Jan. 24, 1950 I. E. McCABE 2,495,378

MEANS FOR AND METHOD OF CONDITIONING REFRIGERATING SYSTEMS

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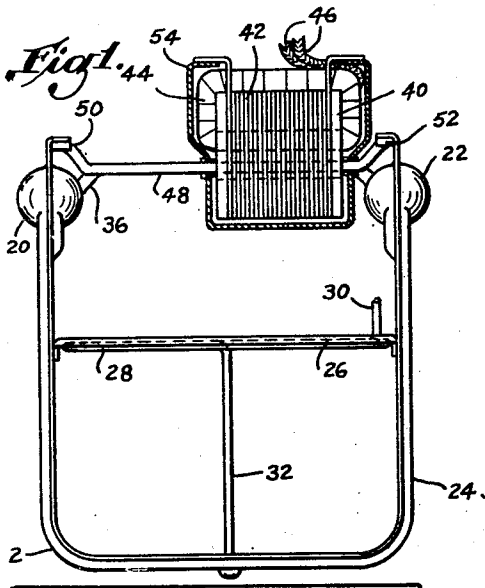
Fig. 1.



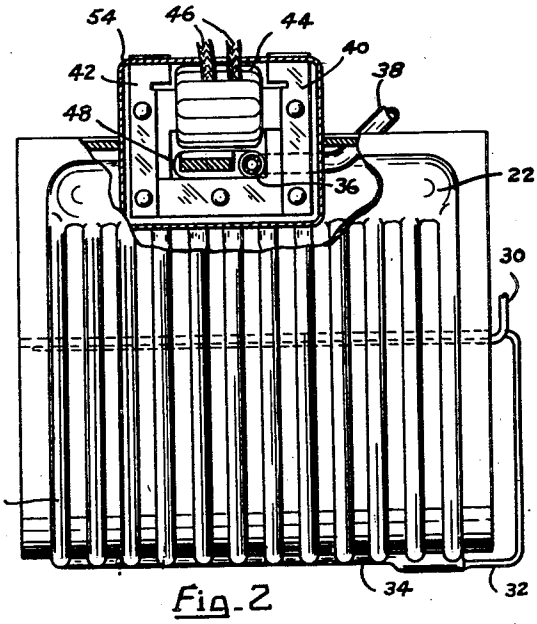


Fig. 2

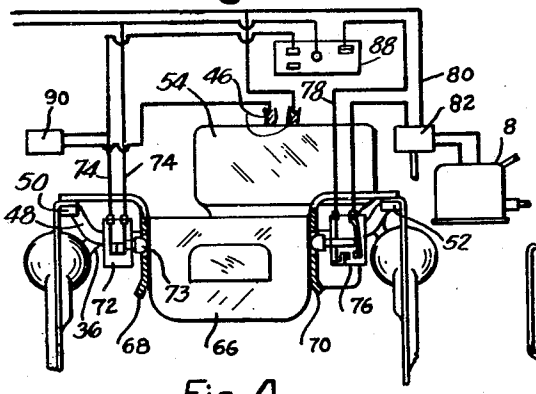


Fig. 4

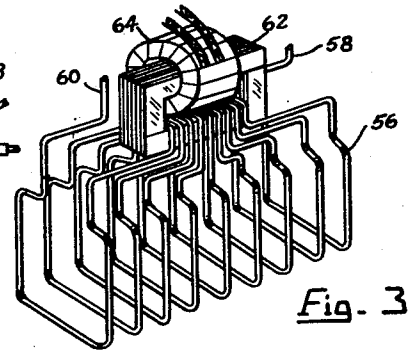


Fig. 3

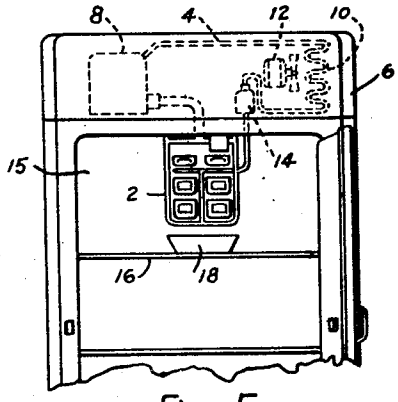


Fig. 5

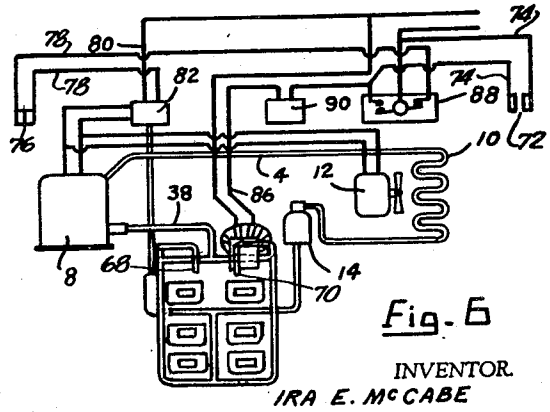


Fig. 6

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MEANS FOR AND METHOD OF CONDITIONING REFRIGERATING SYSTEMS

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8 Claims. (Cl. 62—115)

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The present invention relates to refrigerating apparatus and more particularly to novel means for and method of conditioning the cooling or freezing unit for such apparatus.

Among the objects of the present invention is to provide novel means for removing accumulations of frost from the cooling or freezing unit of refrigerating apparatus.

As is well known at the present time, electrically operated refrigerators, such, for example, as home or domestic refrigerators, are provided with a cooling or freezing unit, generally referred to as an evaporator, located within the food compartment of the refrigerating box. Such evaporator is disposed within a circulatory system for a refrigerant which, upon expansion from a liquid to gaseous state, lowers the temperature of the evaporator and maintains the desired temperature in the food compartment. This evaporator is likewise used for making ice cubes in the well known manner. During the operation of the refrigerating system frost accumulates upon the evaporator, sometimes to considerable depth, which greatly impairs the efficiency of the refrigerating unit and must from time to time be removed. Such removal of these frost deposits becomes an annoyance and inconvenience both as to time and energy consumed and has the further undesirable result that the condition of the food stuffs in the box is endangered and the ice cubes are caused to be melted.

In accordance with the usual procedure at the present time, such defrosting is effected by rendering the refrigerating system inoperative over a period of time, thus allowing the temperature of the food compartment to be raised in order to melt the frost on the evaporator. At best, this is an operation which is inconvenient and troublesome requiring a considerable length of time and even after the refrigerating system is rendered operative it requires a prolonged refrigerating period in order to restore a normal refrigerating temperature within the box.

Various ways have been devised to improve the defrosting operation as above described, but the same are inherently defective in producing the results desired so that the defrosting operation is still an onerous task to the average householder. As one illustration of such attempts, reference may be made to automatic defrosting where the defrosting is initiated manually and the operation of the refrigerating unit resumed automatically after certain conditions have been produced in the apparatus. Such automatic defrosting results in the melting of the ice cubes with their

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absorption of the odors of the food stored within the food compartment upon being refrozen, which is highly undesirable.

Accordingly, it is an object of the present invention to provide novel means in a refrigerating system adapted to defrost an evaporator or the like over a very short period of time to increase the efficiency of the unit and without thawing the ice cubes or appreciably or materially raising the temperature of the food compartment.

The present invention in its broad aspect contemplates the provision of electrical means involving a resistance element or elements through which an electric current can pass to raise the temperature of the evaporator the desired amount to quickly and effectively remove accumulations of frost thereon.

More particularly, the present invention contemplates in its preferred form the provision of electric means including a transformer as an element thereof whereby induced current of an appropriate value may be passed through the evaporator or cooling unit to increase the temperature thereof within a relatively short period of time to remove accumulations of frost thereon.

A further object of the present invention is to provide a transformer assembly in a refrigerating system in which the evaporator or cooling unit thereof is incorporated in the transformer as its secondary coil, whereby electrical energy of low voltage but high amperage is utilized to raise the temperature of the evaporator forming the core for such frost accumulations and to thus cause a removal of the same from the evaporator with a minimum of heat being applied thereto.

Still a further object of the present invention is to provide in a refrigerating system as above described novel means in association with the evaporator which is adapted to receive ice cube trays of current conducting material and which, when such trays are embraced thereby, will form a shunt circuit in the system adapted to raise the temperature of the said trays to free the ice cubes contained therein.

A still further object within the purview of the present invention is to provide electrical defrosting means in a refrigerating system and to provide in conjunction therewith suitable control means for such defrosting means and the compressor unit of said system. The present invention in this respect is characterized as having within its scope a control system for operating the defrosting means and the compressor in any desired relation to one another.

Other objects, features, capabilities and ad-

vantages are comprehended by the invention, as will later appear and as are inherently possessed thereby.

Referring to the drawings—

Figure 1 is a detached view, partly in end elevation and partly in section, of an evaporator or cooling unit for a refrigerator and in which improvements made in accordance with the present invention are incorporated.

Figure 2 is a view, partly in side elevation and partly in section, of the cooling unit shown in Figure 1 of the drawings;

Figure 3 is a view in perspective of a modified form for a cooling unit which has embodied therein improvements made in accordance with the present invention;

Figure 4 is a fragmentary view in end elevation of an evaporator such as disclosed in Figure 1 of the drawings but including additional novel structure to secure further advantages comprehended by the present invention;

Figure 5 is a fragmentary view in elevation of a household refrigerator which embodies the basic improvement of the present invention as shown in Figures 1 and 2; and

Figure 6 is a diagrammatic view of a wiring diagram for an electrically operated refrigerating system embodying the several improvements coming within the invention.

Referring now more in particular to the drawings, an embodiment selected to illustrate the present invention is shown in part in Figures 1 and 2 as comprising a cooling or evaporator unit generally designated as **2**, which forms an element in the refrigerating system **4** for a domestic refrigerator **6**, more particularly shown in Figure 5 of the drawings. This refrigerating system involves an electrically driven compressor unit disclosed generally as **8** and hermetically sealed within an appropriate casing, the said compressor, through suitable conduits, being adapted to supply a condenser **10** cooled through the medium of a fan **12** and which directs the liquid refrigerant to a receiver **14** and thence to the evaporator **2** from which such refrigerant in gaseous form is returned to the compressor **8**. As shown in the drawings, the disposition of the various elements for the refrigerating system is conventional at the present time, involving the positioning of the evaporator in the upper part of the food compartment **15**, which may be divided by one or more shelves, such as **16**, for receiving and supporting food as well as a tray, such as **18**, adapted for use in holding edibles or for receiving frost and water during a defrosting operation.

The cooling unit or evaporator **2** may be of any conventional design such, for example, as shown in the United States Patent No. 2,043,917 which discloses an evaporator conforming in a good many respects to the one herein set out on the drawings. Such evaporator may be formed of inner and outer members suitably secured together as by means of welding and formed to provide headers **20** and **22** adjacent the upper marginal edges of the evaporator which are inter-connected through the medium of circulatory passages, such as **24**, formed as pressed out sections of the outer member whereby a refrigerant is allowed to circulate throughout a substantial portion of the exterior surface of the evaporator. In the illustrative embodiment of the evaporator, the space enclosed thereby is subdivided by a partition **26**, formed with a plurality of circulatory passages **28** which have their intake **30** connected to the pressure side of the compressor **8** for receiving liquid refrigerant from a receiver tank **14**. The outlet **32** for such passages communicates through one or more passageways, such as **34**, with the passageways **24** of the evaporator. Furthermore, headers **20** and **22** are inter-connected by way of the conduit **36** having outlet means **38** communicating with the suction side of the compressor and delivering refrigerant in gaseous form thereto.

The present invention, however, is more particularly directed to the provision of means for quickly and effectively removing frost accumulations from the evaporator unit **2**. According to one form of the invention as disclosed in Figures 1 and 2 of the drawings, such means involves the use of a transformer **40** incorporated within an electrical circuit as will be hereinafter more fully pointed out. This transformer is characterized as having a laminated core **42**, one side of which is embraced by a primary coil **44** connected into the electrical circuit through the leads **46**, the said transformer further including as its secondary coil the evaporator **2** by virtue of the disposition of the conduit **36** as well as the bar **48** which embrace the other side of the core **42**, the latter of said elements extending between and being connected to the upper marginal edges of the side walls of the evaporator. It is also desirable in order to provide for the proper distribution of current through the evaporator so as to secure even heating thereof and to eliminate hot spots at conducting medium junctions or connections to either thicken the marginal edges of the evaporator or to provide strips of metal, such as **50** and **52**, as shown in the drawings. Furthermore, the primary winding of the transformer is suitably enclosed within a housing such as **54** which is supported by the bar **48**.

From the above description of the invention as disclosed in Figures 1 and 2, it will be clearly appreciated that the evaporator becomes, by virtue of its disposition with respect to the core and primary coil of the transformer, the low voltage secondary coil of the transformer when the primary is connected to the ordinary alternating current house circuit or to a direct current circuit, where converter means is provided to supply alternating current to the transformer. The transformer in its various details of construction is designed to induce electrical energy of low voltage and high amperage in the single loop secondary coil formed by the evaporator in order to generate sufficient heat within the evaporator to raise the temperature thereof to remove accumulations of frost thereon within a very short period of time.

It is to be recognized that in some instances the evaporator or evaporator circuit may comprise portions which may not require heating to the same extent as those upon which larger amounts of frost may accumulate. When such conditions prevail, it is contemplated that the evaporator, or the connections leading thereto should the transformer comprise an isolated separate unit, may comprise sections of material of different cross section by means of which the structure may be balanced in such a manner as to provide a good conductor of lesser resistance at some points than at others thereby creating heat to a greater extent in those sections where it is more essential. Defrosting is thus accomplished with the expenditure of the smallest possible amounts of electrical energy.

With this invention, the minimizing of the

heat energy, afforded thereby, for melting the frost greatly adds to the efficiency of the refrigerating unit as a whole. As will be appreciated, whatever form of the invention may be employed for causing the melting of the frost, such defrosting is followed by a refrigerating cycle to restore or maintain the desired refrigerating temperatures. Thus with the present invention a decided advantage is obtained when the heat effect upon the cooling space is maintained very low.

It is apparent that in applying heat to the frosted portions of the evaporator, as disclosed herein, it is accomplished through the innermost layers of frost and the heat being absorbed in the process of melting the frost does not materially raise the cooling compartment temperature. Furthermore, the amount of heat transferred to the frost is greater than to the refrigerant due to the greater absorbing characteristics of the frost so that the refrigerant temperature, while frost is being removed, is not unduly increased. The novelty of, and one highly desirable result obtained through the use of the invention resides, in part, in the ability to melt the frost by heating it from the inside rather than the outside, thus minimizing the effect of such heating upon the cooling compartment as well as the electrical energy required to produce the result of defrosting.

Further evidence of the utility of this invention will be apparent to those skilled in this art in the application of the invention in refrigeration systems of the multiple type in which refrigeration may be employed not only for daily food preservation but for deep freezing and air conditioning. In such systems this invention lends itself to application only to those portions of the system in which defrosting will be considered essential or desired thus eliminating the shutting down of the entire system to effect the defrosting of only one part.

In the appended claims the term, evaporator, is intended to embrace all such parts of the refrigeration system which serve as the cooling element or unit of the space to be cooled. This unit is generally referred to in connection with domestic refrigerators as the evaporator. However, brine systems which employ freezing units within the cooling space and which have refrigeration coils immersed within the brine filled unit or units through which brine is circulated therethrough are considered to come within the term evaporator.

It is to be understood that the electrical means of the present invention may have those design characteristics which are necessary under any given conditions to secure defrosting of the evaporator within the time period desired. The rapidity with which these accumulations of frost are melted is due primarily to the application of heat thereto through the medium of the evaporator which in effect forms the core of such deposits.

During a defrosting operation the receptacle 18 may be used as disclosed in Figure 5, or if desired, any suitable built-in structure may be provided for collecting these frost deposits after removal and directing the same to the exterior of the box where they may be disposed of in any desired manner.

While Figures 1 and 2 show one illustrative embodiment of the invention wherein the evaporator forms a single secondary coil for the transformer, nevertheless the present invention

contemplates the use of an evaporator of multipart construction to form a plurality of turns for the secondary of the transformer, one such contemplated structure being shown in Figure 3 in which the evaporator is formed from a conduit 56 suitably shaped to receive ice trays or other receptacles in the usual manner and having an intake as at 58 to the pressure side of a compressor and an outlet or discharge 60 leading to the suction side of the compressor. In this modified form of assembly the transformer core 62 is embraced by a primary coil 64 and has its secondary coil constituted by a plurality of loops formed by the conduit 56 embracing the core 62 in opposed relation to the primary coil 64.

It is, of course, clearly understood that the transformer of this embodiment may be incorporated in an electrical system in the same manner as the transformer of Figures 1 and 2 and may be similarly controlled, as will be hereinafter more fully explained.

If desired, the structure of Figures 1, 2 and 3 may incorporate additional means as shown in Figure 4 of the drawings for shunting the current from the main body of the evaporator through a tray 66 of current conducting material containing ice, whereby the temperature of said tray will be raised to release and free the ice cubes contained therein. For example, the spring clips or brackets 68 and 70 may be provided, the same being connected to the side walls of the evaporator and having resilient arms adapted to receive and embrace the tray 66. Since the induced voltage in the secondary coil is very low, the operator will be able to handle the trays 66 and contact other current carrying parts of the circuit without being injured. When an ice tray is embraced by the brackets 68 and 70 and the transformer is energized the induced current flows through the secondary comprising the bar 48, the marginal strips 50 and 52, the spring brackets 68 and 70, and the ice tray 66 embraced thereby. This closed secondary circuit constitutes a shunt circuit with respect to the evaporator and through which the current tends to flow instead of flowing through the main evaporator circuit since the shunt circuit through the ice tray offers the least resistance.

The invention as disclosed in Figure 4 of the drawings contemplates the provision of a switch 72 connected in circuit shown in full lines, Figure 6, the said switch being in association with bracket 68 provided in the transformer circuit through the leads 74 and which is pressed into closed position upon introduction of the tray 66 between the spring brackets 68 and 70 to complete the transformer circuit and to provide the heating required to thaw the ice cubes therein. If desired, the assembly according to Figure 4 may likewise include the switch 76 disposed in the compressor circuit through the leads 78 as shown in full lines of Figure 6, such switch under the action of the tray 66 rendering the compressor circuit inoperative when the transformer circuit is operative.

It is of course understood that the invention contemplates the provision of an ice removal means such as shown in Figure 4 which is separate and apart from the freezing unit but which may be used in the manner described for freeing the ice from the receptacles when incorporated into an electric circuit.

The invention contemplates the possibility of using switch 72 to energize the transformer as

a means of freeing ice trays from the evaporator, if desired. As is well known, trays are frequently placed in the evaporator when the same are wet, or on occasions water contained therein will splash over the trays or spill onto the supporting surface for such trays, which causes the trays to be frozen in place and exceedingly difficult to remove. Often-times pressure applied between such frozen trays and their support causes damage to be done to either or both the trays and the evaporator.

By operating switch 72, the transformer circuit may be held closed for a period long enough to raise the evaporator temperature so that the trays can be readily removed from the evaporator even though it may not be desired at that time to completely remove the accumulated frost deposits on the evaporator. For example, such trays may be readily removed by depressing the plunger 73 of switch 72 for a short interval of time to free the trays from the evaporator before one or more is placed between the brackets 68 and 70. It may be desired under such circumstances to form the switch 72 with a limit control, either temperature, pressure or time operated, or to provide such means independently of switch 72, to prevent closure of the switch for such an extended period of time that hazards may arise from unduly raising the temperature of the refrigerant.

In connection with the use of the defrosting mechanism, the invention contemplates various control mechanisms whereby defrosting can be controlled in any desired manner. According to the disclosure in Figure 6 of the drawings, the compressor circuit, generally referred to as 80, incorporates a thermostat or control mechanism 82 which through the bulb 84 in the environment of the evaporator 2 regulates the operation of the compressor in accordance with the temperature in the vicinity of said evaporator. Such a thermostat may take the form disclosed in United States Patent No. 2,333,263. The transformer circuit generally referred to as 86 may be controlled by a control switch 88, which is diagrammatically shown in the drawings as being included also in the compressor circuit. Thus the switch 88 may be used to close the transformer circuit for defrosting and simultaneously interrupting the supply of electrical energy to the compressor circuit so that no refrigeration is in progress during the period of defrosting. The switch 88 may be manually operated or controlled in any desired manner.

As shown in Figure 6, the switch 76 of the structure shown in Figure 4 is incorporated in series relation with the thermostat or control mechanism 82. Switch 72 is incorporated in parallel relation with the circuit for the transformer and as previously pointed out, in order to prevent prolonged heating of the refrigerant, control switch 90 may be provided in the transformer circuit. The limit control 90 thus serves to prevent the hazards that may arise through the closure of the transformer circuit by either switch 72 or switch 88 for such a length of time as would unduly raise the temperature of the refrigerant.

While the present invention has been particularly directed to the problem of removing accumulations of frost in a refrigerating system, nevertheless the same contemplates a novel process of conditioning the refrigerating system for receiving refrigerant. For example, as is well known in the art at the present time, all traces of moisture must be removed from the circulatory system of the apparatus before the system can be charged with a refrigerant. The present invention contemplates the use of electrical means involving the evaporator as a resistance element whereby all such traces of moisture will be removed prior to the charging of the system with a refrigerant. Of course, such charging may take place under various conditions. For example, such conditioning is necessary at the time of manufacture of the device and in accordance with the present invention, the transformer is incorporated as an element of the evaporator assembly and, accordingly, it is merely necessary to supply electric energy to the transformer to secure such results.

In all of the illustrations immediately above set forth, the processes comprehend applying an electric potential to the primary beyond its normal operating voltage to greatly increase the temperature normally used in removing frost accumulations in order to make certain that all traces of moisture are removed from the system before the system is charged with a refrigerant.

While the above improvements have been disclosed in connection with their use in domestic refrigerators, nevertheless the invention is of such a scope as to embrace other refrigerating systems, both domestic and industrial.

While there has been described herein illustrative embodiments of the invention and processes contemplated by the invention, it is to be understood that the invention is not limited thereto but may comprehend other details, features and process steps without departing from the spirit of the invention.

What is claimed is:

1. In a refrigerator mechanism, the combination of a freezing unit having means included in a circulatory system for a refrigerant, electrical means including a circuit embodying said unit as an element thereof for raising the temperature of said unit, and means associated with said unit adapted to receive ice receptacles to complete a shunt circuit in said electrical means to raise the temperature of said receptacles for removal of ice therefrom.

2. In a refrigerating system, an evaporator, a coil, and a magnetically permeable core, said evaporator, coil and core being associated to form a transformer wherein the coil constitutes a multi-turn primary, the evaporator constitutes a single-turn secondary, and the core magnetically links said coil directly with said evaporator for magnetically inducing current directly in the latter.

3. In refrigerating apparatus, an element subject to frosting during normal operation of the apparatus, said element consisting of a substantially tubular shell and refrigerant circulating means associated in heat exchange relation with the shell, and electromagnetic circuit means including a core in direct magnetic relation with said shell for magnetically inducing current directly in said element to effect defrosting thereof.

4. In a refrigerating system, an evaporator defined in part by opposed side walls, structural means joining the side walls and electrically connecting said walls to form with the evaporator an integral, unitary closed circuit conductor, a coil and a magnetically permeable core, said core embracing said structural means and being supported thereby, said closed circuit conductor, coil and core being associated to form a transformer wherein the coil constitutes a multi-turn primary, the closed circuit conductor constitutes the secondary, and the core magnetically links said coil

with the closed circuit conductor for magnetically inducing current directly in the latter.

5. In a refrigerating system, an evaporator defined in part by opposed walls and characterized as being a low resistance conductor, electrical distributing means connecting the opposed side walls of the evaporator for feeding a low voltage current through said evaporator for defrosting purposes, the evaporator and said electrical distributing means forming an integral, unitary closed circuit conductor, a coil adapted for connection across a source of alternating current, a magnetically permeable core embracing said distributing means and being supported thereby, said closed circuit conductor, coil and core being associated to form a transformer wherein the coil constitutes a multi-turn primary, the closed circuit conductor constitutes a secondary, and the core magnetically links said coil with the closed circuit conductor for magnetically inducing current directly in the latter when the coil is connected across said source.

6. The combination with an evaporator adapted to form part of a refrigeration system and having means for the circulation of a refrigerant, a primary coil connecting with a source of electric energy, a core embraced by said coil, means for supporting said core and coil upon said evaporator in a manner whereby said supporting means is embraced by said core, said evaporator and said supporting means forming a closed electric circuit and constituting a secondary coil having inductive relation with said primary coil through said core, whereby energization of said primary coil will induce an electric current in said evaporator to raise the temperature thereof for defrosting, and a shunt circuit connecting with the secondary coil and including means adapted to receive ice receptacles for completing said shunt circuit to raise the temperature of said receptacles for the removal of ice therefrom.

7. The combination with an evaporator adapted to form part of a refrigeration system and having means for the circulation of a refrigerant, of a source of electric energy, a primary coil, an energizing circuit for said coil connecting the coil with said source, a core embraced by said coil, means for supporting said core and coil upon said evaporator in a manner whereby said supporting means is embraced by said core, said evaporator and supporting means forming a closed electric circuit and constituting a secondary coil having inductive relation with said primary coil through said core, whereby energization of said primary coil will induce an electric current in said evaporator to raise the temperature thereof for defrosting, a shunt circuit connecting with said secondary coil and including means adapted to receive ice receptacles for completing said shunt circuit to raise the temperature of said receptacles for the removal of ice therefrom, and a normally open switch in said energizing circuit operable to closed position upon insertion of an ice receptacle into said shunt circuit.

8. The combination with a refrigerant circulatory system including a compressor and an evaporator, of a source of electric energy including circuit means connecting said source with the compressor, a transformer primary coil also including circuit means connecting the coil with said source, a core embraced by said coil, means for supporting said core and coil upon said evaporator in a manner whereby said supporting means is embraced by said core, said evaporator and supporting means forming a closed electric circuit and constituting a secondary coil having inductive relation with said primary coil through said core, whereby energization of said primary coil will induce an electric current in said evaporator to raise the temperature thereof for defrosting, a shunt circuit connecting with said secondary coil and including means adapted to receive ice receptacles for completing said shunt circuit to raise the temperature of said receptacles for removal of ice therefrom, a normally open switch in the circuit for the primary coil actuated to closed position upon insertion of an ice receptacle into said shunt circuit for energizing said primary coil, and a normally closed switch in the circuit for the compressor actuated to open position upon insertion of an ice receptacle in said shunt circuit for de-energizing said compressor.

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