ABSTRACT

A food refrigeration appliance including a freezer compartment for storing food at a first temperature below the freezing point of water and a refrigeration compartment for storing food at a second temperature above the freezing point of water. A duct is provided between the freezer compartment and the refrigeration compartment. A fan is used for moving air through the duct from the freezer compartment to the refrigeration compartment. A battery supplies power to the fan when electrical power from an external source is interrupted during a power outage.
REFRIGERATOR POWER BACK UP SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of Invention

[0002] The present invention relates to a food refrigeration appliance and, more particularly, to a food refrigeration appliance that includes a power back up system that utilizes cold air from a freezer compartment to keep food stored in a refrigerator compartment below a predetermined temperature during a temporary power outage.

[0003] 2. Description of Related Art

[0004] Most food refrigeration appliances in use today include a food refrigeration compartment and a freezer compartment. Food stored in the food refrigeration compartment is kept slightly above, but near, the freezing point of water to retard the activity of bacteria and delay the onset of spoilage. The freezer compartment is kept well below the freezing point of water, typically about 0°F, which allows for the virtual indefinite storage of many food items. Milk, for example, can be safely stored in a refrigerator compartment for about two weeks, but can be safely stored in the freezer compartment for months.

[0005] Food refrigeration appliances use the evaporation of a compressed refrigerant gas to absorb heat. The compressed refrigerant gas becomes a liquid that evaporates at an extremely low temperature, so it can create temperatures below the freezing point of water inside the freezer compartment and the food refrigeration compartment. A compressor compresses the refrigerant gas, which raises the pressure and temperature. Heat-exchanging coils, typically disposed outside the refrigerator allow the refrigerant to dissipate the heat of pressurization. As the refrigerant cools, it condenses to form a liquid that flows through an expansion valve. When the liquid flows through the expansion valve, the liquid refrigerant moves from a high-pressure zone into a low-pressure zone. Expansion causes evaporation, which allows the refrigerant to flow through the coils inside the freezer compartment and the food refrigeration compartment absorb heat, making it cold. Fans help move air adjacent to the coils through the compartments.

[0006] The compressors in most food refrigeration appliances are powered by an external electrical alternating current (AC) power source. When this external power is interrupted, such as during a power outage, refrigeration ceases. Once refrigeration ceases, the temperature inside the food refrigeration compartment rises. If the power outage is sufficiently long in duration, the food will be exposed to a risk of spoilage.

[0007] If the refrigerator door is not opened, a typical refrigerator will maintain the temperature within the food refrigeration compartment for a period of four to six hours during a power outage. After that period of time has elapsed, food stored within the food refrigeration compartment will begin to spoil. Milk, for example, will begin to develop bacteria within two hours when exposed to temperatures in excess of 40°F.

[0008] A freezer compartment, on the other hand, will typically hold the temperature for about 24 to about 48 hours during a power outage, assuming the freezer door is not opened. The food stored within the freezer compartment may begin to defrost, but typically does not begin to spoil during this time.

[0009] Power outages occur for many reasons. Most often, power outages are temporary events caused by inclement weather. Most power outages are brief. It has been observed that 67% of power interruptions last five minutes or less. Sustained interruptions account for 33% of outages, where the average duration of a sustained outage is about 106 minutes. In most prolonged instances, power is restored within 9 to 12 hours.

[0010] However, in recent times, a state of hurricanes and other circumstances have created power blackouts that resulted in sustained periods of time in which refrigerators could not function. It has been determined that such extended blackouts result in out-of-pocket expenses of $2 billion for consumers for food spoilage and consumable goods such as candles, flashlight batteries and prepared food, i.e. in restaurants.

[0011] 75% of American homeowners experienced a power outage in 2000. 99% experienced a power outage between 1996 and 2000. In 2000, the average metro homeowner experienced 2.9 outages, while non-metro homeowners experienced more. The average duration of the longest blackouts in 2000 was 16.8 hours. 10% of American consumers plan to buy a portable generator, which cost in a range between $399 and $1199.

[0012] In the event of a sustained or extended outage, it is known that milk will begin to develop bacteria and spoil within two hours if exposed to temperatures above 40 degrees. A typical food refrigeration appliance cannot hold this temperature within a food refrigeration compartment for periods extending beyond 4 to 6 hours, depending on ambient temperature in the kitchen. A freezer compartment it would be highly desirable to have a food refrigeration appliance that could keep food stored in a refrigerator compartment below a predetermined temperature during a temporary power outage.

BRIEF SUMMARY OF THE INVENTION

[0013] The difficulties and drawbacks of previous-type systems are overcome by the food refrigeration appliance of the present invention including a freezer compartment for storing food at a first temperature below the freezing point of water and a refrigeration compartment for storing food at a second temperature above the freezing point of water. A duct is provided between the freezer compartment and the refrigeration compartment. A fan is used for moving air through the duct from the freezer compartment to the refrigeration compartment. A battery supplies power to the fan when electrical power from an external source is interrupted during a power outage.

[0014] The foregoing and other features of the invention are hereinafter more fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the present invention may be employed.
BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIGS. 1A, 1B and 1C are assembled views showing exemplary side-by-side, top-bottom and bottom-top refrigerators, respectively.

[0016] FIGS. 2A and 2B are respective front and side sectional views of an exemplary refrigerator in accordance with the present embodiments.

[0017] FIGS. 3A and 3B are graphs respectively indicating temperatures in a refrigerator compartment without a backup fan and with a backup fan in accordance with the present embodiments.

[0018] FIGS. 4A, 4B and 4C are assembled views showing exemplary integrated, stand-alone and hard-wired battery backup systems, respectively, according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] A typical food refrigeration appliance, i.e., a "refrigerator," includes a freezer compartment and a separate refrigerator compartment, which may be subdivided into smaller specific purpose compartments. The freezer compartment is for storing food at one or more temperatures below the freezing point of water in order to maintain food items in a frozen state for extended periods of time. The refrigerator compartment is for storing food at one or more temperatures slightly above the freezing point of water but temperatures at which bacteria is actively cultured, to maintain freshness of food and beverage items to be consumed in the near term.

[0020] Specific reference is now made to the figures, where it is appreciated that like reference numerals refer to like elements. The three most common types or configurations of refrigerators are shown in FIGS. 1A, 1B and 1C. FIG. 1A illustrates a standard "side-by-side" refrigerator 10a having a substantially full vertical height freezer compartment 12a situated to the left and adjacent to a substantially full vertical height refrigerator compartment 14a. It will be appreciated that the freezer compartment 12a and the refrigerator compartment 14a can be located on either side of the refrigerator. FIG. 1B illustrates a standard "top-bottom" refrigerator 10b having a substantially full horizontal width freezer compartment 12b situated on top of a substantially full horizontal width refrigerator compartment 14b. FIG. 1C illustrates a standard "bottom-top" refrigerator 10c having a substantially full horizontal width refrigerator compartment 14c situated on top of a substantially full horizontal width freezer compartment 12c. Other configurations are possible, but these three configurations are most common.

[0021] The freezer compartments 12a, 12b and 12c are respectively closed by a standard freezer door 22a, 22b and 22c. The refrigerator compartments 14a, 14b and 14c are respectively closed by a standard refrigerator door 24a, 24b and 24c. It is to be understood that these doors 22a, 22b, 22c, 24a, 24b and 24c are hinged so as to allow a user to open them along a pivotal axis, as is common in the art. These doors 22a, 22b, 22c, 24a, 24b and 24c may also include shelving for retaining additional food items within the freezer compartment 12a, 12b and 12c or the refrigerator compartment 14a, 14b and 14c when the door 22a, 22b, 22c, 24a, 24b and 24c is closed. The freezer compartment 12a, 12b and 12c and refrigerator compartments 14a, 14b and 14c are retained within a respective cabinet 20a, 20b and 22c. The cabinet 20a, 20b and 22c and the doors 22a, 22b, 22c, 24a, 24b and 24c are preferably thermally insulated to maintain a cold temperature within the compartments 12a, 12b, 12c, 14a, 14b and 14c defined by them.

[0022] As shown FIGS. 2A and 2B, a refrigerator 10a includes a compressor 30 for driving a refrigerant gas into a condenser coil 32, where heat is eliminated from the refrigerant gas. The refrigerant is throttled through an expansion valve 34, i.e., a venturi of the like, where it absorbs heat from the ambient environment, resulting in refrigerant cooling in the evaporator coil 36. The evaporator coil 36 is typically disposed proximal to the inside of the freezer compartment 12a, thereby cooling down the air therein. In some refrigerators, portions of the evaporator coil 36 are also disposed proximal to the inside the refrigerator compartment.

[0023] As indicated in FIG. 2B, a fan 40 draws cold air from the immediate vicinity of the evaporator coil 36 and circulates it through the freezer compartment and/or supplies it to the refrigerator compartment 14a through a duct 42, which is typically provided between the freezer compartment 12a and the refrigerator compartment 14a. The fan 40 typically moves cold air through the duct 42 from the freezer compartment 12a to the refrigerator compartment 14a on an as needed basis to maintain the temperature within the refrigerator compartment 14c at a desired level. In the preferred embodiment, the fan 40 operates in a range of about six to ten watts (6-10 watts). The cold air is discharged into the refrigerator compartment 14c through one or more vents 44 extending from the duct 40.

[0024] It will be appreciated that the refrigerator 10a shown in FIGS. 2A and 2B is exemplary, and that the location of the various elements comprising the refrigeration system (e.g., the compressor, condenser coil, expansion valve, evaporator coil, duct, fan and vents) will vary by manufacturer and by refrigerator style and thus is not critical. It is important, however, that the refrigerator be provided with a fan 40 that is operable to move cold air through a duct 42 from the freezer compartment to the refrigerator compartment.

[0025] Refrigerators operate normally only when a constant supply of power, typically alternating electrical current, is received from an external source such as a standard home electrical outlet or the like. This external power source is required to drive the compressor 30 and the fan 40. In the event of a power outage, the compressor and fan cease to operate, and refrigeration to both the freezer compartment and the refrigerator compartment therefore ceases. In the event of an external power failure, the insulated cabinet 20a, 20b and 20c can keep the freezer compartment 12a, 12b and 12c relatively cold for about 24 to about 48 hours, especially when the freezer compartment is loaded with frozen food items, which serve as a thermal ballast. However, the refrigeration compartment 14a, 14b and 14c tends to warm up more quickly than the freezer compartment in the event of a power outage, particularly when the refrigerator is in a warm ambient environment such as is typical in a home. The temperature within the refrigerator compartment of a conventional refrigerator typically rises above 40°F within about 2 hours after a power failure or outage.
The present invention serves to prolong the time during which the temperature within the refrigerator compartment is maintained below a desired temperature, and thus also serves to protect the food and beverage items stored in the refrigerator compartment from spoiling for a significantly longer period of time than would otherwise occur with a conventional refrigerator. The present invention provides a battery backup system that selectively energizes a fan to move cold air from the freezer compartment through the duct into the refrigerator compartment. This extends the period during which the refrigerant contents can be maintained at a sufficiently cold temperature to retard food spoilage. Depending upon various factors, which are discussed below, the present invention can maintain the temperature in the refrigerator compartment below a desired temperature for a period of twenty hours or more in the event of an external power failure.

The present invention provides a battery backup system 50 for supplying electrical power to the fan 40 when electrical power from the external source is interrupted during a power outage. A battery 52 supplies power to the fan 40, which moves air through the duct 42 from the freezer compartment to the refrigeration compartment. The air within the freezer compartment is cooled by the food items and other frozen items in or adjacent to the freezer compartment, and thus the fan transfers cold air from the freezer compartment to the refrigerator compartment, as needed, to maintain the temperature of the food items stored in this compartment below a temperature at which spoilage is likely to occur. The battery 52 can be of any desired size, but preferably is large enough and has sufficient capacity to supply power to the fan for at least about 20 hours of operation. Batteries and systems containing batteries suitable for use in the invention can be purchased from Emerson Network Power’s Liebert Division.

The battery backup system 50 also preferably comprises a thermostat 46, which can be set to control the operation of the fan 40 during a power outage. In the preferred embodiment, the thermostat 46 is mounted within the refrigeration compartment 14a, 14b and 14c. The thermostat 46, which may be the same as or different from a thermostat used to control the temperature of the refrigeration compartment during the normal operation of the refrigerator using an external power source, preferably includes a switch that closes to send power to the fan 40 when the thermostat 46 senses that the temperature within the refrigerator compartment exceeds a desired set temperature, and opens to stop sending power to the fan 40 when the thermostat 46 senses that the temperature within the refrigerator compartment has fallen below the desired set temperature. It will be appreciated that the thermostat 46 can also include a sensor that sends a signal to a microprocessor control device incorporated into the battery backup system 50, which controls operation of the fan 40.

The backup power system 50 may further comprise thermal ballast elements 54, which assist in the maintenance of cooling in the event of a power outage. The thermal ballast elements 54 can be one or more freezer packs maintained within the freezer compartment 12a, 12b and 12c. It will be appreciated that frozen food items can serve as thermal ballast in the event of a power outage.

In order to insure that the battery 52 is adequately charged in the event of an external power failure, the present battery backup system 50 preferably further comprises a battery charger 56 for recharging and maintaining the charge of the battery 52 using power from the external source. The battery charger 56 is preferably connected to the same power connection 58 that operates the fan 40 under normal conditions such that sufficient charging of the battery 52 can occur when the external power source is functioning properly. The battery backup system 50 also preferably comprises an inverter 60 for switching the electrical power to operate the fan 40 from the external source to the battery 52 during a power outage.

The components comprising the battery backup system 50 can be arranged in a variety of ways. In one embodiment, which is generally shown in FIG. 4A, the majority of the components of the battery backup system 50a (e.g., the battery 52a, transformer 55a, battery charger 56a, inverter 60a etc.) are integrated within a module that is attached to or made a part of the internal structure of the refrigerator. The refrigerator is plugged into an external power source such as a conventional alternating current wall outlet. The external power source supplies power to the battery charger 56a of the battery backup system 50a and operates the refrigerator until a power failure or outage occurs. In the event of an external power failure or outage, the battery backup system 50a activates. The battery backup system 50a does not power the compressor and the other elements of the refrigeration system, but rather it powers the fan 40, as needed, to keep the temperature within the refrigerator compartment at or below the desired set temperature as indicated on the thermostat. Once external power is restored, the battery backup system deactivates, except for the battery charger 56a, which recharges the battery 52a.

In another embodiment of the invention, which is generally shown in FIG. 4B, the battery backup system 50b is a stand-alone device that is similar, in some respects, to an uninterruptible power supply typically used to temporarily maintain the operation of computer equipment in the event of an external power failure. In this embodiment, the battery backup system 50b is plugged into an external power source such as a wall outlet 61. The refrigerator is preferably plugged into an outlet 62 provided in the battery backup system 50b, but could be plugged into a separate wall outlet 61. As in the case of the integrated battery backup system 50a previously described, the external power source supplies power to the battery charger of the stand-alone battery backup system 50b and operates the refrigerator until a power failure or outage occurs. In the event of an external power failure or outage, the battery backup system 50b activates. The battery backup system 50b does not power the compressor and the other elements of the refrigeration system, but rather it powers the fan 40, as needed, to keep the temperature within the refrigerator compartment at or below the desired set temperature as indicated on the thermostat. Power is supplied from the battery (not shown, but it resides within the housing) through a cable attached to the refrigerator and a cable port connector 65b (e.g., a four pin wiring harness). Once external power is restored, the battery backup system deactivates, except for the battery charger, which recharges the battery.

In yet another embodiment of the invention, which is shown in FIG. 4C, the battery backup system 50c is hard wired into a wall between vertical studs 67 or other similar building structure (e.g., floor or ceiling) in a building. In this
embodiment of the invention, a face portion 63 of the battery backup system 50c includes an outlet 69 for receiving the power plug from the refrigerator and a separate cable port connector 65: (e.g., a four pin wiring harness) for establishing an electrical connection between the battery and the fan 40. As in the other embodiments of the invention, in the event of an external power failure or outage, the battery backup system 50c activates. The battery backup system 50c does not power the compressor and the other elements of the refrigeration system, but rather it powers the fan 40, as needed, to keep the temperature within the refrigerator compartment at or below the desired set temperature as indicated on the thermostat. Once external power is restored, the battery backup system 50c deactivates, except for the battery charger, which recharges the battery. It will be appreciated that a hard wired battery backup system 50c: according to the invention can further include surge protection devices, telephone jacks 71, jacks for Internet connectivity 72 and connections for coaxial cable 73, if desired.

[0034] The following example is intended only to illustrate the invention and should not be construed as imposing limitations upon the claims.

EXAMPLE

[0035] Measurements were performed using a 22 Cu. Ft. Side-by-Side Refrigerator-Freezer. Model ED2V1HGXMQOA0 sold by Whirlpool Corporation. An 8-channel DATA PAQ data logger was used to sample interior temperatures during testing. An emergency backup lighting unit with a 20-hour battery was used as a power source. Typical freezer temperatures during use are about 0 to −5 degrees F., while a typical refrigerator temperature was about 35 to 37 degrees F. During testing, the refrigerator compartment was filled with cans of soda, bottles of water and other beverages and the freezer was packed with 66 pounds of bagged ice.

[0036] Without using the power backup system according to the invention, as shown in FIG. 3A, the temperature in the refrigerator compartment was found to exceed 40 degrees F. about two hours after external power to the refrigerator was shut off. However, when the power back system according to the invention was installed and activated, as shown in FIG. 3B, temperatures were maintained below 40 degrees F. in the refrigerator compartment for an average of about 17 hours. Three tests were performed in which the temperature was maintained below about 40 degrees F. for about 20 hours, about 16 hours and about 14 hours, respectively. The fan was observed to operate for about 25 minutes every hour until the batteries were exhausted.

[0037] The temperature did not rise above 40 degrees F. in the refrigerator compartment during any test until the battery was completely discharged and the fan ceased operation. Therefore, it is concluded that the temperature could be maintained in the refrigerator compartment for a much longer time than 17 hours if sufficient battery power was available, and at least until substantial thawing of the freezer contents occurred. It will be appreciated that the length of time during which the refrigerator compartment could be kept below a predetermined temperature in the event of a power failure would depend on variables such as the volume of frozen items stored in the freezer compartment (i.e., the extent of the thermal ballast), the end-user's freezer temperatuure setting, the ambient temperature of the room in which the refrigerator is stored and the number of times that the refrigerator or freezer doors were opened.

[0038] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and illustrative examples shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A food refrigeration appliance comprising:
   a freezer compartment for storing food at a first temperature below the freezing point of water;
   a refrigeration compartment for storing food at a second temperature above the freezing point of water;
   a duct between the freezer compartment and the refrigeration compartment;
   a fan for moving air through the duct from the freezer compartment to the refrigeration compartment; and
   a battery for supplying power to the fan when electrical power from an external source is interrupted during a power outage.

2. The food refrigeration appliance of claim 1, further comprising a thermostat for controlling the operation of the fan during a power outage.

3. The food refrigeration appliance of claim 1, further comprising a battery charger for supplying electrical charge to the battery from an external source.

4. The food refrigeration appliance of claim 1, further comprising an inverter for switching an electrical connection on the fan from the external source to the battery during a power outage.

5. The food refrigeration appliance of claim 1, further comprising a thermal ballast for assisting in the maintenance of cooling in the event of a power outage.

6. An accessory for a food refrigeration appliance comprising:
   a duct for connecting a freezer compartment to a refrigeration compartment in a food refrigeration appliance;
   a fan for moving air through the duct from the freezer compartment to the refrigeration compartment; and
   a battery for supplying power to the fan when electrical power from an external source is interrupted during a power outage.

7. The accessory of claim 6 further comprising a thermostat for controlling the operation of the fan during a power outage.

8. The accessory of claim 6, further comprising an electrical connection to an external source of electricity.

9. The accessory of claim 8, wherein the electrical connection further comprises a switch that activates the accessory when a power outage is detected.

10. The accessory of claim 8, wherein the electrical connection further comprises a battery charger for supplying electrical charge to the battery from an external source.

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