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REFRIGERATING APPARATUS

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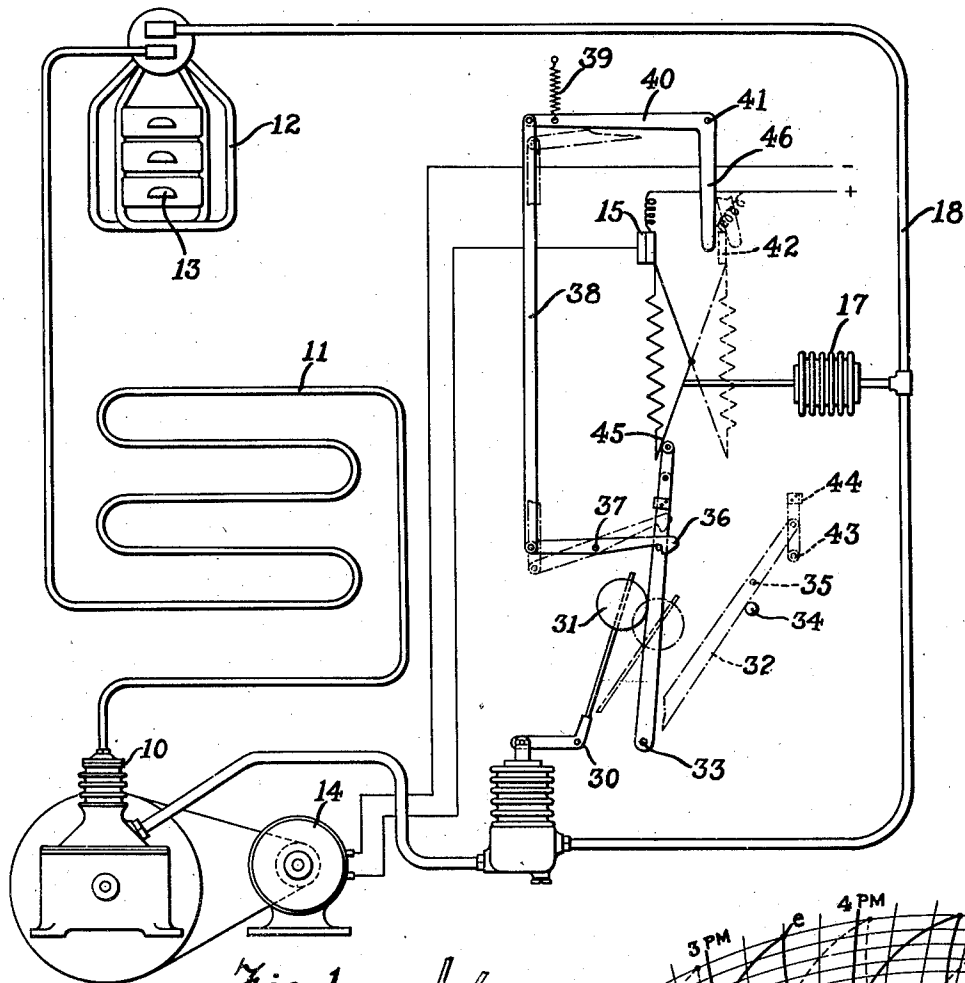


Fig. 1

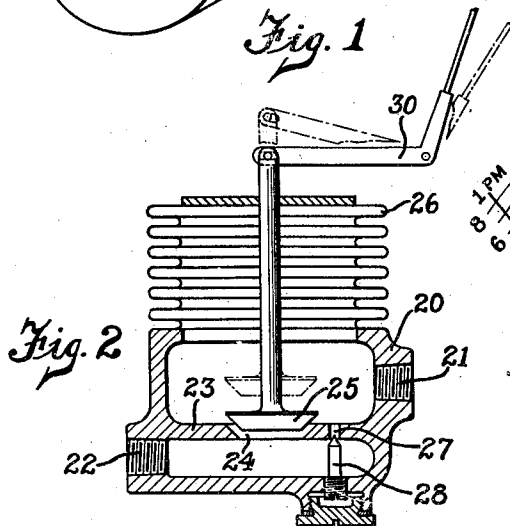


Fig. 2

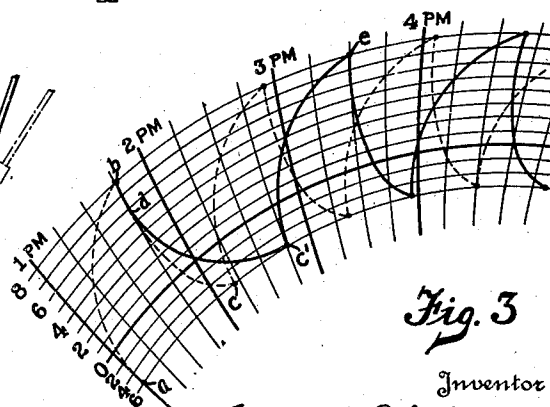


Fig. 3

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REFRIGERATING APPARATUS

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This invention relates to refrigerating apparatus particularly to refrigerating apparatus which is adapted to be operated intermittently and automatically to freeze ice and to cool a storage cabinet.

One of the objects of the invention is to provide an improved method and means for temporarily increasing the ice freezing rate of such systems.

More specifically it is an object of the invention to provide improved means which temporarily increase the percentage of operating time in intermittently operated apparatus so as to freeze ice more quickly.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred form of the present invention is clearly shown.

In the drawings

Fig. 1 is a diagrammatic illustration of my invention applied to a conventional refrigeration system;

Fig. 2 is a section of a portion of the control means shown in Fig. 1; and

Fig. 3 shows time-pressure curves of refrigerating apparatus both with and without my invention.

Referring to the drawings, the system comprises the usual compressor 10, condenser 11 and flooded evaporator 12 provided with ice freezing containers 13. The compressor is operated for example by a motor 14 under the control of a switch 15 actuated in response to the condition of the system in any suitable manner for example, by means of the pressure-responsive device 17 connected to the vapor conduit 18 which connects the evaporator with the intake side of the compressor. The apparatus so far described is well-known in the art and its specific construction and arrangement form no part of the present invention. In such apparatus the pressure of the refrigerant within the evaporator is a function of the temperature of the evaporator. The apparatus is automatically started by the switch 15 whenever the pressure in the evaporator and conduit 18 is above a predetermined high value representing a definite

high temperature, and is stopped automatically by the switch whenever the pressure is below a predetermined low value corresponding to a definite low temperature. Fig. 3 shows the pressure values in the evaporator plotted against time for several cycles of operation. In this figure time is measured as abscissas along the generally horizontal arcuate lines (of small radius) and pressure is measured as ordinates along the generally vertical arcuate lines (of large radius). At the point *a* the pressure in the evaporator is low, being shown, by way of example, as about six inches of mercury vacuum, at which value the compressor is not operating. The refrigerant gradually absorbs heat from the cabinet so that the pressure of the refrigerant within the evaporator gradually rises as shown by the dotted curve *a b*. At *b* the pressure as shown on the curve is about 8 pounds per square inch, gauge, which is sufficient to close the automatic switch 15 to operate the compressor. The compressor circulates refrigerant through the evaporator, and the evaporation of refrigerant gradually reduces its temperature and pressure as is well known. The pressure is gradually reduced to six inches of mercury vacuum along the dotted curve *b c*, about 25 minutes being required for the pressure to reach this low value as shown by the curve. At *c* the switch is opened and the compressor stopped. The cycle of operating phases and idle phases above described will then repeat itself.

My invention is concerned with prolonging the proportion of the time during which the evaporator operates in the lower portion of the temperature range, in order that ice may be frozen, whenever desired, in a shorter space of time. To this end I increase the percentage of operating time and preferably provide all of the increase in the lower portion of the temperature range only. I accomplish this by throttling or restricting the flow of refrigerant, preferably after the evaporator has been somewhat reduced in temperature.

Referring to Fig. 3, we assume for example that the evaporator is at a pressure of six inches of mercury vacuum at 1 p. m. as shown

by point *a* on the curve. The pressure rises along the curve *a b* as previously described. The switch then closes to operate the compressor and the pressure is reduced along the curve *b c* to the point *d*. At this point the flow of refrigerant is restricted after which the compressor circulates refrigerant more slowly and consequently reduces the pressure more slowly. The pressure is reduced as shown by the solid curve *d c'* to the value of six inches of mercury vacuum. As shown by the curve approximately 1 hour is required for the reduction of pressure from the point *b* to the point *c'*. Thus the water in the containers 13 has been exposed for a longer proportion of the time to a low temperature. The slow rate of circulation of the refrigerant is sufficient to remove heat from the water being frozen as fast as the heat can be conducted to the refrigerant from the water through the paths of rather high thermal resistance usually existing in apparatus of this character. Therefore, by prolonging the proportion of each operating cycle during which the temperature is very low, or below freezing, the water will be frozen in a shorter elapsed time. After the switch has opened at the point *c'* the pressure in the evaporator rises along the curve *c' e* which may be identical with the curve *a b*.

Refrigerating systems as above described may be set to operate with the evaporator at times above the freezing point of water in order that the evaporator may be defrosted every cycle, as explained in the application of Jesse G. King, filed October 23, 1923, Serial No. 670,359. In such cases the water in containers 13 will be frozen only while the evaporator is below the freezing temperature. In this event it is desirable, when ice is to be frozen quickly, to reduce the pressure very rapidly to the value corresponding to the freezing point of water and thereafter to prolong the operating period of the compressor; therefore the point *d* at which the flow of refrigerant is restricted may be the pressure corresponding to the freezing point of water.

Any suitable means can be used to restrict the flow of refrigerant as above described. One such means is illustrated in Figs. 1 and 2. A casing 20 is connected at 21 and 22 in the vapor return conduit between the evaporator and the compressor. This casing is divided into two chambers by a partition 23 having a valve opening 24. A valve 25 is adapted to be seated in the opening and is mounted on an expansible metal bellows 26, the outer end of which is closed and the inner end of which is sealed to the casing. A by-pass 27 controlled by an adjustable needle valve 28 permits a small quantity of refrigerant to flow through the conduit 18 when the valve 25 is closed. The valve 25 is closed whenever it is desired to restrict the flow of refrigerant through the conduit. One method of doing

this is by means of the apparatus illustrated in Fig. 1. The valve is mounted on one arm of a bell-crank lever 30, the other arm of which carries a weight 31 which normally rests in the dotted line position. Near the weight is a lever 32, pivoted at 33, and normally resting against a stop 34 as shown in the dotted line position. The lever may be rotated to the full line position, where it is held by the pin 35 which is engaged by a catch 36 pivoted at 37 and normally urged into latching position by a rod 38 and spring 39. The upper end of the rod 38 is pivoted to the free end of one arm of a bell-crank lever 40, pivoted at 41. The other arm of the bell-crank lever 40 is placed so that it will be in the path of some moving part 42 of the switch 15.

The apparatus above described operates as follows: When it is desired to restrict the flow of refrigerant the arm 32 is rotated to the full line position in Fig. 1, and latched. This raises the weight 31 from the dotted line to the full line position. In this position the valve is not closed and does not restrict the flow of refrigerant, but the moment of the weight is reduced to such an amount that the desired reduction of pressure within the bellows can close the valve against the moment of the weight. In order to insure that the switch 15 will be closed and the motor consequently operated when the arm 32 is set to restrict the flow of refrigerant, the arm 32 is provided with a pivoted handle 43. The handle normally rests in the position shown in dotted lines in Fig. 1, but when it is rotated in a counter-clockwise direction a stop 44 engages the arm 32, making the arm rigid with the handle and thus rotates the arm 32 with the handle 43. The handle 43 is in the path of another moving part 45 of the switch 15, and consequently closes the switch when the arm 32 is rotated to the full line position. After the switch is closed the latch 36 holds the arm in the full line position and the handle 43, being loosely pivoted to the arm 32, may be freely rotated by the portion 45 of the switch when the switch is opened by the bellows 17. Thus while the handle 43 closes the switch, it does not prevent its opening. While the latch 36 is operating the arm 46 of the bell-crank lever 40 moves into the path of the moving part 42 and is held there by the latch. The compressor now operates and withdraws refrigerant from the evaporator. When the pressure within the evaporator has fallen to a predetermined value (which may correspond to the freezing temperature of water) the bellows 26 collapses, due to the low pressure within it, and closes the valve 25. Refrigerant is thereafter withdrawn from the evaporator at a low rate and the pressure within the evaporator is very gradually reduced to the point at which the auto-

matic switch is set to open. When this occurs the part 42 strikes the arm 46 and trips the latch 36, allowing the arm 32 to drop to its dotted line position. Thereafter when the pressure in the bellows increases the weight will drop to its dotted line position and open the valve to permit the next cycle of operation to take place with unrestricted flow of refrigerant unless the arm 32 is again set by hand.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerating apparatus comprising in combination a refrigerating element, means for circulating refrigerant through the element, means responsive to the condition of the system for periodically operating circulating means, means adapted to restrict the flow of refrigerant, means for rendering said last mentioned means operative, and means for rendering said means inoperative after a predetermined operation of the circulating means.

2. Refrigerating apparatus comprising in combination a refrigerating element, means for circulating refrigerant through the element, means responsive to the condition of the system for periodically operating the circulating means, means adapted to restrict the flow of refrigerant, means for rendering the restricting means operative and means for rendering the restricting means inoperative at the end of the next succeeding period of operation of the circulating means after the restricting means has been rendered operative.

3. Refrigerating apparatus comprising in combination a refrigerating element, means for circulating refrigerant through the element, means for restricting the flow of refrigerant, means adapted to actuate the restricting means in response to the condition of the system, and means for simultaneously rendering the actuating means and the circulating means operative.

4. Refrigerating apparatus comprising a refrigerating element, means for circulating refrigerant through the element, means adapted to start the operation of circulating means at a predetermined high temperature and adapted to stop the operation of the circulating means at a predetermined low temperature, means adapted to respond to a predetermined intermediate temperature to prolong the operation of the circulating means, and means for rendering said last mentioned means operative.

5. Refrigerating apparatus comprising a refrigerating element, means for circulating refrigerant through the element, means adapted to start the operation of the circulating

means at a predetermined high temperature of the refrigerating element and adapted to stop the operation of the circulating means at a predetermined low temperature of the refrigerating element, means adapted to respond to a predetermined intermediate temperature to restrict the flow of refrigerant, and means for rendering the said last mentioned means operative.

6. Refrigerating apparatus comprising a refrigerating element, means for circulating refrigerant through the element, means adapted to start the operation of the circulating means at a predetermined temperature of the refrigerating element above the freezing point of water and adapted to stop the operation of the circulating means at a predetermined temperature of the refrigerating element below the freezing point of water, means adapted to respond to the existence of a water-freezing temperature to restrict the flow of refrigerant when the refrigerating element is below the freezing point of water, and means for rendering said last mentioned means operative.

7. Refrigerating apparatus comprising a refrigerating element, means for circulating refrigerant through the element, means adapted to start the operation of the circulating means at a predetermined temperature of the refrigerating element above the freezing point of water and adapted to stop the operation of the circulating means at a predetermined temperature of the refrigerating element below the freezing point of water, means adapted to prolong the period of operation of the circulating means, means for actuating the prolonging means when the temperature of the refrigerating element is below the freezing point of water, and means for rendering said last mentioned means operative.

8. Refrigerating apparatus comprising an evaporator, means for circulating refrigerant through the evaporator, means for restricting the flow of refrigerant, means adapted to actuate said restricting means in response to the pressure of the system, means for rendering said actuating means operative, and means for rendering the actuating means inoperative after a predetermined operation of the circulating means.

9. Refrigerating apparatus comprising in combination an evaporator, means including a vapor conduit for circulating refrigerant through the evaporator, a pair of parallel outlets for the conduit, a valve in one outlet, and means adapted to close the valve in response to the pressure in the conduit, the other outlet being continuously open.

10. In refrigerating apparatus which intermittently circulates refrigerant through a refrigerating element to reduce the temperature of the element from above the freezing point of a substance to below the freezing

point, the method of decreasing the elapsed time required to freeze the substance which consists in restricting the flow of refrigerant when the temperature is below freezing to increase the proportion of the time during
5 which the element operates below freezing.

11. Refrigerating apparatus comprising a refrigerating element, means for circulating refrigerant through the element, means
10 adapted to start the operation of circulating means at a predetermined high temperature and adapted to stop the operation of the circulating means at a predetermined low temperature and means adapted to respond to a
15 predetermined intermediate temperature to prolong the operation of the circulating means.

In testimony whereof I hereto affix my signature.

20 WARREN H. F. SCHMIEDING.

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