Feb. 2, 1937. I. ALLISON 2,069,201

DEFROSTING APPARATUS

Filed Sept. 16, 1932 2 Sheets-Sheet 1

Fig. 3.

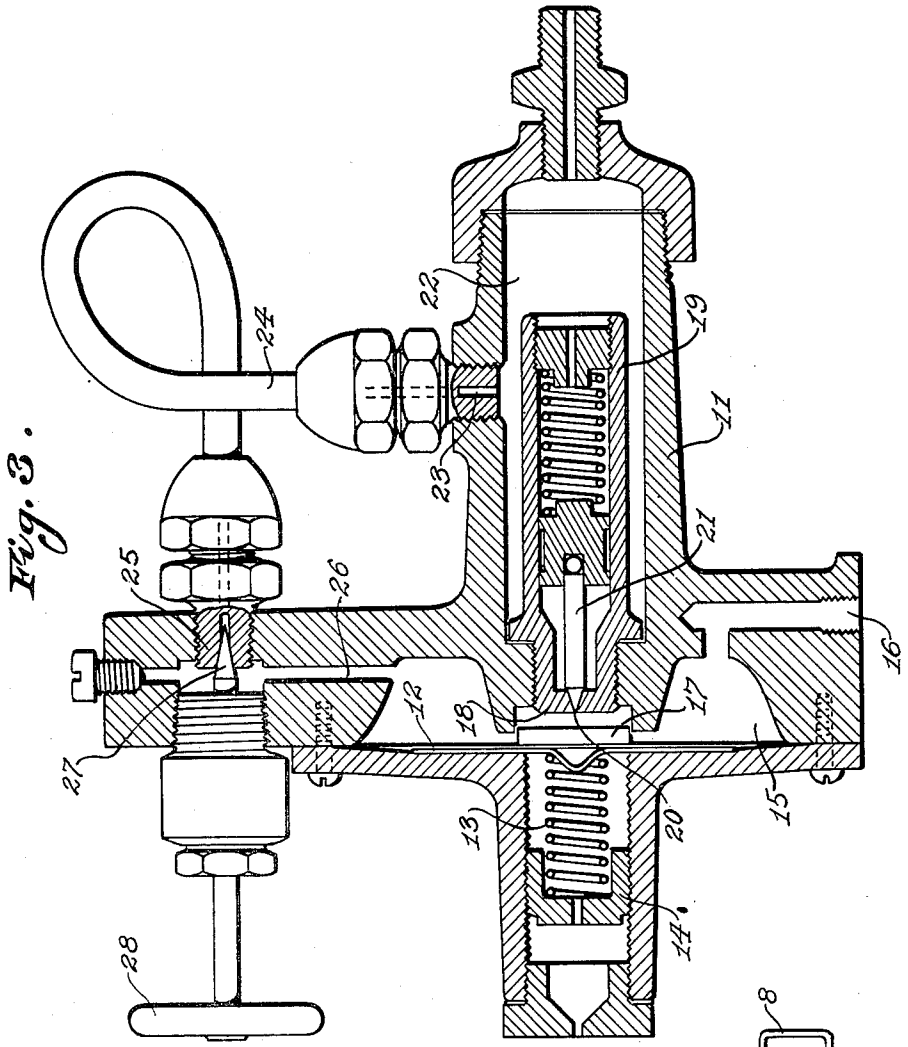


Fig. 1.

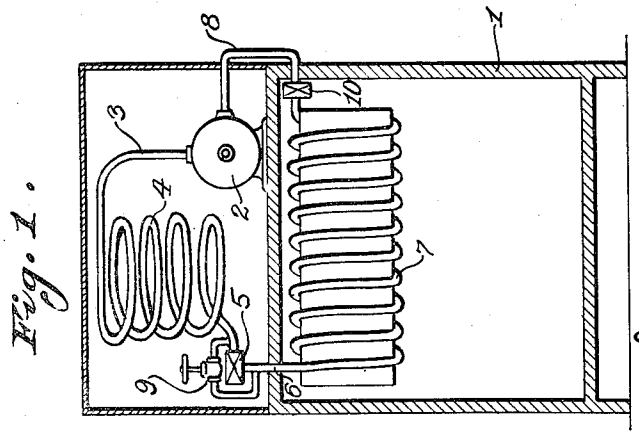
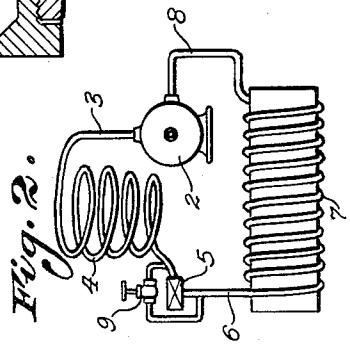


Fig. 2.



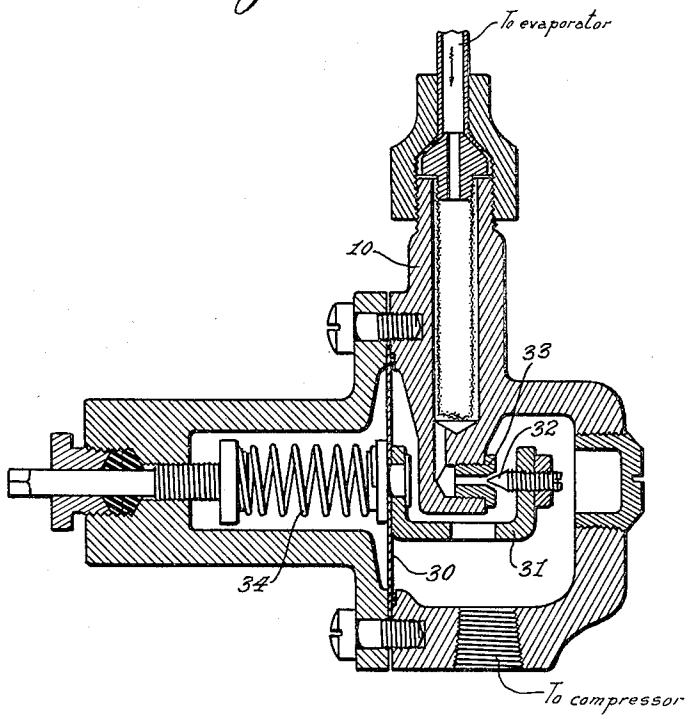
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Fig. 4.



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UNITED STATES PATENT OFFICE

2,069,201

DEFROSTING APPARATUS

Ira Allison, St. Louis, Mo., assignor, by direct and mesne assignments, to Arthur L. Hardin

Application September 16, 1932, Serial No. 633,444

7 Claims. (Cl. 62—3)

This invention relates generally to refrigerating apparatus, and particularly to apparatus for rapidly defrosting the refrigerating coils of such an apparatus.

The tendency for refrigerating coils, such for instance as the evaporator coils, employed in domestic mechanical refrigerators as well as in larger installations, as for instance showcase refrigerators and even larger boxes, to become frosted to such an extent that the refrigerating efficiency is severely impaired, is well known. For instance in a domestic refrigerator where vapors are constantly rising from the food products and circulated on the interior of the refrigerator and into contact with the refrigerating coil, it is well known that when such vapors contact with the refrigerating coils which are at a temperature lower than the freezing point of such vapors they accumulate thereon in form of a frost. In view of the fact that frost layers are relatively poor heat conductors, it is apparent that the efficiency of refrigerating apparatus when so frosted is considerably reduced. It has heretofore been the practice, particularly in domestic mechanical refrigerators, to periodically defrost such machines, the usual method being either to disconnect the source of motive power or else leave the door of the refrigerating chamber open in order to permit the refrigerator and its contents to rise to a temperature sufficient that the frost will melt and run off the refrigerating coils. It is among the objects of the present invention to provide an apparatus suitable for defrosting refrigerator coils and with which the defrosting can be accomplished rapidly and without necessitating a discontinuance of the operation of the machine for a long period.

The object of the present invention generally stated is to provide a refrigerating apparatus which may be rapidly and conveniently defrosted.

A further object of the invention is to provide refrigerating apparatus wherein defrosting is accomplished by producing a heat interchange between the usual condenser and the usual evaporator of the refrigerator.

Another object of this invention is to provide apparatus for defrosting refrigerating systems whereby refrigerant may be conducted directly from the condenser to the evaporator independently of the usual expansion valve.

A more specific object of this invention is to provide an apparatus for defrosting refrigerating systems wherein a bypass connection is provided around the usual expansion valve and operable to directly connect the condenser with the evaporator of the system.

Other objects will become apparent to those skilled in the art when the following description is read in connection with the accompanying drawings, in which:—

Figure 1 is a diagrammatical view of a domestic mechanical refrigerator provided with a defrosting apparatus constructed in accordance with the present invention;

Figure 2 is a diagrammatic view of a slightly modified form of defrosting apparatus;

Figure 3 is a detail sectional view of an expansion valve having a bypass connection and suitable for use in accordance with the present invention;

Figure 4 is a detail sectional view of a pressure responsive valve suitable for use in the refrigerating system of the present invention.

In accordance with the present invention, means is provided whereby the usual condenser may be directly connected to the usual evaporator of a mechanical refrigerator whereby the condensed refrigerant contained in the condenser may be introduced into the evaporator without expansion and in view of the fact that the condensed refrigerant is at a temperature considerably higher than the operating temperature of the evaporator the presence of the condensed refrigerant in the evaporator will be effective to raise the temperature thereof sufficiently to cause the accumulated frost or ice to melt and drip off quickly. In accordance with one embodiment of the present invention means is provided which may operate independently of the usual expansion valve for placing the condenser in unrestricted communication with the evaporator whereby the refrigerant may flow directly from the condenser to the evaporator without expansion. The present invention further contemplates an expansion valve constructed and arranged so as to provide a bypass connection operable to connect the inlet with the outlet independently of the expansion mechanism.

Referring now particularly to the drawings the usual refrigerator having a cabinet 1 suitably insulated is provided with a compressor 2 which may be motor driven as for instance by electricity. The compressor 2 may be connected through a pipe 3 to discharge into a condenser coil 4 diagrammatically shown but which may be provided with any conventional cooling mechanism as for instance a fan and with or without fins. At the lower end the condenser coil 4 may

be connected to the usual expansion valve 5 which operates in a manner well known to those skilled in the art to maintain a high pressure on the condenser side as distinguished from a reduced pressure on the other side thereof. From the expansion valve 5, a pipe 6 leads to the usual evaporator coils 7 which are disposed within the cabinet 1 of the refrigerator and the other end of the evaporator 7 may be connected through a pipe 8 to the inlet end of the compressor 2.

In accordance with the present invention one embodiment of which is illustrated in Figure 1 a suitable valve 9 may be connected in parallel circuit relation to expansion valve 5 and so arranged as to form when open a bypassing connection adapted to place the condenser coil 4 in unrestricted communication with the evaporator coil 7. The valve 9 may be manually operated as shown and is preferably operable independently of expansion valve 5 although it will be understood that the same may be arranged to be operated through or by means of the usual dial provided on domestic mechanical refrigerators for controlling expansion valve 5.

As shown in Figure 1 there may be provided an additional valve 10 between the evaporator coil 7 and the compressor 2. The valve 10 although not necessary with some types of refrigerant, nevertheless, provides a safeguard against the return of liquid refrigerant to the compressor. The valve 10 may be of any suitable well known type adapted to remain open until a predetermined pressure is reached. Furthermore the valve 10 preferably operates as an expansion valve after responding to the predetermined pressure in the evaporator, but under ordinary operating conditions it will be understood that the valve 10 remains in open position so as to permit unrestricted flow of the refrigerant from evaporator 7 through pipe 8 to compressor 2. The pressure responsive valve 10 may be set so as to remain open so long as the pressure in evaporator 7 does not reach the vapor pressure of the refrigerant at a temperature sufficiently high to melt the accumulated ice and frost on the exterior of the evaporator.

It will be understood, therefore, that the valve 10 will operate as a safeguard to prevent liquid refrigerant from being returned to compressor 2 so long as valve 10 is set to operate at a back pressure slightly below the vapor pressure of the refrigerant at around 32° F. In view of the fact, however, that under ordinary conditions the temperature of the evaporator in a refrigerator is around 5° F. the evaporator normally operates under a pressure considerably less than the vapor pressure of the refrigerant at 32° F. For instance when sulphur dioxide is employed as the refrigerant the evaporator usually operates under about three pounds vacuum while ammonia operates at around 20 pounds per square inch positive pressure. The normal operating pressure of the evaporator constitutes one limit and the vapor pressure of the refrigerant at about 32° F. constitutes another limit between which limits valve 10 may be set to close. The specific pressure at which valve 10 closes will be determined in accordance with operating condition but in the case of sulphur dioxide a pressure of about ten pounds per square inch is practical while with ammonia a pressure of about thirty-five pounds per square inch is practical. It is beneficial that the valve 10 be set to close at a relatively low back pressure since in that manner a greater interchange of heat will take place between the condenser and the evaporator than would take place if the valve 10 was so set as to barely prevent liquid refrigerant from passing the same. When the valve 10 is set to operate at a pressure of for instance ten pounds per square inch with sulphur dioxide, it is apparent that the refrigerant actually throws off heat to the coils of the evaporator as the pressure builds up therein and consequently the evaporator becomes in fact a condenser temporarily. When the pressure in the evaporator is built up to a value sufficient to close valve 10 it will be understood that the valve continues to operate as an expansion valve permitting a small quantity of the refrigerant to pass and expand beyond. By thus providing resistance in the refrigerating circuit, racing of the motor which drives the compressor is prevented and in view of the fact that when the refrigerant is expanded adjacent the compressor the operating parts are cooled.

In Figure 2 is diagrammatically illustrated a refrigerating system identical in all respects with that shown in Figure 1, except that auxiliary valve 10 is not provided. Under most circumstances it should not be necessary to provide such a valve as 10, particularly since defrosting is generally complete before the pressure in the circuit has had sufficient time to reach the critical point.

In Figure 3 there is illustrated in detail a valve providing both the usual expansion valve and a bypass connection, and accordingly such valve is adapted for use in place of expansion valve 5 and bypassing valve 9. The valve illustrated in Figure 3 may consist generally of a casing 11 having mounted therein the conventional expansion valve mechanism which may consist generally of a spring-biased diaphragm 12 adapted to be adjusted by manipulation of the tension of a spring 13 seated against an abutment 14 which may be adjustable in any suitable manner. Around the diaphragm is provided a chamber 15 connected to an inlet portion 16 and adapted to receive refrigerant from the condenser. Mounted on the diaphragm 12 is a valve member 17 adapted to be seated against the end 18 of a sleeve 19. The end 18 of sleeve 19 is provided with a central opening 20 through which refrigerant may pass. On the inside of sleeve 19 and seated in the central opening 20 is a needle valve 21 spring-biased and suitably adjustable so as to open when the desired differential pressure between condenser and evaporator is present. It will be understood that when suitable pressure is built up in the condenser the diaphragm 12 is forced toward the left against the action of spring 13 and valve element 17 is pulled away from end 18 so that opening 20 is connected to chamber 15. The pressure of the refrigerant in the condenser is then applied to the point of needle valve 21 which when sufficient to move needle valve 21 against the action of the spring will open the same and permit the refrigerant to flow through opening 20 into chamber 22 connected with the evaporator and at a considerably lower pressure than is present in the condenser and chamber 15.

In the wall of casing 11 and communicating with chamber 22 is an outlet 23 having suitably connected therewith a tube 24, the other end of which terminates at and is suitably connected to an opening 25 communicating through a passage 26 with chamber 15. A valve 27 is provided for controlling the passage at opening 25 and may be provided with a suitable operating means as for

instance a handle 26. It is apparent from the construction just described that the tube 24 forms a bypassing connection, when valve 27 is open, which will permit refrigerant to flow between chambers 15 and 22 and will, therefore, place the condenser which is connected to chamber 15 in unrestricted communication with evaporator 7 which is connected to chamber 22.

Referring now particularly to Figure 4 for a showing of a pressure responsive valve 10, such as is suitable for use between the evaporator and the compressor, it will be observed that the valve is provided with a diaphragm 30 to which is connected an arm 31 which carries at its opposite end a needle valve 32 seating in a seat 33. As shown in the drawings, the valve 32 is normally held open by the action of a spring 34 back of diaphragm 30. This is during normal operation of the refrigerating system when the pressure between the evaporator and the compressor is low. When, however, the refrigerant is permitted to flow into the evaporator 7 at compressor discharge pressure, the pressure is exerted upon diaphragm 30 moving the same toward the left against the action of spring 34 and closing valve 32. When the valve has closed a further stroke of the compressor will reduce the pressure and permit the diaphragm to move to the right, opening the valve 32 slightly.

From the foregoing description the operation of the apparatus hereinbefore described will be understood to be as follows: Assuming that the refrigerator has been operating for a time sufficient that a layer of frost has accumulated on the exterior of evaporator 7, valve 9 or corresponding valve 27 may be operated so as to place the condenser 4 in communication with evaporator 7 independently of the expansion valve 5. When the evaporator and condenser are thus connected together the condensed refrigerant which is normally in liquid condition and at a temperature considerably higher (usually 70° F.) than the evaporator will flow into the evaporator which is normally under a reduced pressure and temporarily elevate the temperature of the evaporator sufficiently to cause the collected ice or frost to melt at the interface and drop from the coils. Under normal conditions of operation a relatively short period of time usually less than one minute is required for the collected ice and frost to drop from the coils. When the liquid refrigerant is permitted to escape from the condenser 4 into evaporator 7 the released pressure will under ordinary conditions be such as to cause the refrigerant to gasify. When the refrigerant is thus reduced to a gaseous condition, it is apparent that not only is the temperature of evaporator 7 raised due to the higher temperature of the refrigerant therewithin, but such gasification as takes place in condenser 4 operates to cool the latter to a certain extent.

During this time, however, the compressor 2 continues to operate and consequently pressure will be built up in the coils of condenser 4 and evaporator 7. If the valve 9 were permitted to remain open for sufficient time all the refrigerant contained in condenser 4 and evaporator 7 would be reduced to liquid condition as the compressor continued to operate. In order to avoid the possibility of deleterious effect upon the compressor, should this condition arise, so that liquid refrigerant would be delivered to the compressor, a pressure responsive expansion valve 10 may be provided. When such valve 10 is provided and set to close when the pressure within evaporator 7 approaches the critical pressure at which the refrigerant will be liquefied it is apparent that the danger of liquid refrigerant returning to the compressor is eliminated. It will be understood that where the valve 10 has in the foregoing description been referred to as "closing", this expression is to be understood to mean that the valve begins to operate as an expansion or reducing valve so as to maintain a differential in pressure at each side thereof. The expression "unrestricted communication" as used in the foregoing description and in the appended claims is not intended to be understood in the limiting sense of meaning a communication through which equilibrium of two fluids at different pressures would instantaneously occur, but the expression is to be understood in the descriptive sense as distinguishing from communication through an expansion valve, it being understood that in most instances defrosting is substantially complete before the pressure in the evaporator is in equilibrium with the condenser pressure.

After the evaporator 7 has been heated sufficiently to cause the accumulated ice and frost to drop therefrom the valve 9 may be restored to its closed position so as to interrupt the unrestricted flow of the refrigerant from the condenser 4 to evaporator 7. Thereafter such refrigerant as is delivered to the evaporator must be first expanded by passing through expansion valve 5 and the refrigerator system then continues to operate in its usual manner.

It will be understood that after valve 9 has remained open for a time sufficient to accomplish the desired defrosting, it may then be restored to its closed position so as to cause all refrigerant passing from the condenser to the exaporator to pass through expansion valve 5. When a valve such as 10 is provided, however, it will be understood that such valve continues to operate to drain refrigerant from evaporator 7 after valve 9 is closed. Furthermore in view of the fact that even after closing valve 9 there is sufficient pressure in evaporator 7 to cause the valve 10 to remain open and operate as an expansion valve, it is apparent that a certain amount of expansion takes place in evaporator 7 and consequently there is a noticeable cooling effect due to the expanding refrigerant in the evaporator. The valve 10 continues to drain the refrigerant from evaporator 7 until the pressure in the evaporator is so low that there is no danger of it being in liquid condition at the temperature encountered. The usual operations of a refrigerating cycle are then carried out so as to permit the apparatus to operate to refrigerate chamber 1.

From the foregoing description it is apparent that many modifications of the rapid defrosting arrangement hereinbefore described will present themselves to those skilled in the art without departing from the spirit of this invention. It is to be distinctly understood, therefore, that the invention is not limited to the specific details of the illustrative embodiments hereinbefore described and shown in the accompanying drawings. Furthermore it is to be understood that such modifications and the use of such individual features and subcombinations of features as do not depart from the spirit of this invention are, although not specifiacly described herein, contemplated by and within the scope of the appended claims.

Having thus described the invention, what is claimed is:

1. The combination with a refrigerating system having a compressor, a condenser and an evaporator, of an expansion valve between said condenser and said evaporator having auxiliary means operable to place said condenser and evaporator in unrestricted communication without disturbing the setting of said expansion valve, and a second expansion valve between said evaporator and said compressor.

2. The combination with a refrigerating system having a compressor, a condenser and an evaporator, of an expansion valve between said condenser and said evaporator having auxiliary means operable to place said condenser and evaporator in unrestricted communication without disturbing the setting of said expansion valve, and a pressure responsive valve between said evaporator and said compressor.

3. The method of defrosting evaporator coils of refrigerating systems having a compressor, a condenser and an evaporator connected in continuous circuit relation, comprising discharging refrigerant at substantially compressor discharge pressure into the coils to be defrosted, and expanding the refrigerant beyond the coils to be defrosted to prevent the flow of liquid refrigerant to the compressor.

4. Apparatus for defrosting refrigerating systems in which a compressor, a condenser and an evaporator are connected together in series circuit relation, with an expansion valve between the condenser and the evaporator, the combination comprising, means for connecting the evaporator to receive refrigerant at compressor discharge pressure, and a normally open valve responsive to pressure in the evaporator for preventing the flow of liquid refrigerant from said evaporator to the compressor.

5. Apparatus for defrosting refrigerating systems in which a compressor, a condenser and an evaporator are connected together in series circuit relation, with an expansion valve between the condenser and the evaporator, the combination comprising, means for connecting the evaporator to receive refrigerant at compressor discharge pressure, and an expansion valve between the evaporator and the compressor for preventing the flow of liquid refrigerant toward the compressor.

6. Apparatus for defrosting refrigerating systems in which a compressor, a condenser and an evaporator are connected together in series circuit relation, with an expansion valve between the condenser and the evaporator, the combination comprising, means for connecting the evaporator to receive refrigerant at compressor discharge pressure, and a normally inoperative expansion valve responsive to pressure in the evaporator to prevent the flow of liquid refrigerant toward the compressor.

7. The method of defrosting evaporator coils of refrigerating systems having a compressor, a condenser and an evaporator connected in continuous circuit relation, comprising discharging hot refrigerant into the coils to be defrosted at a pressure above the normal evaporator pressure, and restraining the flow of liquid refrigerant from the evaporator to the compressor.

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