 1 is a view partly in side elevation and partly in vertical section of a coil embodying the device and in position within a low temperature insulated space or box.

Figure 2 is mainly a vertical sectional view and shows the various parts of the defrosting device arranged in the usual operative position with respect to one another altho in this view widely separated elements are shown more closely arranged to provide both a detail and schematic view or arrangement.

Figure 3 is a fragmentary plan view, with parts broken away to reveal underlying parts, of what is known as the spray head.

Figure 4 is a fragmentary horizontal sectional view taken on the line 4—4 of Figure 1.

The numeral 5 indicates a conventional fin-and-tube coil, refrigerated, as indicated in the foregoing discussion, by any suitable means and which, as indicated above is unsuited to being temporarily charged with a high pressure or high temperature vapor or liquid. This coil is provided with the usual fan 6 for moving air over the coil surfaces, while the usual casing or housing 7 is provided to partially enclose the coil, and to constrain air from the fan to properly move over the coil surfaces, and, to provide the usual drip pan 8.

While the scale of the drawings does not permit of showing a large compartment, the walls of such box or compartment are in part shown and indicated at 9, and it is to be understood that the coil may be located well within the space 10 and well removed from any wall thereof; the invention providing for definite removal of all ice from the coils without regard to the distance from the coil to the nearest wall.

The drip pan is provided at the lowest portion thereof with a drain spout 11 which acts to drain therefrom all water reaching it to this spout there being connected a conduit 12 which is suitably inclined to freely drain and to be devoid of pockets or traps and which continues as at 12a externally of the space 10 to deliver or waste water therefrom at a point well removed. In keeping with features of this invention this conduit is of such proportionate length and diameter that the last water flowing thru it after a defrosting operation will act to form a moving slug or piston to draw after it an amount of air sufficient to dislodge films or drops of water from the drain spout and from that part of the conduit passing thru the cold interior 10, that the drainage system shall not subsequently become clogged by freezing of residual water. Also, in keeping with features of this invention the conduit shall be of rubber or some composition having a lower heat transfer factor and a lower specific heat factor than metal, so that with the proper diameter indicated above, the first flow of water thru this conduit at the beginning of a defrosting operation, shall not freeze and clog the low temperature parts of the conduit. While it will be seen hereinafter that the device provides a very ample flow of water at temperatures a few degrees, at least, above freezing, even this flow can be incapable of passing, by gravity particularly, thru a long length of small diameter metal pipe which has been refrigerated to a temperature of 50 degrees or more below the freezing point of water. A rubber or composition conduit will however serve the purpose, I have discovered, without becoming clogged and while having such diameter as to perform as otherwise required.

The housing, at a point above the coil, supports a pan 14, the bottom of which is uniformly perforated as at 15, these perforations 15 being distributed co-extensively of the entire upper-end area of the coil. This pan, hereinafter known as the spray head, is provided with a spout 16 which is a combined inlet and drain and which is located so as to drain all possible water therefrom when permitted to do so. To this spout is connected a second conduit 17, which like the conduit 12 is of low specific heat, preferably rubber or the like and continuing outwardly downwardly to carry water to the same remote points as that to which conduit 12 carries its waste water. Like conduit 12, this conduit 17 shall act, when just about to fully drain, to provide a slug or moving piston of leaving water which will draw air after it thru perforations 15 and thru spout 16 in such manner that residual water will be dislodged or removed to an extent that the drain system just described shall not become subsequently clogged by freezing of residual water.

Conduit 17 is also used as a supply conduit and

altho being exposed for many hours to a very low temperature within the space 10, it does not act to chill incoming water of the ordinary ground temperature to an extent that ice will clog the conduit or spout to interfere with a new supply of water.

In conduit 17 is interposed, preferably at a point outside of the space 10, a control valve 18. This valve is of the three-way or three-port type; the port 19 thereof being open normally to provide the drain system shown and described for the spray head; while the port 20 thereof is always open and provides, thru the corresponding part of the hose, direct communication between the spray head and the interior space 22 of the valve. At the other side of the space 22 there is provided an inlet port 21 to which is connected a pressure line 23 for supplying fresh water, such as at normal ground temperature and under suitable pressure.

This water may come from any service or municipal main direct to the valve without being salted or otherwise treated and it will be apparent that its average temperature may not be above 60 degrees Fahrenheit. Ports 19 and 21 respectively are the same in size and axially alined and are served by a single disc 25 capable of seating at either port to close one while leaving the other open.

While this valve disc may be operated by any means, it will be understood that the customary or standard defrosting controls are electric and accordingly I have shown the valve as being of the solenoid-actuated type and having its stem 25a continuing from said disc out thru the body of the valve to terminate in a solenoid core. The solenoid magnet or winding is indicated at 26 surrounding the core freely and in turn supported by the valve body. This valve, by reason of the arrangement of ports and conduits shown acts to keep the spray head drain system open and the supply of new water shut off whenever the solenoid is energized. This arrangement is advantageous in that by well known electrical hook-ups fresh water cannot pass the valve while a motor, such as the motor for the fan, or a motor (not shown) operating to produce refrigeration, is being energized by a circuit in which the valve is placed.

To defrost the coil with the device illustrated, the solenoid is de-energized so that water pressure will unseat the disc from port 21 and will force it into seating position over port 19 so that fresh water will flow into the spray head and not escape thru port 19. Water reaching the spray head will start to escape at once thru the perforations but will be sufficient in quantity to build up a slight depth or head therein to insure uniform distribution. The fresh water on its way to the spray head will not become clogged by freezing, as explained.

Operation of the fan is positively discontinued during defrosting by means of the usual switch or the like (not shown) and either simultaneously with or just before admission of water to the spray head.

Water, with its high heat content per unit volume proves to be highly effective in defrosting and even when rather indifferently applied to a coil will add heat to all of the surfaces thereof directly or indirectly and will result in effective defrosting. However, I have observed that the frost or ice found on frequently and properly defrosted coils, and particularly on coils defrosted according to this invention, is porous to and permeable by water. The rather gentle application of water to the fins as provided by the spray head illustrated causes the water to be to some degree absorbed by the irregular surfaced frost coating and the manner in which the frost quickly melts is quite surprising and unexpected. The water and melted ice reaching the drip-pan and draining therefrom does not re-freeze in the drain hose to clog same but yet it emerges at such low temperature as to indicate that the coil and its parts are not subjected to temperatures or vapor pressures higher than those for which they are designed.

When the proper interval has elapsed the solenoid is again energized so that the water supply is cut off and the drain system for the spray head is ready to function. Water will drain from the drip-pan as explained and will evacuate same and the attached conduit or hose, while the drain system for the spray head will perform in the same manner. Thus when defrosting is completed the entire system will be quite free of water and there will be no danger of ice forming to clog valves, conduits, spray heads or perforations, drip-pans or the like. While my discovery that properly applied fresh water has a surprisingly efficient and unexpected result on frosted coils, the provision of means for positively ridding the entire system of all but a few drops of water, and otherwise preventing clogging by freezing makes it possible to take full advantage of the first named discovery and also makes it possible to melt ice with water in the presence of a body of adjacent air which continues to remain at temperatures well below the freezing point of water.

At this time, when the water supply is shut off, various well known methods for renewing refrigeration and air motion may be followed according to dictates. However, my invention produces an advantage where the compressor or refrigeration plant is first put into operation before the fan. While the coil is now much cooler than had it been defrosted by other methods there is opportunity for water to drain therefrom before the fan starts and before the refrigerant shall have cooled the coil enough to freeze any residual water. Of course a slight amount of water will remain at certain points but this is not enough to be detrimental. By starting with renewed refrigeration before the fan is started this slight remaining water can be frozen in place rather than to be re-evaporated when the fan begins. Again, where starting of both air motion and refrigeration are delayed, the invention offers the advantage of allowing a draining period before appreciable freezing or evaporation can take place. In any event, by flushing the coil surfaces with excess water the residual water after draining is frequently much less than where a light frost coating is melted in place by internally applied heat and, as far as re-evaporation of water from the coils is concerned, when the fan is started after defrosting by my method there is less residual heat to promote objectionable re-evaporation. Under any condition the fan is again positively started after the supply of water to the spray head has been discontinued. This restarting of the fan is accomplished preferably by the same switch or the like (not shown) employed for stopping the fan. It will be seen now that my invention is directed more particularly to using the thermal and flushing effects of extraneous water for defrosting and cleansing the coil while providing against interference sub-

sequently from frozen residual water and that the device illustrated may be changed without departing from the invention.

I claim:

1. In combination with a refrigerated space, a refrigeration coil in said space having frost-accumulating surfaces, a valve-controlled conduit for periodically supplying water to said surfaces during a defrosting period, and valve means connected with said conduit for normally venting said conduit to the atmosphere to effect draining of all portions of said conduit within said space after each defrosting period and for admitting water to said conduit during said defrosting periods.

2. The combination as in claim 1 and further including a drip pan for said coil and a self-draining conduit leading from said drip pan to points external to said space.

3. The combination as in claim 1 and in which said conduit has a relatively low specific heat.

4. The combination as in claim 1 and further including a drip pan for said coil and a self-draining conduit leading from said drip pan to points external to said space and having relatively low specific heat.

5. The combination as in claim 1 and in which said means operates to finally draw air thru said conduit.

6. The combinations as in claim 1 and further including a drip pan for said coil, and means operable after each periodic water supply to automatically drain said pan; said first named means and said last named means each operable to finally move air thru same.

7. In combination with a refrigerated space, a refrigeration coil operating to refrigerate said air and having frost-accumulating surfaces, a spray head over said coil, a self-draining water supply conduit leading to said spray head and capable of supplying water of originally normal temperature to said spray head, a drip pan below said coil, and a self-draining conduit leading from said drip pan to points remote from said space and operable at any time to convey water from said pan to said remote points without freezing same.

8. The combination as in claim 7 and in which said conduits are of such proportionate diameter with respect to length as to cause draining water to finally draw air after it thru the corresponding conduit.

9. In combination, a refrigeration coil, a spray head over said coil, a valve having a constantly-open port and a pair of controlled ports; a water conduit leading from the constantly open port to said spray head, a water supply main connected to one of said controlled ports, a drain conduit connected to the other controlled port, and a single valve disc to said valve movable to close either controlled port while opening the other controlled port; said valve positioned at a lower elevation than said spray head.

10. In combination with a refrigeration space, a coil adapted for periodic defrosting, fins arranged on said coil to provide vertical channels extending from end to end thereof for gravitational flow of water over said fins and coil and channels extending from face to face thereof for flow of air; a spray head positioned immediately above said coil co-extensively of the upper plane thereof, a drip pan below said coil to receive water draining from all of said fins down through the vertically extending channels; a fan at one face of said coil normally forcing air through the corresponding channels and capable of being discontinued during defrosting periods; said fins, said spray head and said drip pan respectively co-operating to substantially prevent thermosyphonic flow of air over said coil and fins when the fan is discontinued whereby the air of said refrigerated space does not rise above the freezing point of water during the time required for defrosting said coil and fin surfaces, a self-draining conduit leading from said drip pan to points exteriorly of said space, a self-draining conduit leading from said spray head to a drain outlet exteriorly of said space acting normally to fully drain said spray head, and valvular means external to said space operable during discontinuance of operation of said fan to close said drain opening and to admit water to said spray head; said valvular means subsequently operable before operation of said fan to discontinue supply of water and to again open said drain outlet.

11. The combination as in claim 10 and in which said conduits are composed of a slow-heat-conducting low-specific-heat material.

12. In combination with a refrigeration coil having frost-accumulating surfaces, defrosting means comprising, a spray-head positioned to flow water over said surfaces, a supply conduit connected to supply water to said spray head and extending from a point remote from said coil and having at said remote point an open end normally in communication with the atmosphere whereby said conduit and the spray-head are self-draining, and means for periodically supplying water to the said remote open end of said conduit during defrosting.

13. In combination with a refrigerated space, a coil adapted for periodic defrosting, a spray-head positioned to distribute water over said coil for defrosting thereof, a fan to move air of said space over said coil adapted to be discontinued during defrosting periods whereby the air of said space does not rise above the freezing point of water during the defrosting period, a drip pan disposed below said coil to receive water and ice gravitating from said coil, a self-draining conduit leading from said drip pan to points remote from said space, and an inclined water supply conduit leading from a point remote from said space to said spray-head; said water supply conduit at said remote point provided with an opening normally open to the atmosphere whereby the conduit and spray-head respectively are self-draining, and means for periodically supplying water to said supply conduit during period when said fan is inoperative.

14. In combination with a cooling chamber containing a refrigeration coil having frost accumulating surfaces, defrosting means comprising spray means in said chamber for delivering water onto said surfaces, a conduit for water having one end thereof connected with said spray means and its other end extended to a point exterior of said chamber, electrically operated valve means connected with said other end of said conduit and arranged to normally maintain said conduit in communication with the atmosphere to provide for draining of said spray means and said conduit and to cut off communication of said conduit with the atmosphere and admit water into said conduit during defrosting.

HARRY H. McADAM.

Disclaimer

2,219,393.—*Harry H. McAdam*, Los Angeles, Calif. DEFROSTING DEVICE. Patent dated Oct. 29, 1940. Disclaimer filed Aug. 14, 1948, by the assignee, *Refrigeration Engineering, Inc.*; the inventor, joining, assenting, and acquiescing.

Hereby enters this disclaimer to claims 1 to 9, inclusive, and claims 12 and 14 of said specification.

[*Official Gazette Sept. 7, 1948.*]