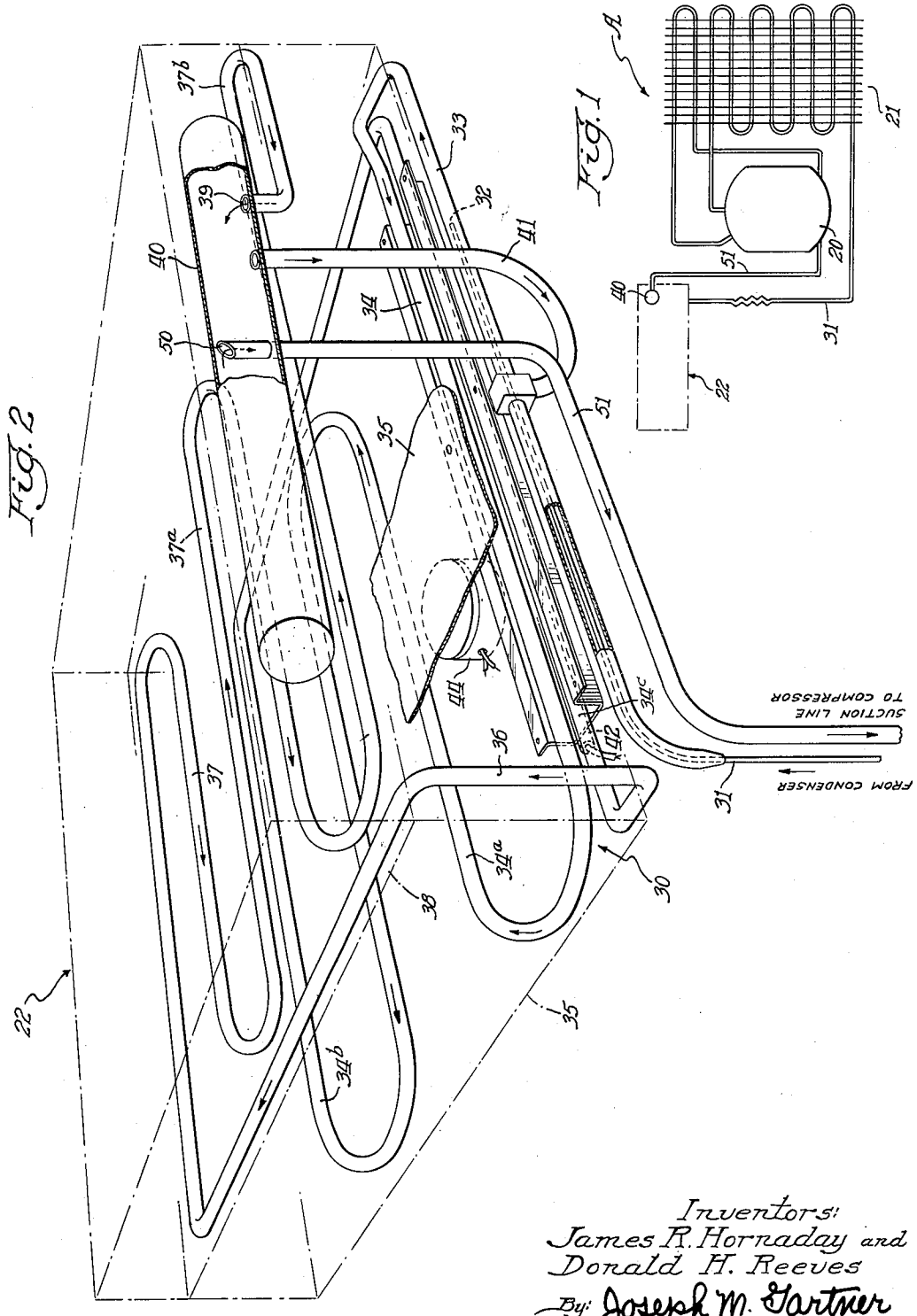
Sept. 20, 1955 J. R. HORNADAY ET AL 2,718,121

REFRIGERATING APPARATUS

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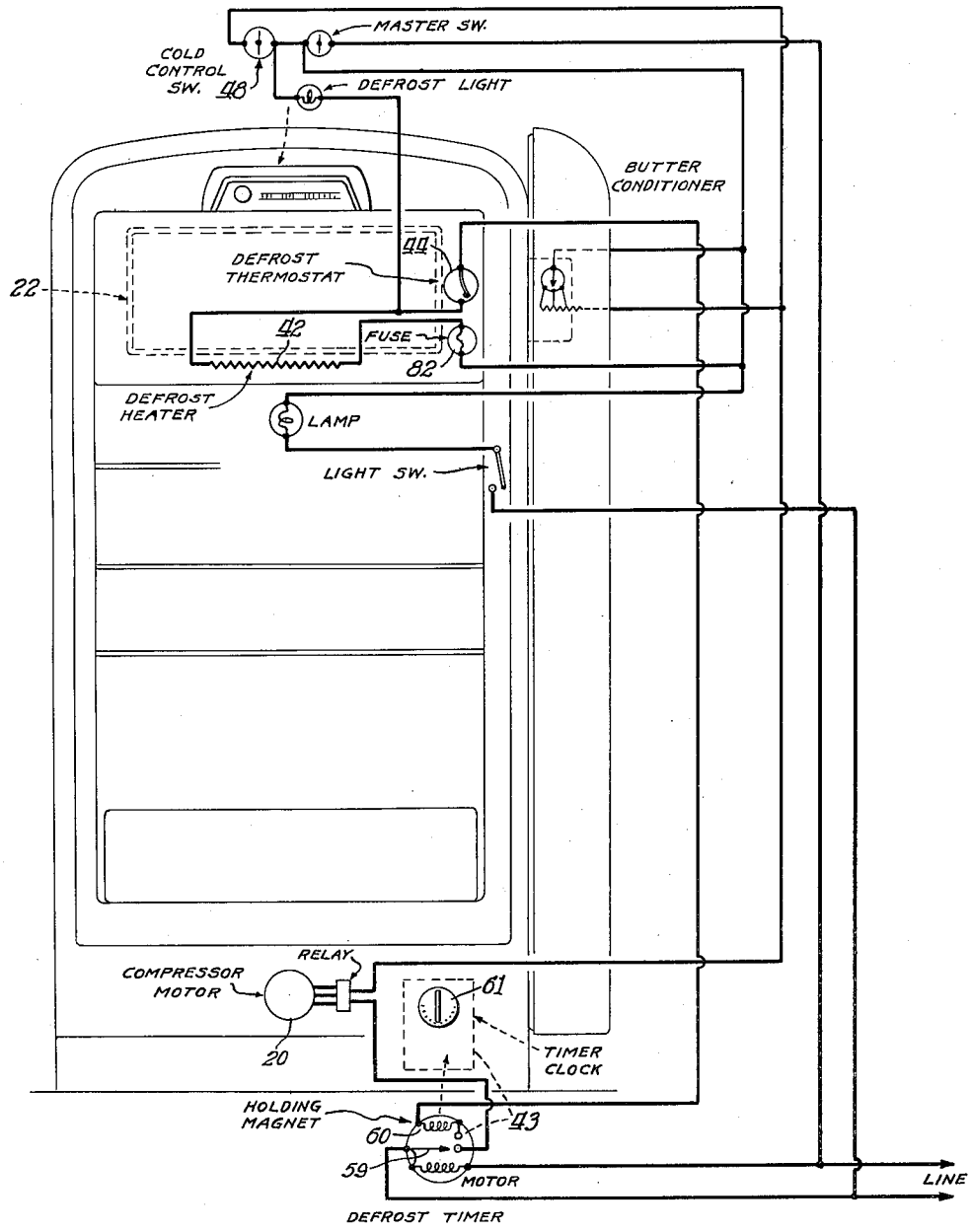
Inventors:
James R. Hornaday and
Donald H. Reeves
By: Joseph M. Gartner
Atty.

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Fig. 3



Inventors:
James R. Hornaday and
Donald H. Reeves
By: Joseph M. Gartner
Atty

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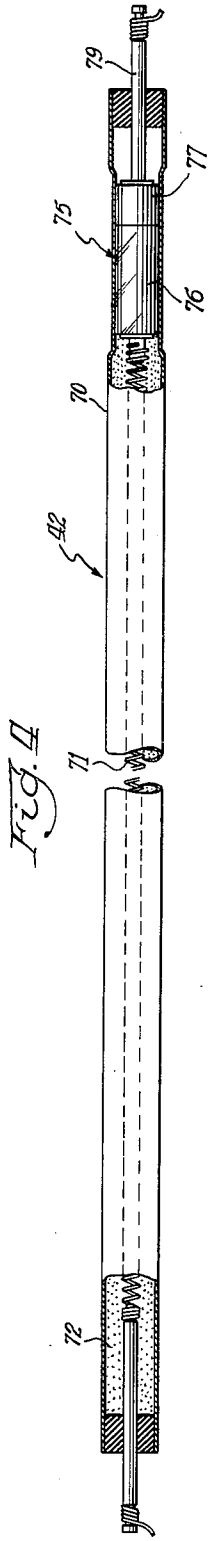


Fig. 4

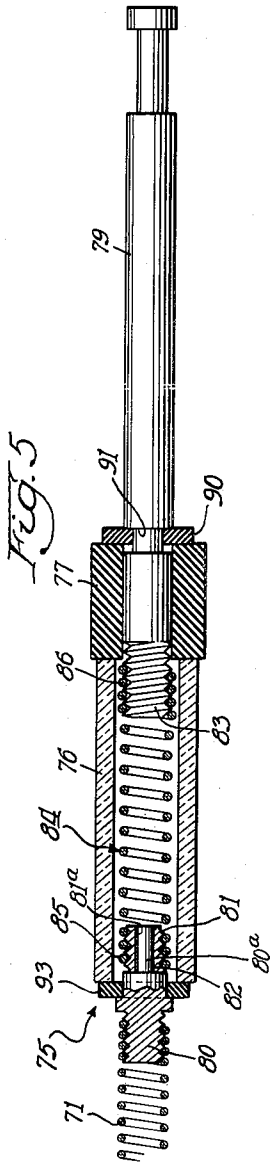


Fig. 5

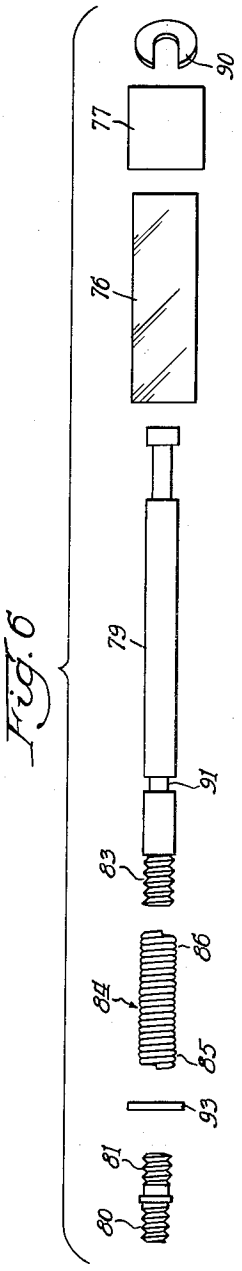


Fig. 6

Inventors:
James R. Hornaday and
Donald H. Reeves
By: Joseph M. Gartner
Atty

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REFRIGERATING APPARATUS

James R. Hornaday, North Muskegon, and Donald H. Reeves, Muskegon, Mich., assignors to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

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4 Claims. (Cl. 62—4)

This invention relates to refrigerating apparatus and more particularly to refrigerating systems which are provided with means for automatically defrosting the evaporating means at timed intervals.

Otherwise stated, the invention is concerned with a refrigerator control system, particularly a system adapted to supplement the normal control means, and has for its principal object and accomplishment the provision of a defrosting system wherein the actual duration of a selected defrosting interval is automatically varied in accordance with the requirements of the refrigerator instead of being arbitrarily fixed for a definite period of time as in the usual prior art defrosting systems.

More specifically stated, the invention contemplates the provision of a defrosting system for a refrigerator by the employment of heat and a novel control system therefor whereby the heat source is energized by a timed control mechanism and deenergized by a predetermined rise in temperature effecting operation of a thermal responsive means.

To this end the invention seeks to provide an automatic refrigerator comprising an evaporator unit and having means normally controlling the circulation of refrigerant in said evaporator unit, a heating element disposed adjacent portions of said evaporator unit and adapted to warm the refrigerant contained in said evaporator unit, control means operable at predetermined intervals to render ineffective the operation of said normal control means and simultaneously therewith control energization of said heating element, and thermal responsive means for controlling the duration of the period wherein the operation of the normal means is ineffective and operable to restore control of circulation of refrigerant in said evaporator unit to said normal control means.

It is customary in refrigeration to maintain the evaporating means at freezing temperatures. This causes the accumulation of frost upon the evaporating means which acts as insulation and thereby reduces the efficiency and capacity of the refrigerating system. It is, therefore, desirable that this accumulation of frost be kept at a minimum and periodic defrosting of the refrigerating system is necessary. Heretofore, defrosting of the system was accomplished by stopping the apparatus for a period of time and after the accumulation of frost is melted the refrigerating apparatus is again started, these operations being accomplished manually. It is notable that the starting and stopping of the refrigerating system for defrosting purposes has also been accomplished by means of a clock mechanism which is adapted to stop the mechanism at regular intervals, this system being clearly illustrated, for example, in the J. C. Buchanan et al. Patent No. 2,429,449 issued October 21, 1947.

Heretofore, automatic defrosting systems have employed time switches which open a circuit, dead or alive, at a certain time and, in like manner, close at the end of a fixed interval. Such switches have been known to be comparatively expensive and require relatively powerful clock movements to open and close the switches.

Moreover, the clock movements were required to be very rugged and strong to open circuits carrying motors under load or receiving initial starting inrushes.

The present invention contemplates the provision of a cut-out mechanism combining both mechanical and electro-magnetic action effective to open the compressor motor circuit during the interval of the defrosting cycle thereby preventing normal circulation of the refrigerant for that interval.

It is preferred to provide a daily defrosting cycle of sufficient average duration to defrost the coils, keep the ice drawers and the drawer frame reasonably free of ice, and yet not long enough to allow the refrigerator temperature to rise too high for the ice cubes to melt.

It is an important object and accomplishment of the invention to provide a novel automatic defrosting system for a refrigerator and which is simple to operate and rugged and reliable in use.

An ancillary object and accomplishment of the invention is to provide a new and improved defrosting mechanism for a refrigerating apparatus and which is adapted to be economically manufactured and which is so designed as to permit the manufacture and assembly thereof in accordance with present day large scale mass production manufacturing methods of construction and assembly.

Another important object and accomplishment of the invention is to provide an automatic refrigerating system which includes an evaporator unit having refrigerant conduits thereon, a refrigerant circulating in said conduits, heating means disposed adjacent to at least one portion of said refrigerant containing conduits to warm the refrigerant contained therein, and defrosting means utilizing the circulation of said warmed refrigerant through said conduits to transmit the heat from the heating means throughout the refrigerant containing conduits and said evaporating unit for defrost purposes.

A further object and accomplishment of the invention is to provide in a refrigerating system including an evaporator unit having conduits for refrigerant thereon and a refrigerant circulating in said conduits, defrosting means including heating means adjacent to more than one portion of said conduits for warming the refrigerant and arranged so that defrosting portions of said conduits are intermediate of said several refrigerant warming portions of the conduits.

The invention seeks, as a final object and accomplishment, to provide a defrosting system of the character indicated and which is particularly characterized by a design arrangement to more advantageously and satisfactorily perform the functions required of it and adapted to provide a compact unit which will successfully combine the factors of structural simplicity and durability, and yet be economical to manufacture.

Additional objects, features and advantages of the invention disclosed herein will be apparent to persons skilled in the art after the construction and operation are understood from the within description. It is preferred to accomplish the various objects of this invention and to practice the same in substantially the manner as hereinafter more fully described, and as more particularly pointed out in the appended claims.

Embodiments of the invention are illustrated in the accompanying drawings forming a part hereof and wherein:

Fig. 1 is a diagrammatic view illustrating the mechanical apparatus employed in a refrigerating system with which the present defroster mechanism may be adjunctively employed to advantage;

Fig. 2 is a perspective view of the defroster system embodying the features of the present invention;

Fig. 3 is a wiring diagram disposed compositely upon

one form of refrigerator with which the present invention may be advantageously employed;

Fig. 4 is an elevational view of a heater element which forms an important component part of the subject defroster system, this view having portions thereof shown in section to more clearly illustrate the internal construction thereof;

Fig. 5 is a sectional view illustrating a fusible link forming an important component part of the heater disclosed in Fig. 4; and

Fig. 6 is an exploded view of some of the important component parts of the fusible link illustrated in Fig. 5.

The drawings are to be understood to be more or less of a schematic character for the purpose of illustrating and disclosing a typical or preferred form of the improvements contemplated herein and in the drawings like reference characters identify the same parts in the several views.

Referring to the drawings, particularly Fig. 1, there is illustrated diagrammatically a refrigerating apparatus designated in its entirety by the letter A and which may comprise a motor driven compressor **20**, a condenser **21**, and an evaporator **22**. The described system may be of the compressor-condenser-expander type wherein refrigerant is circulated by means of the compressor **20** through the condenser **21** for extracting or dissipating heat from the refrigerant medium and thence to a freezer or evaporator **22** in which the refrigerant medium is expanded or vaporized for absorbing heat and refrigerant medium is thereafter returned to the compressor from whence the cycle is repeated.

The defroster mechanism with which the present invention is particularly concerned is illustrated in Fig. 2 and designated in its entirety by the numeral **30**. In Fig. 2 it can be seen that the defroster mechanism **30** is operatively associated with the evaporator **22** forming a component part of the refrigerating system A as illustrated in Fig. 1.

Suffice it to say, since the invention is not particularly concerned with the precise construction of the refrigerating system A as diagrammatically illustrated in Fig. 1, and/or its associated parts, they will not be further described in detail, and it is deemed sufficient for all intentions and purposes herein contained to show only portions thereof adjacent to and cooperating with the defrosting system **30** with which the invention is particularly concerned.

Having thus described, by way of example, a possible adaptation of the defroster mechanism **30** and the general environment surrounding said adaptation, the specific details of construction and cooperating functions of the various parts of the defrosting mechanism **30** with which the present invention is particularly concerned, will now be described in detail.

In the exemplary embodiment of the invention depicted in Fig. 2, the defrosting mechanism **30** as associated with the evaporator **22**, comprises, in general, a refrigerant inlet **31** upper end portions of which are received into a refrigerant conduit **33**, said inlet and said conduit being arranged for cooperative co-action to impart a jet action to the refrigerant as it leaves the inlet and enters the conduit, this being an important feature of the invention and will be more fully described hereinafter, a refrigerant conduit **34** forming a continuation of the conduit **33** and formed to define a substantially serpentine shape as at **34***a* and **34***b* and disposed in thermal contact with the lower shelf **35** of the evaporator **22**, a refrigerant conduit **36** as a continuation of the refrigerant conduit **34** but formed to define a vertical leg, a refrigerant conduit **37** forming a continuation of said conduit **36** and formed to define a substantially serpentine shape as at **37***a* and **37***b* and disposed in thermal contact with an intermediate shelf **38** of the evaporator **22**, said refrigerant conduit **37** terminating as at **39** into an accumulator **40**, a refrigerant conduit

41 connected between said accumulator **40** and said refrigerant conduit **33**, and an electrically operated heating element **42** disposed adjacent portions of said refrigerant conduit **34** and carried by the evaporator shelf **35**, said heater element **42** being electrically energized responsive to operation of a timed control mechanism **43** and deenergized responsive to predetermined temperature settings of a thermostat element **44** wired in circuit with said timed control mechanism and carried by the lower shelf **35** of the evaporator **22** and disposed adjacent said heating element **42**.

It is important to note that during the normal refrigerating cycle the refrigerant enters the evaporator **22** from the condenser **21** via the refrigerant inlet conduit **31** which discharges as at **32** into the refrigerant conduit **33** where the refrigerant will be forced by a jet action to continue in its circuitous path through the refrigerant conduit **34** and portions thereof as at **34***a* and **34***b* and then flow into the refrigerant conduit **36** which defines a vertical leg whereby the refrigerant is carried upwardly in the evaporator **22** for disposition into a refrigerant conduit **37**, the end portions **39** of which open into an accumulator **40** where the refrigerant may be sucked as at **50** into a suction line **51** by which it is returned to the compressor **20** and wherein the refrigerant is compressed for a recycle through the system.

For a proper understanding of the important operational concepts of the subject defrosting system, it must be remembered that time starts the defrosting cycle while temperature stops the defrosting cycle. Otherwise stated, the time control mechanism **43** will operate to start the defrosting cycle in accordance with a predetermined setting which may be manually variable in accordance with the desires of the user or may be set for operation at a predetermined time every twenty-four hours. The invention contemplates the provision of temperature responsive means such as the thermostat element **44** which is wired in circuit with the timed control mechanism **43** and which is operable to stop the defrosting cycle and effect the conditioning of the refrigerating system for normal operation wherein the conventional cold control thermostat will have prominent control to regulate operation of the refrigerating system responsive to temperature requirements in the food compartment of the refrigerator.

In accordance with the teachings of the present invention the compressor motor does not run during the defrosting cycle, the interruption of the electric current to the compressor motor being accomplished by a cam means forming a part of the timed control mechanism **43** and adapted for predetermined engagement with portions of the electrical switch **59** to open this particular circuit, and said electrical switch **59** being held in this open position by the holding magnet **60** (Fig. 3) which is operable during the defrosting cycle and which is set in its operation by the timed control mechanism **43**. Completion of the defrosting cycle responsive to predetermined operation of the thermostat element **44** will effect inoperation of the holding magnet **60** which is effective to place the system in condition for normal operation wherein the conventional cold control thermostat **48** (Fig. 3) will have prominent control.

It is important to understand that the user may start the defrosting cycle at any time by turning the defrost timer dial **61** one complete revolution. This dial is a part of the timed control mechanism **43**. Rotation of the dial as aforesaid will start the defrost cycle as hereinbefore described and the defrost cycle will be stopped automatically responsive to a predetermined rise in temperature which is effective to cause operation of the thermostat element **44**.

The defrost cycle may be described as follows: When the timed control mechanism **43** is properly positioned for defrosting, the cam means forming a part of the timed control means **43** will become engaged with portions of the electrical switch **59** to open this particular circuit, and

said electrical switch will be held in this open position by the holding magnet **60** whereby to cause inoperation of the compressor motor **20** and simultaneously the heating element **42** associated with the evaporator **22** is electrically charged and operable to heat refrigerant passing through the refrigerant conduit **34** because of the close association of these parts. Otherwise stated, the timed control mechanism **43** controls the operation of two things automatically and simultaneously. For example, electric current is turned off to the compressor motor **20** and turned on to the heating element **42**. Although the compressor motor **20** remains off during the defrosting cycle, high pressure in the condenser **21** forces the liquid refrigerant through the inlet conduit **31** and into the evaporator tubing comprising refrigerant conduits **33**, **34**, **34***a*, **36** and **37**.

It is important to note that the refrigerant is heated twice, once when it enters the evaporator from the conduit portion **33** and flows into the conduit **34** which is disposed adjacent the heating element **42** as can be seen in Fig. 2, and again after the refrigerant passes through conduits **34***a* and **34***b* it will return to make a second pass adjacent the heating element **42** via the conduit portion **34***c*. As the refrigerant flows through the conduit portion **34***c* it will receive a second charge of heat for transmission thereof via the vertical leg **36** to the refrigerant conduits **37**, **37***a* and **37***b*.

It is well known that a liquid, when warm, is lighter than when it is cold. Therefore, the refrigerant warmed by the heater **42** as it passes through conduit portion **34***c* tends to rise through conduit **36** while the refrigerant in the accumulator **40** which has been cooled in passing through conduit **37**, tends to fall through conduit **41**, thus causing a thermal circulation of the refrigerant which augments the circulation caused by the refrigerant entering conduit **33** through the inlet conduit **31** effected by the higher residual pressure in the condenser.

Although the compressor remains off during the defrosting cycle there remains a high residual pressure in the condenser which causes a continuous flow of refrigerant liquid into the refrigerant conduit **33** from the refrigerant inlet conduit **31**.

It is important that the relative disposition of the inlet conduit **31** with respect to the refrigerant conduit **33** be arranged so that the end portions as at **32** of the refrigerant inlet conduit **31** will impart a jet-like action to the refrigerant during the defrosting cycle effected by the residual high pressure of the refrigerant in the condenser whereby to cause the warm liquid refrigerant to circulate through the bottom evaporator shelf **35** and then circulate through the ice tray shelf **38** above. Recirculation of the refrigerant within the confines of the evaporator **22** is accomplished by the provision of the refrigerant conduit **41** which is connected to and opens from the accumulator for receipt of refrigerant therefrom whereby to convey the same into the conduit **33** and, because of the jet-like action of the refrigerant coming from the end portions of the inlet conduit **31** as at **32**, the refrigerant entering the conduit **33** from the conduit **41** will be drawn to move in the direction of the arrows through the conduit **34** whereupon the cycle is repeated. Each time the liquid refrigerant passes the heating element area and through conduits **34***a* and **34***c* and becomes warmer, the rate of flow is again augmented by virtue of the warmed liquid tending to rise. Thus, it can be seen that there is a pronounced circulation of refrigerant through the evaporator conduits responsive to the coaction of the jet flow and the heating element in providing warmed liquid refrigerant.

As is well known, the undesirable frost accumulations sought to be removed will naturally be disposed on the evaporator walls and on or adjacent to the refrigerant tubes associated with the evaporator. Thus, the heated refrigerant passing through these conduits will quickly melt any frost accumulation and thereby accomplishing the defrosting action.

When the liquid refrigerant reaches a temperature of approximately 32 degrees, the ice and frost accumulations will melt rapidly from the evaporator. The length of time for the defrosting cycle will vary in accordance with the frost accumulation. There are many factors which govern the amount of frost accumulation such as, for example, the relative humidity in the room where the refrigerator is used, the number of times the door is opened, and the amount of uncovered food disposed in the food compartment of the refrigerator. All of these factors have a direct bearing on the amount of frost and frost thickness governs the length of defrosting time. However, regardless of the time required, ice cream, frozen foods and desserts remain frozen during the defrosting cycle. The holding temperature within the freezer or evaporator **22** only varies a few degrees during the defrosting cycle.

During the defrosting cycle the warmed liquid refrigerant circulates in the conduits associated with the evaporator and does not flow into the compressor or condenser because refrigerant at defrosting temperatures is under a lower pressure than the refrigerant in the compressor and condenser, and it is well known that low pressure refrigerant will not go into a high pressure area of its own accord.

As the frost accumulation melts and drops away from the evaporator the heating element **42** and the thermostat element **44** rapidly increase in temperature, until the thermostat reaches its predetermined high point setting at which temperature the thermostat element **44** opens the electrical circuit to stop the defrost operation and, simultaneously therewith, conditions the refrigerating system for normal operation where the conventional cold control thermostat **48** will have prominent control.

Thus, it can be seen, that the subject invention provides an automatic refrigerator comprising an evaporator unit **22** and having means **48** normally controlling the circulation of refrigerant in said evaporator unit, a heating element **42** disposed adjacent portions of said evaporator unit **22** and adapted to warm the refrigerant contained in said evaporator unit, control means **43** operable at predetermined intervals to render ineffective the operation of said normal control means **48** and simultaneously therewith control energization of said heating element **42**, and thermal responsive means **44** for controlling the duration of the period wherein the operation of the normal control means **48** is ineffective and operable to restore control of the circulation of refrigerant in said evaporator unit **22** to said normal control means **48**.

In Figs. 5 and 6 it can be seen that the fuse **75** comprises an insulating casing **76** of generally tubular shape, a tubular washer **77** formed of rubber-like material the outer periphery of which is adapted to be press fitted into portions of the casing **70** as illustrated in Fig. 4, thereby to prevent axial movement of these parts when finally assembled in the casing **70**, a stud-like terminal **79**, a stud **80** formed to define the shape substantially as illustrated in Fig. 5 and having a projecting shank portion **80***a*, a bushing **81** having a central through bore **81***a* adapted to receive the projecting shank portions **80***a*, a heat responsive fusible material **82** disposed between the adjacent surfaces of said projecting shank **80***a* and the through bore **81***a* to hold these elements together, said terminal **79** having end portions **83** arranged to project into the casing **76**, and a spring **84** the opposite end portions **85** and **86** of which being respectively screwed on the threaded portions of the bushing **81** and the threaded end portions **83** of the terminal **79**.

It is preferable that the heat responsive fusible material **82** be formed of a eutectic solder having a predetermined melting temperature. This type of solder has been selected because it will not soften or flow under the selected predetermined temperature and upon reaching this temperature will immediately flow.

A thrust washer **90** is disposed in a recess **91** of the terminal **79** and is in engagement with an end wall of the tubular washer **77** thereby to prevent axial movement

toward the left, as seen in Fig. 5, of the terminal 79 responsive to pulling power effected by the spring 84. In like manner, in order to prevent relative axial movement of the stud 80 there is provided the thrust washer 93 adapted to engage the end wall of the casing 76.

The assembly is maintained in position as shown in Fig. 5 during normal operation, but in the event that the heater or any of the component parts of the defrosting system should become defective and cause an overheating of the heater, the heat responsive fusible material 82 will melt upon reaching the predetermined melting temperature whereupon the connection between the stud 80 and the bushing 81 will be broken and with the cooperation and coaction of the pulling power of the spring 84, the bushing will be pulled to the right as shown in Fig. 4, thus breaking all electrical connections through the heater.

From the foregoing disclosure it may be observed that we have provided an improved defrosting mechanism which efficiently fulfills the objects thereof as hereinbefore stated and which provides numerous advantages which may be summarized as follows:

1. Structurally simple, efficient and durable;

2. Economical to manufacture and readily adaptable to mass production manufacturing principles; and

3. The provision of a defrosting system wherein the actual duration of a selected defrosting interval is automatically varied in accordance with the requirements of the refrigerator instead of being arbitrarily fixed for a definite period of time, the start of the defrosting cycle being determined and effected by a timed control mechanism and the stopping of the defrosting cycle and the conditioning of the refrigerator for normal operation being responsive to temperature responsive means such as a thermostat element.

While we have illustrated preferred embodiments of our invention, many modifications may be made without departing from the spirit of the invention, and we do not wish to be limited to the precise details of construction set forth, but wish to avail ourselves of all changes within the scope of the appended claims.

We claim:

1. Refrigerating apparatus comprising means defining an evaporator having a first conduit for refrigerant, a jet in the inlet of said evaporator refrigerant conduit, an electric circuit including a timed control mechanism and a temperature responsive means and a heating source which is disposed adjacent said evaporator refrigerant conduit, and a second conduit for refrigerant interconnected with said first conduit whereby the refrigerant may be recirculated through said first conduit, the circulation of the refrigerant in the first evaporator refrigerant conduit being responsive to the application of heat from the heat source to the adjacent first evaporator refrigerator conduit and augmented by said jet.

2. Refrigerating apparatus comprising an evaporator having a first conduit for refrigerant, an inlet conduit for refrigerant and extending into said first conduit forming a jet and defining with said first conduit an injector, an electric circuit, a heater element in said circuit and disposed adjacent said first conduit, timed control apparatus to control energization of said heater, a temperature responsive means in said circuit to control deenergization of said heater responsive to a predetermined temperature rise, and a third conduit for refrigerant effective to recirculate the refrigerant to said first conduit responsive to operation of said heater element.

3. Defrosting mechanism for a refrigerating apparatus comprising an evaporator having refrigerant conduits including inlet and suction discharge conduits, a jet in said inlet conduit, a heat source disposed adjacent at least one of said evaporator refrigerant conduits and adapted to warm the refrigerant contained therein, a refrigerant conduit in said evaporator adapted to bypass the suction discharge conduit whereby the refrigerant will be recirculated within the evaporator refrigerant conduits, said recirculation of said refrigerant being responsive to operation of said jet coacting with and augmented by the action of the warmed refrigerant responsive to operation of said heater element.

4. Defrosting mechanism for a refrigerating apparatus comprising an evaporator having refrigerant conduits wherein said refrigerants are expanded during normal operation of the refrigerating system, said refrigerant conduits comprising an inlet into the evaporator and a suction conduit, a refrigerant conduit disposed in said evaporator whereby the suction conduit is bypassed for recirculation of the refrigerant in said evaporator refrigerant conduits, and a heat source disposed adjacent at least one of said evaporator refrigerant conduits to warm the refrigerant contained therein to render said recirculation of the refrigerant within the evaporator refrigerant conduits.

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