May 25, 1943. L. F. CLERC 2,320,265

REFRIGERATING APPARATUS

Filed Jan. 22, 1940 5 Sheets-Sheet 1

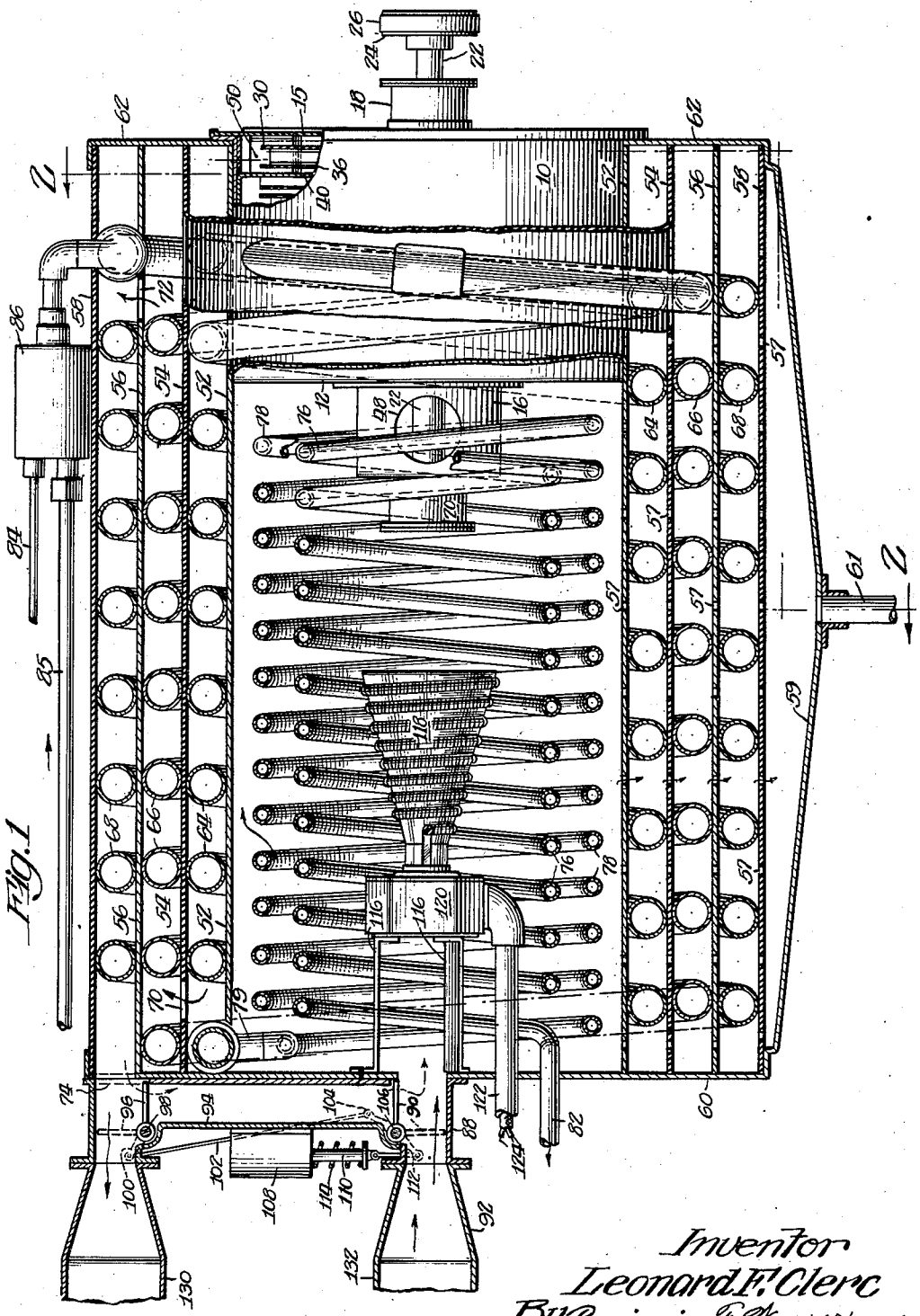

Fig. 1

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Filed Jan. 22, 1940 5 Sheets-Sheet 2

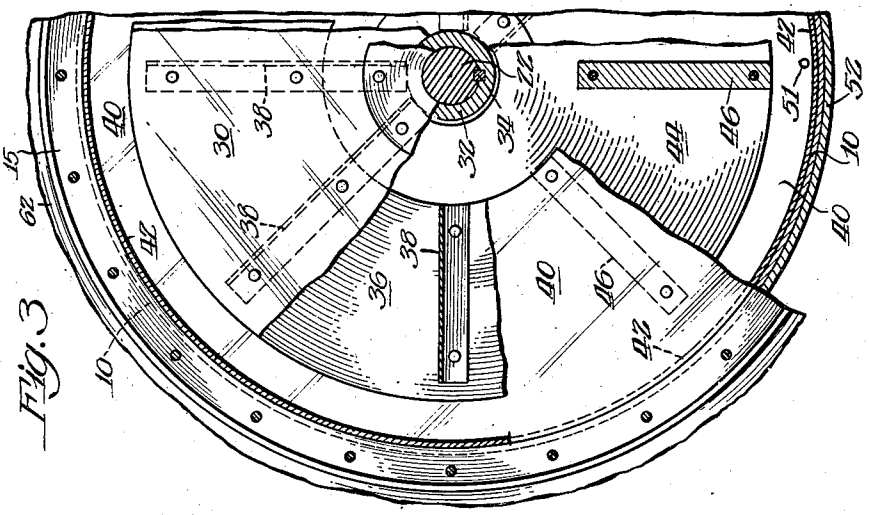

Fig. 3

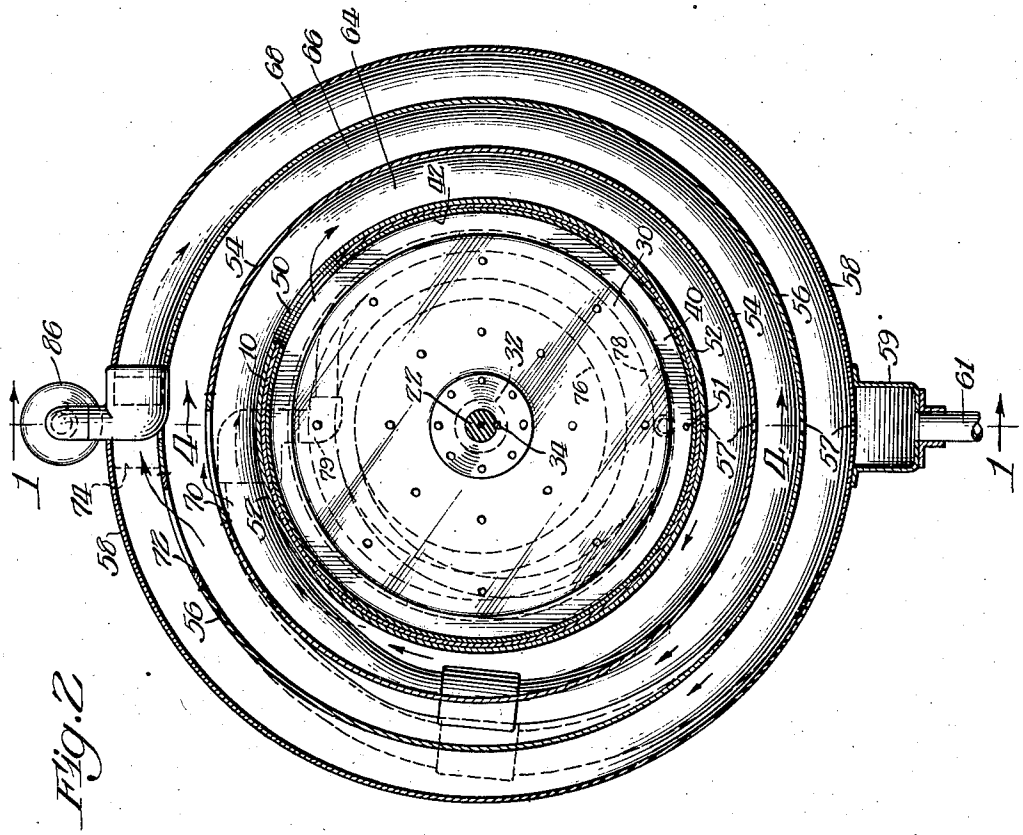

Fig. 2

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REFRIGERATING APPARATUS

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Fig. 5

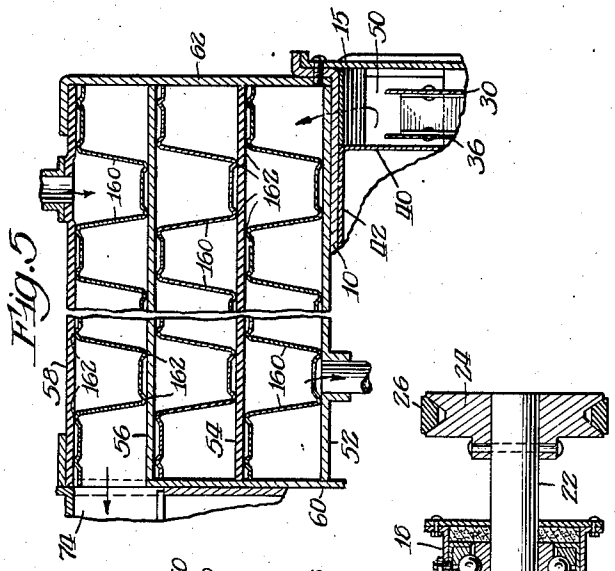
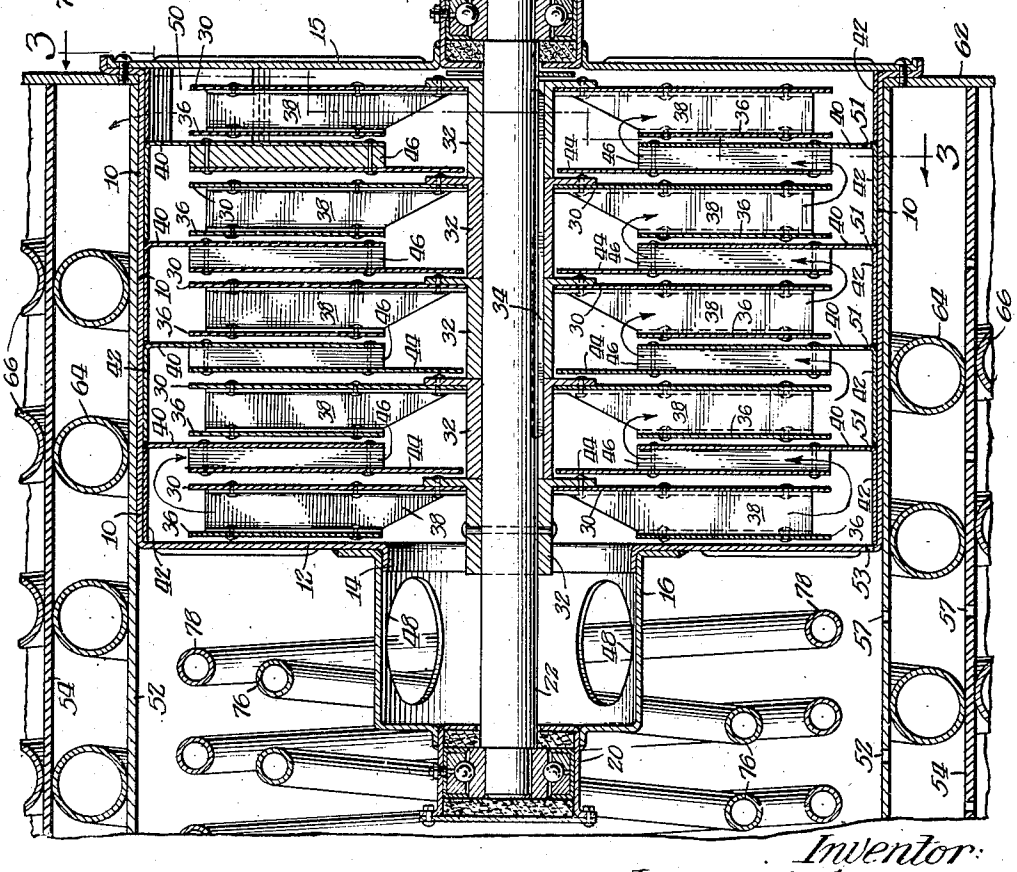


Fig. 4



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REFRIGERATING APPARATUS

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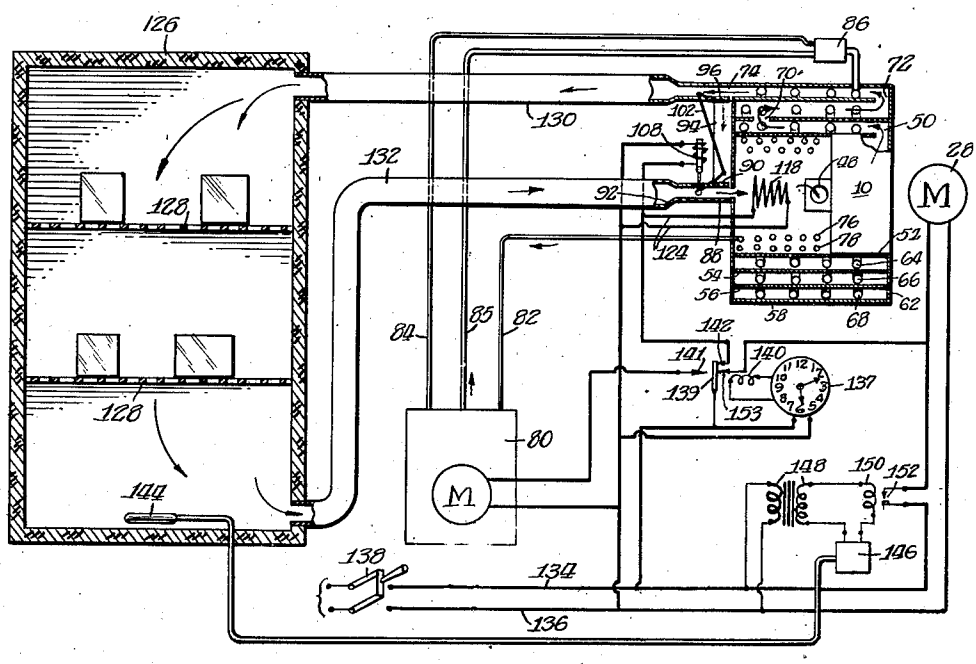
Fig. 6



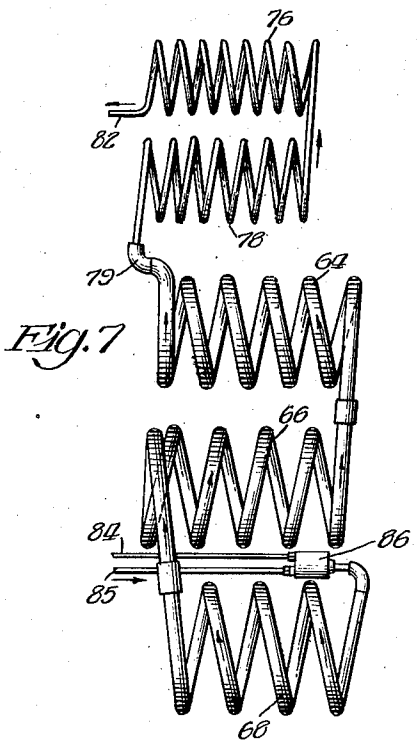


Fig. 7

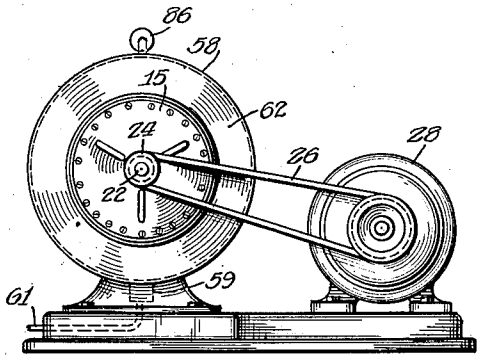


Fig. 8

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REFRIGERATING APPARATUS

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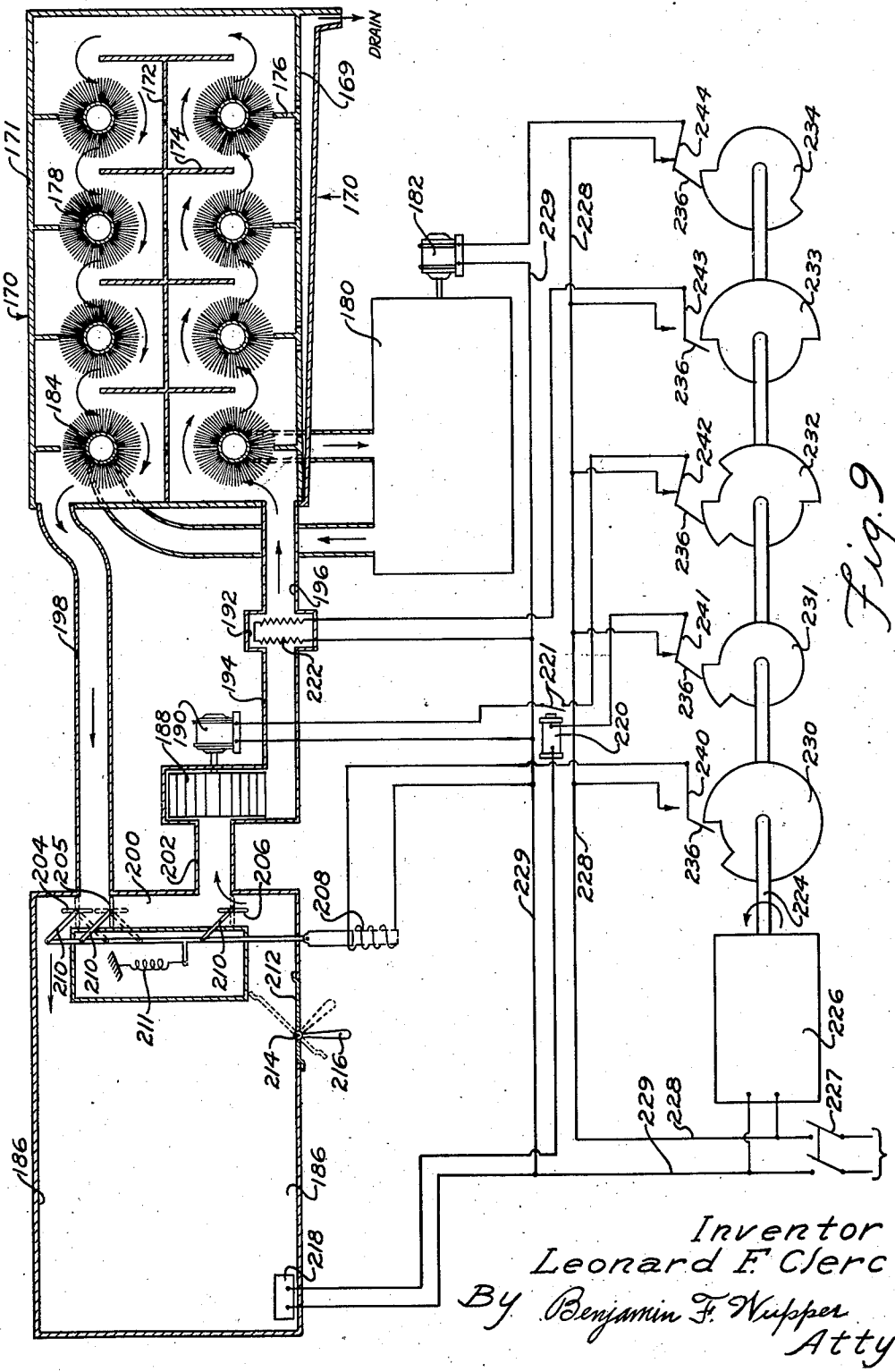

Fig. 9

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Patented May 25, 1943 2,320,265

UNITED STATES PATENT OFFICE

2,320,265

REFRIGERATING APPARATUS

Leonard F. Clerc, Chicago, Ill.

Application January 22, 1940, Serial No. 314,905

8 Claims. (Cl. 62—115)

My invention relates generally to refrigerating apparatus, and more particularly to improvements in refrigerating units of the type which may readily be installed to cool a refrigerating cabinet, shipping container, or other space which is to be cooled or to be maintained at a low temperature.

It is an object of my invention to provide an improved refrigerating apparatus having an improved heat exchanger and having improved means for defrosting the heat exchanger.

A further object is to provide a refrigerating unit having improved means for automatically defrosting the evaporator coils at predetermined intervals.

A further object is to provide an improved refrigerating unit having a forced air circulating means for transferring the heat from the article to be cooled to the evaporator coils of the unit.

A further object is to provide an improved refrigerating unit having means for heating the evaporator coils of the unit so as to defrost them readily.

A further object is to provide an improved refrigerating unit of the type using air as the heat transferring medium, in which means are provided automatically to circulate a limited quantity of air around the evaporator coils of the unit during the operation of defrosting.

A further object is to provide a combined evaporator and air blower unit in which the parts are arranged for high efficiency of heat exchange.

A further object is to provide an improved form of blower.

A further object is to provide improved control means for refrigerating apparatus.

Other objects will appear from the following description, reference being had to the accompanying drawings, in which:

Figure 1 is a broken sectional view of the combined evaporator coil and blower unit taken generally on the line 1—1 of Figure 2;

Figure 2 is a transverse vertical sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a fragmentary sectional view illustrating the blower construction;

Figure 4 is an enlarged longitudinal vertical sectional view of the blower portion of the unit;

Figure 5 is a fragmentary sectional view of a modified form of heat exchanger;

Figure 6 is a diagrammatic view of a complete cooling system incorporating the invention, showing particularly the electrical controls;

Figure 7 is a developed view illustrative of the coils of the evaporator; and,

Figure 8 is a side elevational view of the blower and heat exchange unit showing its driving motor.

Figure 9 is a schematic diagram of a modified form of my invention.

As best shown in Figs. 2, 3, 4, and 5, the blower unit comprises a casing having a cylindrical wall 10, which may be formed integrally with an inner end wall 12, the latter having an enlarged flanged inlet opening 14, an apertured bearing-supporting cup-shaped element 16 being welded or otherwise secured to the inner end wall 12. A suitably ribbed outer end wall 15 of the casing is secured to a flange on the cylindrical wall 10, and has a bearing box 18 welded or otherwise suitably secured at the center thereof. A bearing box 20 is similarly welded or secured to the bearing support 16. The bearing boxes 18 and 20 contain suitable antifriction bearings for a shaft 22, which, at its outer end, carries a pulley 24 driven by a belt 26 from an electric motor 28 (Fig. 8).

A plurality of rotor discs 30 are secured to hubs 32, which in turn are non-rotatably secured to the shaft 22. The left-most hub 32 (Fig. 4) is illustrated as being pinned to the shaft, whereas the remaining hubs 32 are provided with keyways to fit over a feather key 34 secured in the shaft 22. Each of the rotor discs 30 carries an annulus 36 which is held in parallel spaced relation with respect to the rotor disc 30 by a plurality of radial blades 38, the latter secured to the disc 30 and annulus 36 by welding, or, as illustrated, by rivets passing through flanges of the blades. Spaced between the rotors, each composed of a disc 30, its blades 38, and its annulus 36, is a deflector ring 40 having an annular flange 42 fitting snugly within the casing 10, the flanges 42 serving as a means to space the deflector rings 40 properly. Each of the deflector rings 40 is riveted to a partition plate 44, being spaced therefrom by a plurality of radial baffles 46. The parts 40, 44, and 46 may be riveted together, as illustrated, or may be welded together so as to form a rigid unit. The partition plates 44 are centrally apertured so as to leave a small amount of clearance around the adjacent hubs 32.

In assembling the blower, the shaft 22 may be inserted in the bearing box 20, the shaft having the left-most (Fig. 4) rotor disc secured thereto by the pin passing through its hub 32. Thereafter, one of the deflector rings 40 with its baffle 46 assembled therewith, is forced into the casing. This is followed by the assembly of another rotor disc 30 with its associated hub 32 upon the shaft 22, the feather key 34 permitting its hub to slide

along the shaft to its proper position adjacent the hub 32 which is pinned to the shaft. Thereafter, another deflector ring and baffle plate assembly 40, 42, 44, 46 may be pressed into the casing 10, with its flange 42 forming a substantially air-tight seal with the inner wall of the latter, and the parts thus successively assembled, whereupon the outer end wall 15 with its bearing box 18 is secured to the flange of the casing 10 and the pulley 24 pinned to the end of the shaft. The partitions 40 are provided with holes 51, and the inner end plate with a hole 53, to permit drainage of water from the blower casing. These holes are preferably so small that water will be retained therein by surface tension, and upon freezing, seal them. Even though they should not thus be sealed, they are so small as not to constitute serious air leakage paths.

Upon rotation of the shaft 22, air will be drawn into the casing through suitable inlet openings 48 formed in the bearing support 16, and, due to centrifugal action, be forced outwardly through the spaces between the plates 38 which connect the rotors 30 with their annular plates 36. The air thus ejected to the space around the peripheries of the rotors will be forced toward the center through the passageways between the baffles 46, the deflector ring 40, and partition plate 44, arresting the rotary motion of the air. The successive rotors will operate in a similar manner to cause flow of air under pressure from stage to stage in the direction indicated by the arrows in Fig. 4, the air finally being ejected from the casing through an outlet opening 50.

The blower unit is mounted at one end of an evaporator coil housing shown (Fig. 1) as comprising four concentric cylindrical walls 52, 54, 56, 58, and end walls 60 and 62. Suitably located between the cylindrical walls 52, 54, 56, 58, are helical evaporator coils 64, 66, and 68, these coils being connected together, as is clearly shown in Figure 7. These coils fit closely between the cylindrical walls 52—54, 54—56, 56—58, respectively, and successive turns thereof are spaced sufficiently to form connected helical air passageways between them. Commencing at the outlet 50 of the blower, this passageway extends between successive turns of the coil 64, through an opening 70 formed in the wall 54, in a reverse direction (to the right, Fig. 1) along the space between the turns of the coil 66, through an opening 72 formed in the wall 56, and thence to the left along the helical passageway between the turns of the coil 68, to an outlet 74. The walls 52, 54, 56, and 58 have small perforations 57 at their lowest points to permit drainage to a trough 59 which has a drain pipe 61 connected thereto. The perforations, like the holes 51 and 53, will usually seal themselves by the formation of ice, as soon as the unit is cooled upon recommencement of the refrigerating portion of the operating cycle.

Within the inner cylindrical wall 52 are two additional evaporator coil sections 76 and 78 which are concentrically arranged. The left-hand end of the coil 78 is connected by a suitable coupling 79 (Fig. 7) with the left-hand end of the coil 64 so that the coils 76, 78, 64, 66, and 68 form a continuous length of tubing which serves as the evaporator coil of a suitable mechanical refrigerating unit, indicated in Fig. 6 by the block 80. From this diagrammatic figure, it will be noted that the mechanical refrigerating unit has a tube 82 leading from the coil 76 to the refrigerating unit, and a pair of conduits 84, 85 which lead from the unit 80 to an expansion valve 86, the latter being connected to the end of the outer coil 68. The conduit 84 is connected to a suitable controlling thermostat.

Air is admitted to the left-hand end of the inner cylindrical wall 52 through a fitting 88 having a valve 90 therein. An inlet fitting 92 is connected to the valve fitting 88. A conduit 94 leads from the valve fitting 88 to the outlet 74, the upper end of the conduit 94 being normally closed by a valve 96. The valve 96 is carried by a valve stem 98, which has an arm 100 secured thereto, the arm 100 being connected by a link 102 with a similar arm 104 secured to a shaft 106, which carries the valve 90. A solenoid 108 has a plunger 110 which is connected by suitable linkage with an arm 112 which may be formed integrally with the arm 104. The plunger 110 is normally held in its lowermost position by gravity and by a spring 114 so as to hold the valves 90 and 96 in the positions in which they are shown in full lines in Fig. 1. Upon energization of the solenoid 108, the plunger will be swung upwardly, moving the valves 90 and 96 to the positions in which they are shown in dotted lines in Fig. 1.

Suitably secured upon brackets 116 welded to the inner surface of the end wall 60 is an electrical heating unit 118 mounted in a socket 120. A conduit 122 is provided for the current supply conductors 124 leading to the socket 120.

As diagrammatically illustrated in Fig. 6, the apparatus is connected for maintaining a refrigerating chamber 126 at a predetermined low temperature. The refrigerator cabinet 126 is illustrated as having perforated shelves 128 for supporting articles to be cooled or to be maintained at a low temperature, and is shown as being connected to the outlet 74 by a conduit 130 which leads from said outlet to the upper end of the cabinet 126, the air being withdrawn from the cabinet through a return conduit 132, which is connected with the inlet fitting 92.

Power is supplied to main conductors 134, 136 from a suitable source of power upon closure of the main control switch 138. Upon closure of this switch, under normal circumstances, the motor of the mechanical refrigerating unit 80 is supplied with current through normally closed relay contacts 139, 141. The unit 80 thus commences operating to compress the refrigerating medium withdrawn from the blower and evaporator coils through the conduit 82 and to cause the compressed gas or liquid to flow outwardly through the conduit 85 to the expansion valve 86.

Closure of the switch 138 also energizes an electric clock mechanism 137 which is of the program type, having switch mechanism to complete an electric circuit for a predetermined length of time at selected predetermined intervals. Upon closure of the circuit of the clock switch mechanism, the winding 140 of a relay is energized, causing separation of switch contacts 139—141, and causing engagement of the armature contact 139 with a fixed contact 142, thereby completing the circuit to the winding of solenoid 108.

A thermostatic control element 144 is located within the refrigerator chamber 126 at a point at which it is desired to maintain the lowest temperature, this element being adapted to operate a thermostatic switch 146 which is arranged to complete a circuit between the secondary winding of a power supply transformer 148 and the winding of a relay 150, the switch 152 of the latter being connected in series in one of the lines provided for supplying the motor 28 with power.

The motor 28 may also be energized through a parallel circuit including armature contact 139 and fixed contact 153 of relay 140, whenever the latter is energized.

In the operation of the apparatus, assuming that the switch 138 has been closed and that the temperature in the cabinet 126 is above the predetermined maximum temperature for which the thermostat 144, 146 is adjusted, the switch 152 will be closed and the motor 28 operating. At this time, the switch 139—142 will be open so that the solenoid 108 will be deenergized and the valves 90 and 96 will be in their full line positions (Fig. 1). Also, the switch 139—141 will be closed and the unit 80 thus operating. Under these circumstances, the blower will operate to exhaust air from the cabinet 126 through the conduit 132, drawing this air past the evaporator coils 76, 78, so as to pre-cool the air, and raise the air pressure by passing it through successive stages of the blower. The air is ejected under pressure through the outlet 56 and forced back and forth through the helical passageways formed between the turns of coils 64, 66, 68, to the outlet 74 and thence through conduit 136 to the cabinet 126. During the course of its flow around the evaporator coils, the air will be cooled efficiently to substantially the temperature of the outer-most coil 68 (which is at the lowest temperature), so that the air entering the top of the refrigerator cabinet will be at a sufficiently low temperature that frozen or frosted foods may readily be stored in the cabinet.

After a predetermined time interval, selected in the light of past experience with the rate at which the evaporator coils and connected parts become frosted, the program clock 137 will operate to energize the relay winding 140, closing switches 139—142 and 139—153, with consequent energization of solenoid 108, and also connecting the heater 118 to the current supply. If the switch 152 happens to be open at this time, the motor 28 will nevertheless be energized because of the completion of the parallel circuit through switch 139—153.

Energization of the solenoid 108 causes the valves 90 and 96 to shift from the positions in which they are shown in full lines in Fig. 1 to their dotted line positions, whereupon the blower unit will merely recirculate the air within the evaporator coil casings, past the energized heater 118, since the outlet 74 is connected directly to the inlet valve fitting 88, and the ends of the conduits 130 and 132 are closed by the valves. At the same time, the motor of the refrigerating unit 80 is deenergized, because of the opening of switch 139—141, so that defrosting will take place rapidly, the frost being melted from the evaporator coils and adjacent casing parts, and dripping through the small perforations 57 in the cylindrical walls 52, 54, 56, and 58 into the drain trough 59 to which the drain pipe 61 is connected. After the relay 142 has been energized for a sufficient length of time to permit complete defrosting of the evaporator and blower unit, the program clock 137 will open the circuit through the winding 140, whereupon the switch 139—141 will close and the motor of the refrigerating unit 80 will again be energized. The supply of current to the heating unit 118 will be interrupted, and the solenoid 108 deenergized to permit the valves 90, 96 to return to the positions in which they are shown in full lines in Fig. 1, under the influence of gravity and the force of the spring 114, thus completing the operating cycle of the apparatus.

The program clock 137 is of such type that it is capable of closing a circuit for a selected period of time at selected intervals. For example, the clock may be set to energize the winding 140 of the relay for a period of seven or eight minutes each twenty-four hours. It is, of course, preferable that the apparatus should not defrost too frequently, but sufficiently often to maintain reasonably high efficiency as a heat exchanger. The frequency with which it should be defrosted will, of course, depend upon the character of the refrigerating load upon the apparatus. If the apparatus is used to cool a chamber containing food in sealed packages, it will be apparent that defrosting will be necessary at very infrequent intervals, possibly only once a week or once a month, depending upon how often the chamber containing the foods is opened to admit atmospheric air. It will be noted that during the interval that defrosting is taking place, the supply of current to the motor of the refrigerating unit 80 is cut off so that defrosting may take place with great rapidity. For maximum speed in defrosting, the heater 118 should be of the highest wattage permitted by the power supply lines, so that the frost will be melted from the evaporator coils and blower parts as rapidly as possible, and thus prevent the temperature in the chamber 126 from rising appreciably. In order to prevent the heated air which is circulated through the blower and evaporating unit from being circulated through the chamber 126, the winding of the solenoid 108 may be controlled by the program clock 137 so as to be energized for a period of a few minutes after the supply of current to the heater 118 has been interrupted at the end of a defrosting operation. By thus delaying the operation of the valves 90, 96 for a short time after the completion of the defrosting operation, the blower and evaporator coil unit may be brought to a low temperature before the air circulated by the blower is permitted to flow to the chamber 126.

It will be understood that all of the connecting pipes and conduits which are at a low temperature will be suitably insulated to secure the highest efficiency.

In Fig. 5, is illustrated a modified form of the large diameter evaporator coils, to take the place of the coils 64, 66, 68. In this figure, the spaces between the shells 52—54, 54—56, and 56—58 are each divided into two helical passageways by a suitably formed generally corrugated sheet 160, one of the helical pasageways conveying the refrigerating medium and serving as a part of the evaporator coil system, while the other passageway serves as an air conduit for conveying air from the blower to the outlet conduit 130. The ends of the two passageways may be suitably connected with the corresponding passageways formed between the adjacent shells so that the three pairs of passageways between the four shells will, in effect, form two continuous passageways adjacent each other throughout their length. The shell 160 is preferably seam-welded to the adjacent shells 52, 54, 56, or 58, and for this purpose it may be desirable to form the shell 160 with beads 162 so that fluid-tight seals may be obtained by welding.

In Fig. 9, I have shown a modified form of my invention including an improved form of control mechanism and circuits and an improved form of heat exchanger. In this modified form,

the invention is illustrated as of general application, for cooling any type of chamber, or for air conditioning enclosures.

The heat exchanger 170 shown in Fig. 9 comprises a suitable casing 171 which is provided with a central partition 172 and inwardly projecting baffle walls 174. Baffles 176 project inwardly from the casing 171 so as to provide a circuitous air passageway through the casing 171, as indicated by the arrows. Each section of this passageway has a portion of the conduit 178 extending transversely therethrough, the conduit 178 being representative of the evaporator coil of a mechanical refrigerating unit 180 which is driven by a motor 182. The portions of the conduit 178 within the heat exchanger 170 are provided with radially projecting heat collecting wires 184, or may be provided with the usual heat conducting fins.

Air from a chamber 186 which is to be cooled is circulated through the heat exchange device 170 by a blower 188 driven by a motor 190. The outlet of the blower is connected to a heating chamber 192 by a conduit 194, the heating chamber 192 being connected to the inlet of the casing 171 by an inlet conduit 196. An outlet conduit 198 connects the outlet of the casing 170 with a valve chamber 200. The valve chamber 200 is connected to the inlet of the blower 188 by a conduit 202. Valves 204, 205, 206, illustrated as of the butterfly type, are arranged to be operated by a solenoid 208 through a suitable linkage, including arms 210 connected to the pivoted stems of the valves. A spring 211 is provided to hold these valves in normal full-line position. The valve 204 is adapted to control the flow from the conduit 198, to the chamber 186, while the valve 205 controls the flow from this conduit to the valve chamber 200 and hence to the blower inlet conduit 202. The valve 206 controls the flow from the chamber 186 to be cooled to the inlet conduit 202 of the blower.

A deflector valve 212 is mounted for rotation on a pivot 214 and is adapted to be manually operated by means of a handle 216. This valve is so arranged that it may, when in the full-line position shown, cause all of the air flowing past the valve 206 to be drawn from the chamber to be cooled, or when in dotted line position, cause all of the air drawn past the valve 206 to be drawn from the atmosphere. The valve 212 and its associated operating mechanism is, of course, provided whenever the apparatus is to be used for air conditioning or similar purposes where it may be desired to have the system operating wholly on the recirculating principle, using fresh air only, or using part recirculated and part fresh air.

Within the chamber 186 is a thermostat 218 which controls the energization of a relay 220, the switch contacts 221 are in series with the circuit for energizing the blower motor 190 and are opened whenever the relay is energized.

An electrical heating unit 222 is located in the heating chamber 192 so as to heat the air forced through this chamber by the blower 188. A synchronous motor, together with a reduction gearing, providing an intermittent drive for a shaft 224 is diagrammatically represented at 226 and is connected to the distributing conductors 228 and 229 which are normally supplied with power when a switch 227 is closed to connect these conductors to the power lines. The shaft 224 has secured thereto five interrupter cams 230, 231, 232, 233, and 234 which are adapted to engage followers 236 connected to switch arms 240, 241, 242, 243, and 244, respectively. The intermittent gearing 226 is arranged to rotate the shaft 224 slowly, as for example, one revolution in eight minutes, and upon completion of one revolution, to permit the shaft to rest for an extended period, for example, twenty-four hours, depending upon the frequency with which it is desired to defrost the heat exchanger 170, as determined by the particular refrigerating load to which the apparatus is connected.

The switch 240, upon closure thereof by its cam 230, is adapted to complete a circuit from the power supply line 228 through the winding of solenoid 208, and hence to the power supply conductor 229.

The switch 241, upon closure thereof by its cam 231, is adapted to complete a circuit from the conductor 228 through the winding of relay 220 and thermostat 218 to the conductor 229, provided that the thermostat 218 is closed.

The switch 242, when closed by its cam 232, is arranged to complete a circuit from the conductor 228 to the switch contacts 221 of relay 220 and, providing said relay is energized, through the blower motor 190 to the conductor 229.

The switch 243, upon closure by its cam 233, is adapted to complete a circuit from the conductor 228 through the electrical resistance heater 222 to the conductor 229.

The switch 244, upon being closed by its cam 234, completes a circuit from the conductor 238 through the refrigerating unit motor 182 to the conductor 229.

The cams 230 to 234 are shown in the positions they assume when the apparatus is operating normally, i. e., defrosting is not taking place. Upon completion of the interval for normal operation as an apparatus to cool the contents of the chamber 186, the shaft 224 will commerce rotating at a speed which it will be assumed, for purposes of illustration, to be at one-eighth of a revolution per minute.

During the first minute following commencement of the defrosting operation, it will be noted that the valves 204, 205, 206, will be moved from the positions in which they are shown in full lines to the positions in which they are illustrated in dotted lines because of the energization of solenoid 208. As a result, the blower will draw the air directly from the conduit 198 past the open valve 205 and through the inlet conduit 202. The blower will discharge the air through the heating chamber 192 to the exchanger 170. Also, during this first minute, the switch 241 will open, thus deenergizing the circuit to the thermostat 218 and permitting the relay switch 202 to close, irrespective of the temperature in the chamber 186. Likewise during the first minute of the defrosting operation, the switch 242 will open, thus deenergizing the circuit for supplying current to the blower motor 190. During this first minute of defrosting, the switch 243 will close, energizing the resistance heater 222. Also, during this first minute, the switch 244 will open, thus deenergizing the motor 182 of the refrigerating unit.

During the second minute of the defrosting operation, the switch 242 will again be closed, thus energizing the blower motor 190 and causing circulation of air heated by the resistance heater 222 through the heat exchanger 170.

During the fifth minute of the defrosting operation, the heater will be deenergized and the

blower motor deenergized due to the opening of switches 243 and 242.

During the sixth minute of the defrosting operation, the switch 244 will again be closed, causing the refrigerating unit 180 to commence operation through energization of its driving motor 182.

During the eighth minute of the defrosting operation, the switch 240 will be opened, deenergizing the relay 208 and permitting the spring 211 to return the valves 204, 205, and 206 to the positions in which they are shown in full lines. The switch 241 will be closed, thereby establishing a supply circuit for the thermostat 218. At the same time, the blower motor 190 will be again energized by the closing of switch 242.

From the foregoing, it will appear that during the defrosting operation, the air will be circulated solely through the heat exchanger 170, and during the first portion of the cycle, will be heated by the heater 222, causing the melting of the frost from the internal surfaces of the heat exchanger. The melted frost may drain through suitable openings formed in the partition 172 and the bottom of the casing 171 to a suitable drain pipe. After the time has been allowed for the draining of the melted frost, the parts are reenergized for normal operation, as above described.

Some of the circuits, particularly those which supply the motors 182, 190, and heater 222, will in actual practice be completed by relays energized by the closure of switches 242, 244, and 243 respectively, so that the latter switches may be of small current carrying capacity, since they will not carry heavy loads. Such relays will preferably be so arranged that they will be required to be energized only during parts of the relatively short defrosting periods.

Under certain circumstances, particularly where the chamber 186 to be cooled is a room which is to be air conditioned, it may not be necessary to utilize the heater 222 in the circuit, since the air drawn from the chamber will be warm enough to melt the frost from the heat chamber. It will be noted that apertures are provided in all of the horizontal sections of the baffle wall 172 and in the bottom of the casing 169. These apertures permit the melted frost to flow to the drain pipe. Ordinarily, sufficient water will collect in these small apertures due to capillary attraction so that when the refrigerant is again supplied to the heat exchanger, the water in these apertures will freeze, thereby sealing them.

While I have shown and described particular forms of my invention, it will be apparent to those skilled in the art that numerous modifications and variations may be made in the structure thereof without departing from the underlying principles of the invention. I therefore desire, by the following claims, to include within the scope of my invention, all such similar and modified variants of the invention by which substantially the same results may be obtained through the use of substantially the same or equivalent means.

I claim:

1. In a refrigerating system, the combination of a chamber having a space to be cooled, a heat exchanger having generally parallel passageways therethrough for the circulation of air and refrigerant in heat exchange relationship, means to supply a refrigerating medium to said heat exchanger, a blower for circulating air serially through said heat exchanger and said chamber, automatically operable means for limiting the circulation of air by said blower to flow through said heat exchanger during a fixed interval in a refrigerating cycle of predetermined length, and means to heat said heat exchanger while the air is limited to flow therethrough.

2. In a refrigerating system, the combination of a casing, a plurality of concentric cylindrical shells in said casing, a plurality of helical coils of tubing located between said shells and in heat conducting relationship therewith, means for circulating a cooling medium through said coils, and means for circulating air to be cooled through the helical spaces between the turns of said coils.

3. In a refrigerating system; the combination of a plurality of spaced concentric metal cylindrical shells, a length of tubing formed in a plurality of connected concentric helical coils located respectively between pairs of said cylindrical shells, means for circulating a cooling medium through said tubing, and means for circulating air through the helical passageways formed between the said helical coils and said shells.

4. In an apparatus for maintaining a chamber at a relatively low temperature, the combination of a refrigerating means, electrical means controlling the operation of said refrigerating means, a blower connected to circulate air past said refrigerating means, electrical means controlling the operation of said blower, means to heat the air supplied to said refrigerating means by said blower, conduits connecting said chamber and refrigerating means, a valve mechanism for connecting said conduits together and cutting off communication between said conduits and said chamber, electromagnetic means for actuating said valve mechanism, a plurality of switches, a plurality of switch actuators, means to operate said actuators in a predetermined sequence at periodic intervals, and circuits connecting said switches and a source of power in series respectively with said electromagnetic means, said means for controlling the operation of said blower, said heating means, and said means for controlling the operation of said refrigerating means.

5. In a system for maintaining a space at a relatively low temperature, the combination of a heat exchanger, a refrigerating unit connected to said heat exchanger, a motor for driving said refrigerating unit, conduits for conveying air to and from said heat exchanger for cooling by said refrigerating unit, air circulating means in one of said conduits, a motor for driving said circulating means, means connecting the ends of said conduits respectively to the space to be cooled, valve means having two operative positions, in one of which said conduits are connected respectively to said space through said last named means and in the other position of which the ends of said conduits are connected together and disconnected from said space, an electrically operated heater, and automatically operable means to move said valves to said second position and to energize said electrical heater and said motor, whereby said air circulating means will circulate air past said heater and through said heat exchanger without flowing through the space to be cooled.

6. In a refrigerating system, the combination

of a heat exchanger having generally parallel passageways separated by heat conducting walls, said passageways having inlets and outlets, one of said passageways serving to convey a refrigerating medium and the other of said passageways serving to convey air to be cooled, a blower for forcing air through said air passageway, a chamber to be cooled, conduits respectively connecting the inlet and outlet ends of said air passageway with said chamber, a heater located adjacent the inlet to said air passageway, and time controlled means operable automatically to prevent the flow of air through said conduits and to connect the inlet and outlet ends of said air passageway together to form a short-circuit path for the air impelled by said blower past said heater.

7. In a refrigerating system, the combination of a heat exchanger having heat conducting walls forming separate generally parallel passageways, said passageways having inlet and outlet ends, one of said passageways serving to convey a refrigerating medium and the other of said passageways serving to convey air to be cooled, means for forcing air through said air passageway, conduits connecting a chamber to be cooled respectively to the inlet and outlet ends of said air passageway, a heater located in said air passageway, time responsive means operable periodically to prevent the flow of air through said conduits and to connect the inlet and outlet ends of said air passageway together to form a short-circuit path for the flow of air impelled by said blower past said heater, and means for energizing said heater only during the periods that the inlet and outlet ends of said air passageway are connected together.

8. In an apparatus for maintaining a refrigerating cabinet at a relatively low temperature, the combination of a refrigerating unit having a cooling element, a blower connected to withdraw air from said chamber, circulate it past said element and return air to said chamber, automatically operable means to prevent the flow of air to and from said chamber and to cause the air impelled by said blower to flow solely through said refrigerating unit, said last named means being operable during a predetermined period of the operating cycle of the apparatus, means adjacent the blower to heat the air impelled thereby, and control means to cause energization of said heater for a period commencing simultaneously with the said period of the operating cycle but terminating prior to the termination of said period, whereby said blower will continue to circulate air through said refrigerating unit for a length of time after said heating means has been deenergized.

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