GE Appliances

TECHNICIAN MANUAL

REFRIGERATION 101

Pub. No. 31-45404A

FOOD STORAGE TEMPERATURES

The primary function of a refrigerator or freezer is to preserve perishable foods. However, refrigeration does not preserve food indefinitely. Holding food at a low temperature merely reduces the rate at which deterioration takes place.

Ideal Food Temperatures
The ideal food storage temperature will vary, depending upon the nature of the food. Some examples are:

Milk 34°F. — Milk will freeze if chilled below 31°F. When milk is permitted to reach room temperature, or is contaminated with certain types of bacteria, spoilage may occur quickly even when held at temperatures near 32°F.

Lemons 58°F. — Lemons stored at low temperatures develop an undesirable color. Temperatures above 60°F shorten the storage life.

Fresh Meat 32°F. — Fresh meat should be stored at temperatures as near 32°F as is possible without freezing the meat. Bacteria growth in fresh meat, indicated by discoloration, is more rapid when stored at warmer temperatures.

Lettuce 32°F. — Lettuce will freeze if chilled below 31°F, but will retain good quality for considerably longer periods at 32°F than at 38°F. Furthermore, lettuce should not be stored with apples, pears, cantaloupes, or other products that give off ethylene gas thereby causing russet spotting.

Ice Cream 5°F — The composition of ice cream varies from one brand to another, and from one flavor to another depending upon the butter fat content, sugar content, and other ingredients. However, at 0°F, most ice cream is considered hard. The ideal serving temperature is usually 5 to 10°F. At about 12°F, the flavor of ice cream is appreciated by more people than at lower temperatures.

Frozen Meat -10°F. — A temperature of 0°F or lower is desirable to retain the original taste and flavor of frozen meats. The storage life of all meat products is greatly extended when held at -10°F.

Obviously, no refrigerator can be expected to maintain such a wide variance of temperatures.

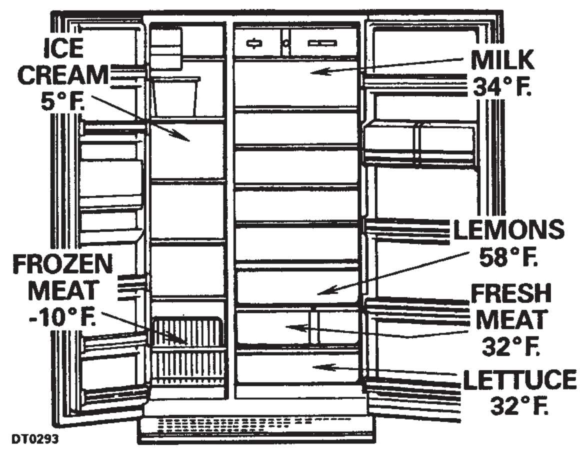

Figure 1- Ideal Food Temperatures

Temperature Control Settings
Automatic defrost refrigerators usually have two temperature controls located in the rear of the fresh food compartment.

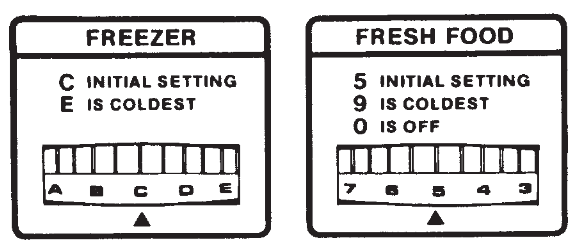

Figure 2 - Dual Controls

On most refrigerator models, the freezer control is a manually operated damper that regulates the amount of cold air entering the fresh food compartment. When the damper is positioned at letter "A", a maximum amount of cold air is diverted from the freezer compartment to the fresh food compartment. This colder mixture of air is sensed by the fresh food control resulting in shorter compressor operation cycles. Conversely, when the freezer control is positioned at letter "E", a minimum amount of cold air is diverted from the freezer resulting in longer compressor operation cycles.

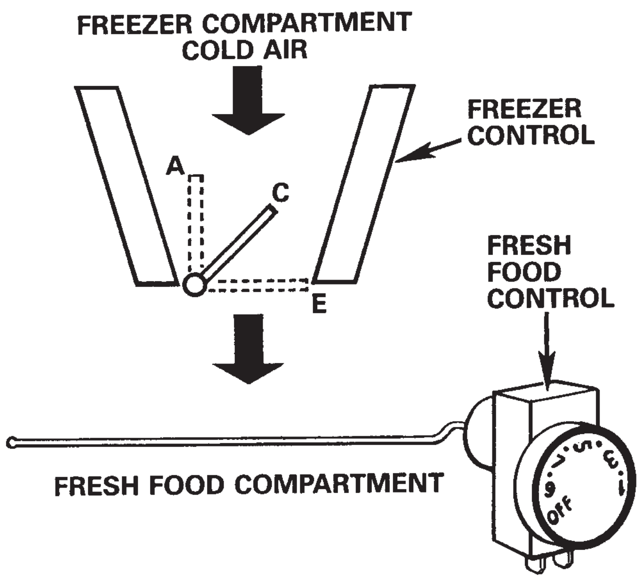

Figure 3 - Dual Control Operation

Most refrigerators are shipped from the factory with the temperature controls positioned at the middle settings. Most freezers are shipped with the control positioned at the "1" setting. At these settings, satisfactory temperatures should be expected. Generally, the range of expected temperatures are:

- fresh food 34 - 42°F
- frozen food 0 - 8°F.

MODEL TYPE	SETTING	FRESH FOOD	FROZEN FOOD
SINGLE DOOR MANUAL DEF.	5	34°–42°	8°–16°
TWO DOOR CYCLE DEF.	5	34°–42°	2°–10°
AUTOMATIC DEFROST	5/C	34°–42°	0°–8°
FREEZERS	1	———	0°–8°

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Figure 4 - Expected Temperatures

Colder or warmer temperatures can be obtained by changing the control settings. Each setting represents a change in temperature of approximately 2°F. After changing the control setting, 24 hours should be allowed for the temperature to stabilize before making any further changes to the control settings.

Heavy Usage

During the summer months, higher than normal kitchen temperatures will exist in some homes. This, in conjunction with a greater demand for ice and an increase in the number and duration of door openings, can result in long compressor run time with fresh food temperatures reaching 45 to 50°F late in the afternoon. Thus, the consumer should be advised to keep the refrigerator door openings to a minimum.

Figure 5 - Heavy Usage Condition

Light Usage

When the kitchen is cool (especially in the winter months) and the refrigerator doors are opened less frequently (no one at home during the day), compressor run time will be shorter than normal. Consequently, the air in both compartments stratifies (warm air at the top and cold air at the bottom). This may cause one or more of the following symptoms to develop:

- fresh food temperature too cold
- vegetables freezing
- slow ice making rate
- soft ice cream
- frost on freezer shelves.

Under these light usage conditions, the consumer should be advised to adjust the freezer control to a higher setting for a colder freezer compartment temperature. This will result in slightly longer compressor run cycles.

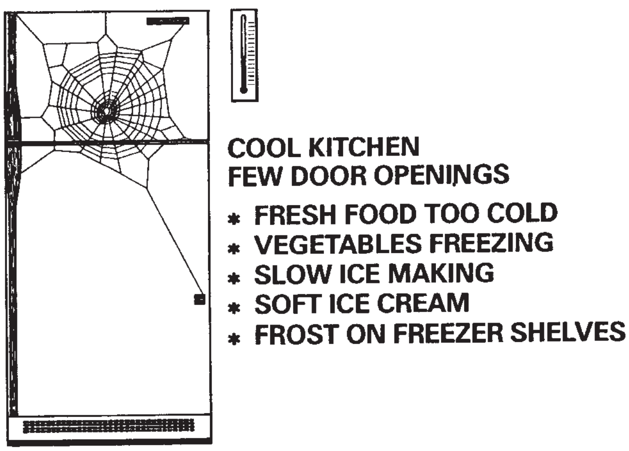

Figure 6 - Light Usage Condition

TEMPERATURE MEASUREMENTS

Accurate temperature measurements are extremely important in determining if a refrigerator or freezer is operating properly. Accordingly, temperature measurements should be made on every call where the complaint is "poor performance". Reliable temperature measurements are dependent upon the condition of the thermometer and the method used for making the measurements.

Thermometer

Various types of thermometers are available for measuring temperatures in refrigerators and freezers.

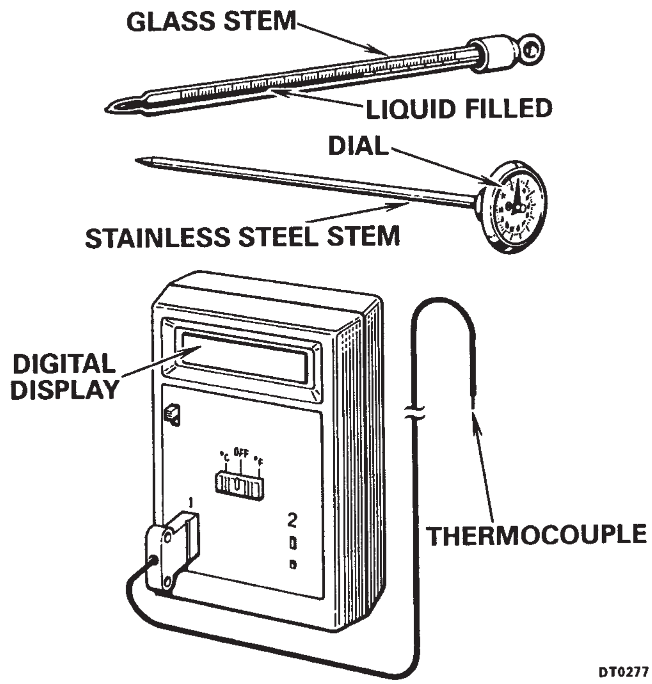

Figure 7 - Thermometer Types

Liquid filled thermometers with a glass stem are generally very reliable but the glass is easily broken if the thermometer is dropped. Also, when using this type, make sure the liquid has not separated within the glass stem.

Dial (analog) type thermometers with a stainless steel stem are easy to use and are less prone to damage. However, this type may require recalibrating occasionally. To check the calibration, fill a foam cup with ice cubes and add a small amount of water. Place the tip of the thermometer into the ice bath, stir the mixture, and observe the reading after four minutes. The temperature of the ice bath should be about 33°F.

Digital type thermometers with a thermocouple give a quick (almost instantaneous) response and are easy to read. Also, the thermocouple enables the meter to be placed outside the food compartment so that the digital display can be read without opening the refrigerator door. Some instruments have two thermocouples that permit monitoring the fresh food and freezer temperatures. However, if the battery becomes weak, the reading will be unreliable. Some instruments have a battery check feature to indicate the condition of the battery.

Making Temperature Measurements
Temperature measurements, in either the fresh food or freezer compartment, should never be made of the air. Air temperature fluctuates drastically any time the door is opened; and depending upon whether the compressor is running, if it has just started running, or if it is near the end of the running cycle. The most reliable method is to measure the temperature of food that has been in the center of the fresh food and freezer compartments for at least 24 hours.

Always measure the temperature in both compartments of the refrigerator. Place the tip of the thermometer between two food packages. Wait at least four minutes before reading the thermometer. Food temperatures will vary from morning to evening — especially with heavy usage during the day.

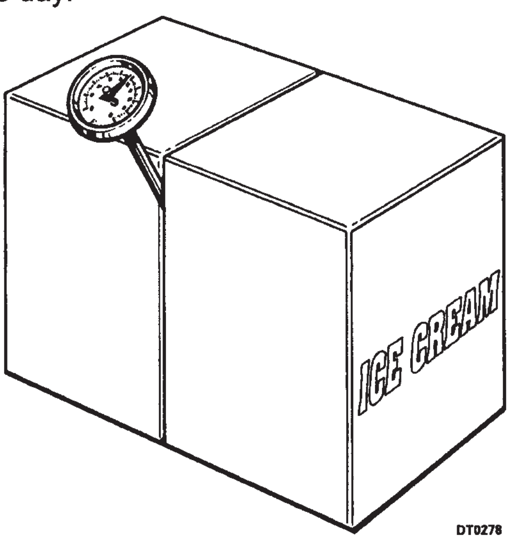

Figure 8 - Food Temperature Measurement

Measure also the ambient (room) temperature. Then, compare the temperatures taken to the "No Load Performance" data in the Mini-Manual. But remember, "No Load Performance" is laboratory data taken with no door openings, no defrosts, and no food load. However, this closely simulates the condition in the home after approximately 8 hours of no usage (such as should normally exist first-thing-in-the-morning). With usage, obviously, the measured temperature will not equate the "No Load Performance" data. Unsatisfactory temperatures may be due to an improper installation or unusual consumer usage — rather than an actual fault with the product.

INSTALLATION REQUIREMENTS

Proper installation of a refrigerator or freezer is required for efficient operation and satisfactory performance.

Location
The location of a refrigerator is usually decided by the design of the kitchen. However, the customer should be advised if the location is detrimental to efficient operation. If possible, a refrigerator or freezer should never be placed immediately adjacent to a range, in direct sunlight, or near a heat vent.

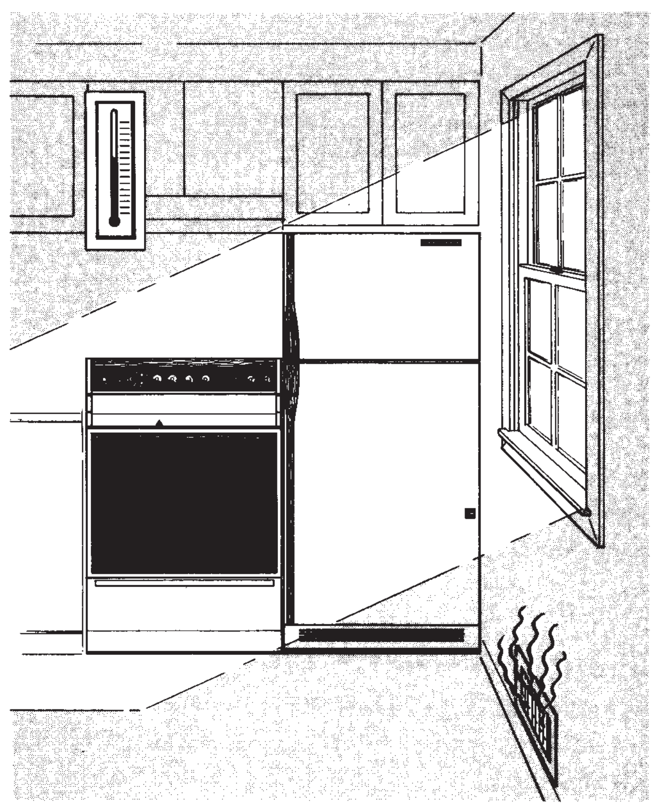

Figure 9 - Improper Installation Location

Furthermore, a refrigerator should not be installed in a location where the ambient temperature will be lower than 60°F, because the compressor will not run frequently enough to maintain satisfactory temperatures. Many homes are equipped with an energy saving set-back thermostat that can be set to a temperature either cooler or warmer than normal during times when the home is unoccupied. Thus, the performance of the refrigerator may be adversely affected if the unoccupied temperature is lower than 60°F.

A freezer should not be installed in a location where the ambient (room) temperature will be either higher than 110°F, or lower than 32°F, for efficient operation and satisfactory performance.

Clearances

Clearances must be provided at the top, sides, and rear of most refrigerators and freezers (as specified on the rating plate). Failure to provide these minimum clearances will result in poor performance of a refrigerator or freezer.

Leveling

A refrigerator or freezer should be firmly positioned on a solid floor. The cabinet should be reasonably level side-to-side and tilted slightly to the rear so the doors will swing closed when opened to a 45° position.

KNOWLEDGE EXERCISE

1. What is the primary purpose of a refrigerator or freezer? ______________________________
____.

2. What range of temperatures should generally be expected:
In the fresh food compartment? ____________°F. In the freezer compartment? _____________°F.

3. How can refrigerator or freezer temperatures best be determined? __________________________
____.

For each of the following statements, select only one response.

4. The ideal storage temperature for ice cream is:
____ a. 12°F.
____ b. 5°F.
____ c. 0°F.
____ d. -10°F.

5. In most automatic defrost refrigerators, adjusting the lettered control to position "E" results in:
____ a. Colder frozen food temperature.
____ b. Colder fresh food temperature.
____ c. Warmer frozen food temperature.
____ d. Warmer fresh food temperature.

6. A refrigerator is operating under "heavy usage" when:
____ a. The fresh food compartment is mostly full.
____ b. The freezer compartment is mostly full.
____ c. The kitchen is hot and the door openings are frequent.
____ d. The kitchen is cool and the door openings are few.

7. A refrigerator operating under "light usage" conditions may result in temperatures:
____ a. Fresh food too cold, frozen food too cold.
____ b. Fresh food too warm, frozen food too cold.
____ c. Fresh food too warm, frozen food too warm.
____ d. Fresh food too cold, frozen food too warm.

8. Temperature measurements, in the fresh food or freezer compartment, should never be taken of:
____ a. The air.
____ b. The water.
____ c. Any food containing sugar.
____ d. Any food containing vinegar.

9. A refrigerator should not be installed in a location where the ambient temperature will be lower than 60°F, because the:
____ a. Fresh food will likely freeze.
____ b. Oil in the compressor will likely gel.
____ c. Compressor will not run frequently enough.
____ d. Compressor will run too frequently.

FUNDAMENTALS

Refrigeration is the process of removing heat. Therefore, to understand the operation of refrigeration systems, a knowledge of some fundamental principles regarding heat is important.

Heat Energy

Heat, like electricity, is a form of energy that can be measured by the effect it produces. It is provided by the sun and exists, to some extent, in every substance on the earth. Even ice has some heat. The removal of heat from a substance causes its temperature to change so that, by comparison, one substance is colder than another.

Most substances will expand when heated and contract when heat is removed. For example: The liquid in a glass stem thermometer will rise or fall, in response to changes in temperature, due to expansion or contraction of the liquid.

The temperature of a substance is an indication of the degree of heat intensity that can be measured with a thermometer. Most commonly, temperatures are measured with a thermometer that has a Fahrenheit scale. On this scale, the melting point of ice is 32°F and the boiling point of water is 212°F.

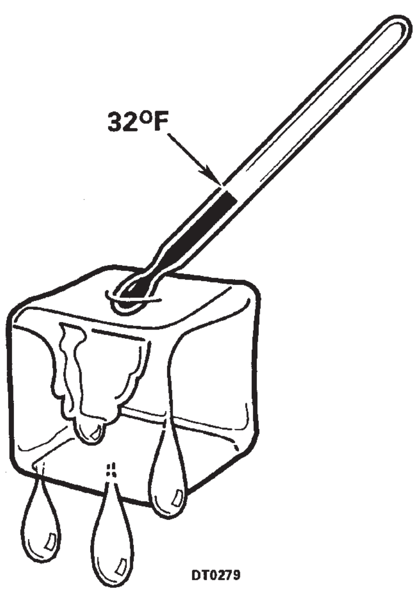

Figure 1 - Temperature of Melting Ice

Temperature is not a measurement of the quantity of heat in a substance. For example: A one pound piece of iron might be at the same temperature as a ten pound piece, but the quantity of heat in the ten pound piece will be ten times as great. The unit of measurement for heat is the British Thermal Unit (BTU). One BTU is the amount of heat required to either increase or decrease the temperature of one pound of water by one degree Fahrenheit. For example: To chill 32 ounces (2 pounds) of water at 60°F, down to 40°F, requires the removal of 40 BTU. Compressors in refrigeration systems are rated by their ability to remove heat and stated as British Thermal Units per hour (BTU/hr.).

Heat Transfer

Heat always flows from a warmer substance to a cooler substance and seeks a common level — regardless of how small the difference in temperature. For example: If a hot piece of iron is dropped into a cup of cold water, the water will be warmed by the transfer of heat until both the water and the iron are at the same temperature.

Heat is transferred by three methods: conduction, convection, and radiation. Conduction occurs when one end of a metal rod is placed in a flame and the other end becomes warm. Convection occurs when hair is dried by warm air blown from a hair dryer. Radiation occurs when we feel heat from the sun, traveling through space, without heating the space.

Figure 2 - Methods of Heat Transfer

The rate of heat transfer is influenced by three factors: temperature difference, surface area, and material conductivity. Therefore, the greater the temperature difference, or the larger the surface area of contact, or the better the conductivity of the material, the more quickly heat will flow.

Change of State
Most substances can exist in the solid, liquid, or gaseous states and can be changed from one state to another by adding or removing heat. Adding heat to a substance can change it from a solid to a liquid or from a liquid to a gas. For example: If a sufficient amount of heat is applied, ice will change to water and, water will change to steam. Conversely, removing heat from a substance can change it from a gas to a liquid or from a liquid to a solid. For example: If a sufficient amount of heat is removed, steam will change to water and, water will change to ice. The operation of refrigeration systems is dependent upon the refrigerant changing state — from liquid to vapor (evaporation) and from vapor to liquid (condensation).

Figure 3 - Evaporation and Condensation

Effect of Pressure
The temperature at which a substance will evaporate or condense is the same — if the pressure remains constant. For example: At sea level, water will change to steam when heated above 212°F and steam will change to water when cooled below 212°F. But, under a lower pressure (at a higher altitude) the change of state will occur at a lower temperature. Conversely, an increase in pressure will increase the temperature at which a substance will evaporate or condense.

Pressure is measured in pounds per square inch (PSI). It is stated either as absolute pressure (PSIA), or gauge pressure (PSIG). Normal atmospheric pressure at sea level is 14.7 pounds per square inch absolute (14.7 PSIA). In refrigeration systems, a compound gauge is used to measure pressures above and below atmospheric pressure. The gauge is calibrated so that a zero reading corresponds to the atmospheric pressure. Thus, a gauge reading above zero is a positive pressure and stated as pounds per square inch (PSIG). However, a gauge reading below zero is a vacuum and stated as inches of mercury (in.Hg).

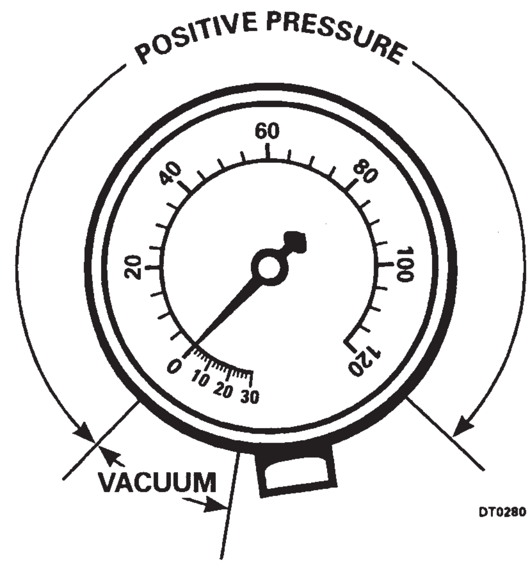

Figure 4 - Compound Gauge

Heat of Compression
Increasing the pressure of a gas increases its temperature and heat content. The operation of refrigeration systems is dependent upon pressure differences. A low pressure is needed in the evaporator to enable the refrigerant to vaporize and absorb heat at a low temperature. A high pressure is needed in the condenser for the vapor to give up heat and condense back to a liquid. The compressor provides the pressure difference within the system.

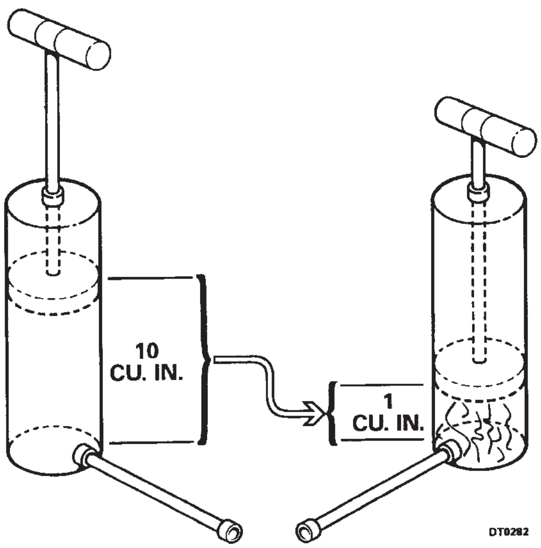

Figure 5 - Heat from Pressure

The low pressure refrigerant vapor entering the compressor from the evaporator is approximately at room temperature. The pressurized vapor discharged from the compressor is at a much higher temperature. Thus, because the compressed vapor is warmer than the temperature of the room, it will give up heat and condense back into a liquid.

CYCLE OF OPERATION

The compressor is the heart of the refrigeration system. It serves as a pump to circulate the refrigerant and provide a difference in pressure within the system. Thus, when the compressor is operating, one portion of the system is at high pressure and the other is at low pressure. The three phases of the refrigeration cycle are: compression, condensation, and evaporation.

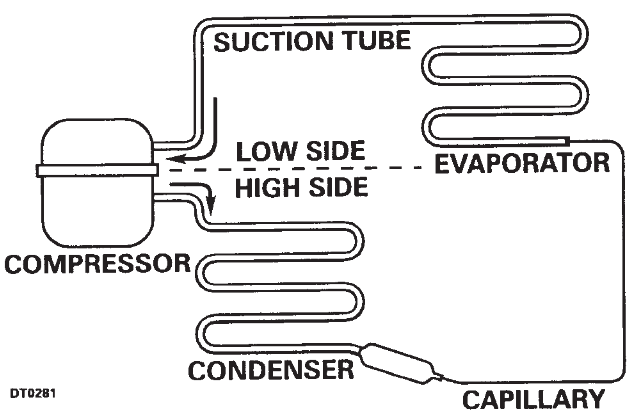

Figure 6 - Refrigeration System

Compression
While the compressor is operating, refrigerant vapor is discharged into the condenser. A capillary (small diameter tube), connected at the outlet of the condenser, limits the flow of refrigerant from the condenser thereby enabling the compressor to increase the pressure in the condenser. Typical operating pressure in the condenser is 140 to 160 PSIG.

Condensation
The compressed refrigerant vapor in the condenser is warmer than the temperature of the room. Therefore, heat from the high pressure vapor is transferred to the condenser and it gives up heat (by convection) to the surrounding air. As heat is removed from the high pressure vapor, it begins to condense into a liquid. The liquid refrigerant flows (by gravity) to the end of the condenser and, being forced by the compressed vapor in the condenser, enters the capillary.

Evaporation
Liquid refrigerant, under high pressure and flowing from the capillary at a very high rate of speed, enters the considerably larger tubing of the evaporator. The evaporator is at low pressure due to the suction of the compressor — typically 0 to 5 PSIG. Thus, the sudden drop in pressure causes the liquid refrigerant to vaporize and absorb heat. Therefore, heat inside the cabinet is transferred (by convection) to the evaporator because the evaporator temperature is lower than the air temperature. At the outlet of the evaporator, all liquid refrigerant has evaporated so that only vapor is returned to the compressor by way of the suction tube.

Equalization
When a sufficient amount of heat has been removed from inside the cabinet, the temperature control will interrupt the electrical circuit to the compressor thereby stopping the refrigeration cycle. However, the refrigerant will continue to flow through the capillary into the evaporator as long as the pressure in the condenser is greater than in the evaporator. Gradually, the pressure will reduce in the condenser and increase in the evaporator until both pressures are nearly the

same. Most compressor motors do not have enough torque to restart the compressor until the system pressures are partially equalized. Usually, after three minutes, the pressure difference will be sufficiently reduced to permit the motor to restart.

SYSTEM COMPONENTS

Prior to 1959, most refrigeration system failures were not repaired but, rather, the complete system was replaced. Even though the replacement system was charged with refrigerant and included essential electrical parts, this was a time-consuming task that usually required two technicians. Most often, the refrigerator was brought to the shop because the replacement system was in a wooden crate almost as large as the refrigerator.

Then, to better serve the consumer, the high and low pressure sides of the refrigeration system were furnished separately. Thus, these two major components for GE refrigerators and freezers were called: "Hi-Side" and "Lo-Side". Today, a wider variety of system components are furnished for specific needs. Therefore, an awareness of these components and an understanding of their function is important.

Compressor

The electric motor that drives the compressor is hermetically sealed (air tight) inside the steel compressor case and, therefore, cannot be replaced separately. Accordingly, a failure of any part inside the compressor case will necessitate replacement of the entire compressor. Oil that lubricates the compressor is also sealed inside the case and never needs to be changed during the life of the compressor. Normally, a slight amount of oil circulates throughout the system along with the refrigerant. Thus, if a leak occurs in the system, a trace of oil may be noticed near the source of the leak. Refrigeration systems that use R134a refrigerant require a different type of oil than systems that use R12 refrigerant. Replacement compressors are furnished with the correct type and amount of oil.

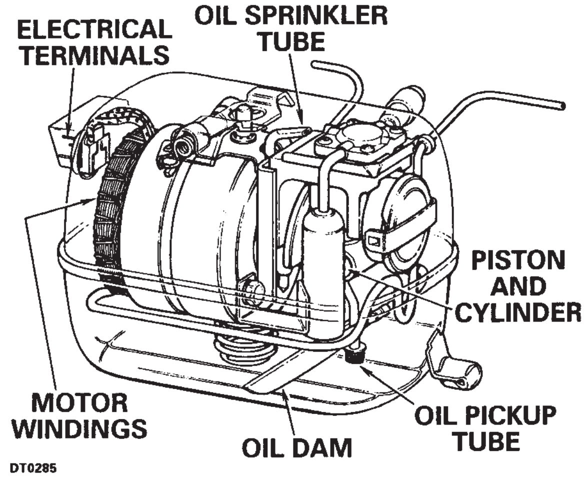

Figure 7 - Typical Compressor Assembly

Two basic types of compressors are used in refrigerators and freezers: reciprocating and rotary. Reciprocating (piston) compressors have been used since the earliest days. Rotary (roller) compressors were used in some models produced during 1985, through 1993. The external appearance of the two types is significantly different. The most distinguishing characteristic is the location of the electrical terminals for the motor windings. On the reciprocating type, the terminals are located on the side of the case. On the rotary type, the terminals are located on the top of the case.

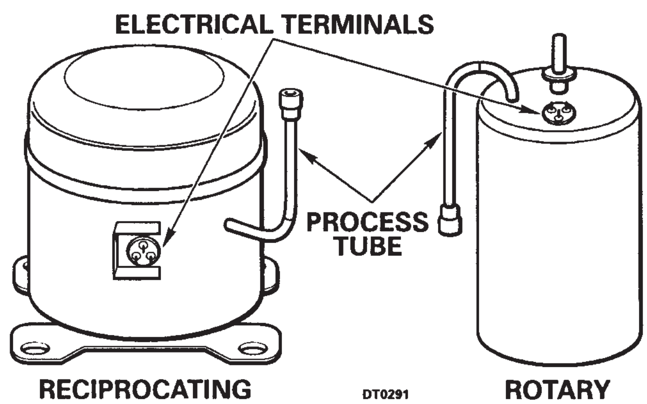

Figure 8 - Compressor Types

Another, and more important, distinction between reciprocating and rotary type compressors is the operating pressure within the case. On the reciprocating type, the case is at low pressure and the process tube connected through the side of the case is also at low pressure. But, on the rotary type, the case is at high pressure and the process tube connected through the top of the case is also at high pressure.

Compressors, in refrigerators and freezers, are rated according to their ability to remove heat from the cabinet. Accordingly, larger cabinets generally require a compressor with a higher BTU/hr rating than smaller cabinets. Furthermore, compressors are designed to accommodate a particular refrigerant. For example: Some compressors are designed for use with R12 and others with R134a. Therefore, a substitute replacement compressor must not be used unless it is a factory authorized supersedure.

Replacement compressors are dehydrated and pressurized with nitrogen to prevent internal corrosion. Most replacement compressors are furnished as a "kit" which includes the relay, overload, and a short wiring harness. Usually, a charging valve is installed on the process tube and a loop of tubing is connected between the discharge and suction ports. Some kits also include a new condenser. Thus, replacement compressors that have interconnecting tubing can be operated (as a test) prior to installation. Installation instructions are included with most replacement compressors.

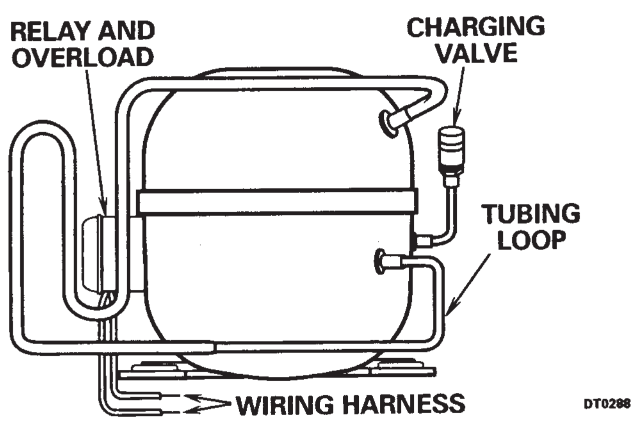

Figure 9 - Typical Replacement Compressor

<u>Condenser</u>
Condensers are normally made of steel tubing and formed into a serpentine pattern. Many models have two or more condensers connected in series. For example: Most recent refrigerator models also have a condenser loop, made of copper tubing, that surrounds the front of the freezer compartment. The outlet of the condenser, that connects to the inlet of the dryer, must be positioned downward to allow liquid refrigerant to flow (by gravity) into the dryer. Three basic types of condensers are used in refrigerators and freezers: natural draft, forced draft and hot wall.

The natural draft type condenser is usually mounted to the rear of the cabinet. Heat rising from the top of the condenser (by convection) creates an air draft that pulls cooler room ambient air upward over the condenser. This continues as long as the condenser is warmer than the room ambient.

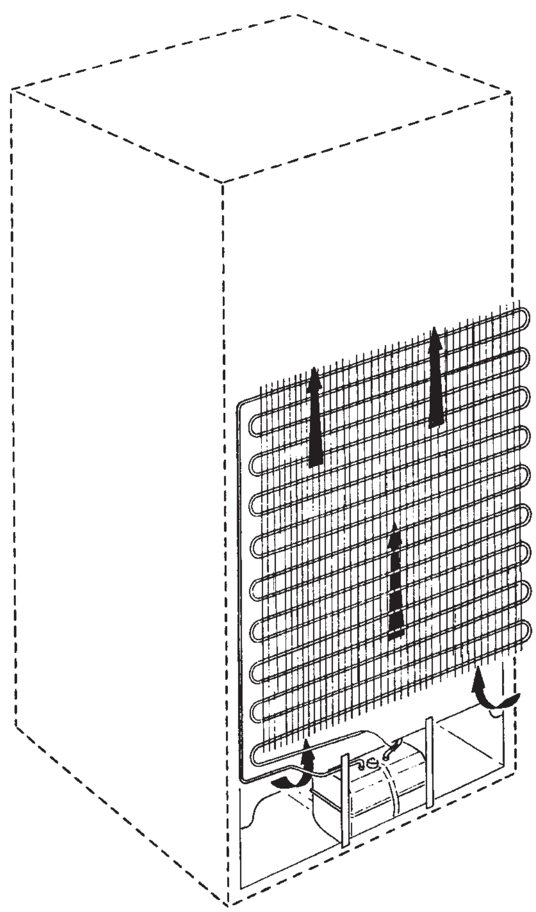

Figure 10 - Natural Draft Condenser

The forced draft type condenser is mounted in the machine compartment along with the compressor. A fan, also mounted in the machine compartment, operates when the compressor is running to circulate cooler room ambient air over and through the condenser. Air baffles, and the rear access cover, must be tightly positioned to ensure proper air flow. In time, condenser fan operation will deposit household lint and dust on the condenser which will impede air flow through the condenser thereby increasing the pressure within the condenser. Thus, a mispositioned baffle, a dirty condenser or an inoperative condenser fan motor can result in longer run time and higher food temperatures.

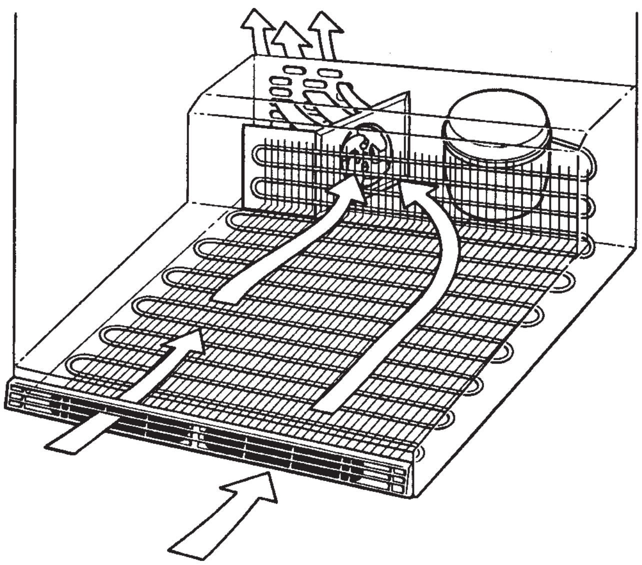

Figure 11 - Forced Draft Condenser

The hot wall type condenser is bonded to the inner surfaces of the outer case and is usually coated with a mastic to aid heat transfer. Thus, heat from the condenser is transferred directly to the outer case which helps prevent sweating on the outer case. This type condenser is used in most chest and upright freezers. Many freezer models have two condensers that are connected in series with an oil loop in the bottom of the compressor case. On these models, high pressure vapor from the compressor first enters the oil cooler then passes through the oil loop and finally into the main condenser.

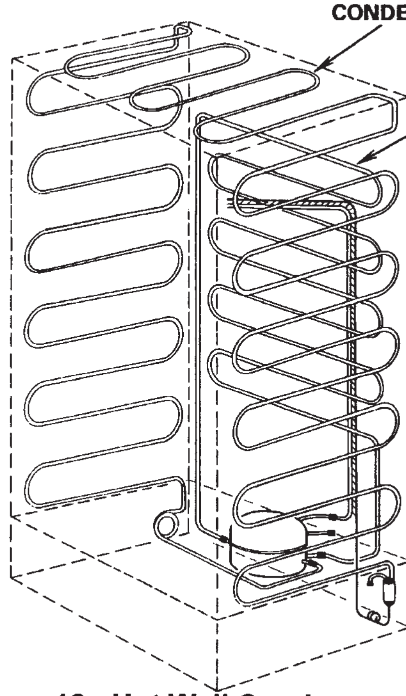

Figure 12 - Hot Wall Condenser

<u>Dryer</u>

The refrigeration system must be free of dirt and moisture because a single particle of dirt, or one drop of water, can cause the system to fail. For this reason, a dryer is a necessary component of the refrigeration system. The dryer consists of molecular sieve beads, a screen at the outlet, and a strainer at the inlet. The beads have a great ability to attract and absorb molecules of water but reject the molecules of refrigerant, oil, nitrogen and most other substances. The fine mesh screen prevents small particles (including crushed beads) from plugging the capillary. The strainer prevents spilling the beads from the inlet.

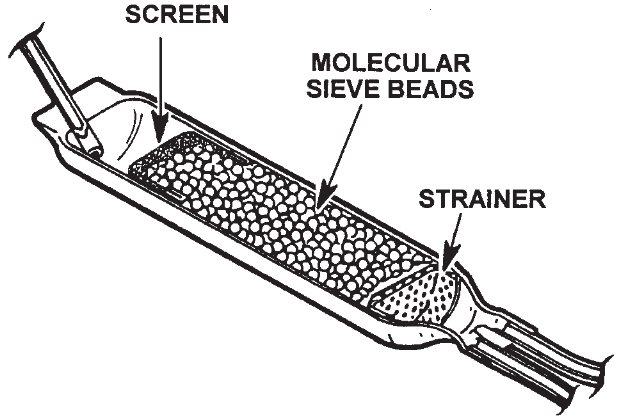

Figure 13 - Typical Dryer Construction

The dryer is normally located between the outlet of the condenser and the inlet of the capillary. However, on some earlier models, it is located inside the last pass of the condenser tubing. On these models, a crimp in the tubing substitutes for a strainer.

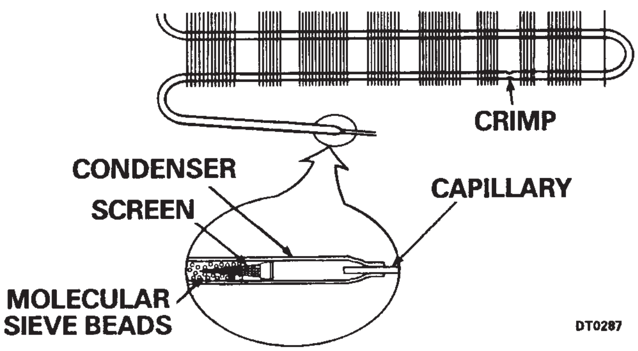

Figure 14 - In-Condenser Dryer

Restrictions in the refrigeration system generally occur as a result of: excessive moisture, a plugged capillary, or a clogged screen. Therefore, replacing the dryer will usually correct the restriction. Furthermore, any time the refrigeration system is repaired, a new dryer must be installed to prevent the possibility of a restriction. Most replacement compressors have a new dryer either installed in the loop of tubing or included loosely with the compressor. When installing a dryer, the outlet end must always be positioned downward so that liquid refrigerant is collected at the inlet to the capillary.

Filter
A filter, having the appearance of a large diameter dryer, is provided in some refrigeration systems and furnished with some replacement compressors. The filter has a solid core, made of a special porous material, that is capable of chemically removing contaminants from the system. In addition, a very fine mesh screen is located at the outlet of the filter. An arrow, stamped on the body of the filter, indicates the proper direction of flow.

For systems using R134a refrigerant, a combination filter/dryer is furnished with the replacement compressor. Furthermore, a new filter/dryer must be installed any time a R134a system is repaired. When a filter/dryer is added to the high side of the system, an additional 1/2 ounce of refrigerant is required.

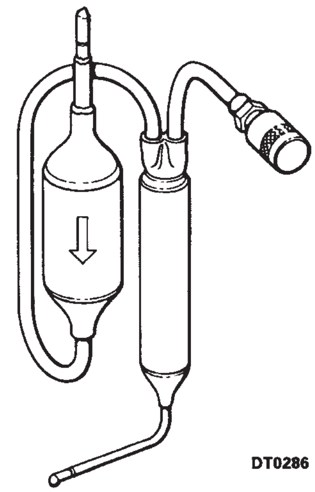

Figure 15 - Filter/Dryer for R134a Systems

Capillary
The capillary in refrigeration systems is a very small diameter tube that is usually about 6 to 8 feet long. Its primary function is to control the flow of liquid refrigerant into the evaporator. The flow rate of a capillary, determined by its diameter and length, is very critical to the proper operation of the refrigeration system. For example: If a capillary is shortened, its flow rate will be increased. Therefore, when repairing a refrigeration system, it is very important to cut the capillary as close as possible to the outlet of the dryer. A replacement capillary is not available separately for any model.

Heat Exchanger
The heat exchanger consists of the capillary and the suction tube. Usually, the capillary is soldered to the outside of the suction tube. However, on some models, the capillary is positioned inside the suction tube — for the greater part of its length.

The function of the heat exchanger is to transfer heat from the warm liquid in the capillary to the cool vapor in the suction tube, thereby improving the efficiency of the system. Reducing the heat of the capillary lowers the boiling point of the liquid entering the evaporator. Increasing the heat of the suction tube increases the density of the vapor entering the compressor. Furthermore, heat applied to the suction tube helps prevent it from sweating.

Heat exchangers are furnished as a part of most replacement evaporators and, generally, are not available separately. However, heat exchangers are available for some freezer models.

Evaporator

The evaporator for most models is made of aluminum tubing and formed into various shapes. Additional metal surfaces that are attached to the evaporator tubing increase its efficiency in attracting heat and accumulating frost.

Some earlier models have a sheet-and-tube type evaporator whereby the tubing is bonded to a metal sheet that is folded to form the frozen food compartment.

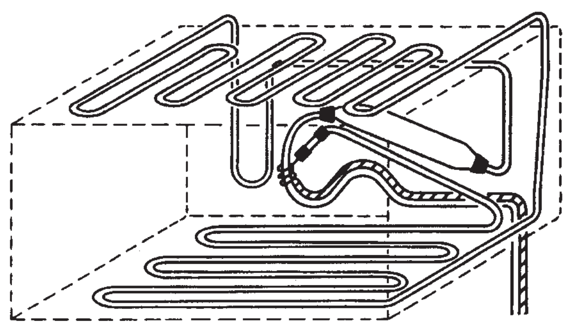

Figure 16 - Sheet-and-Tube Type Evaporator

Some later models have a rollbond type evaporator that is made of two sheets of hardened aluminum bonded together with the refrigerant passageway expanded between the sheets.

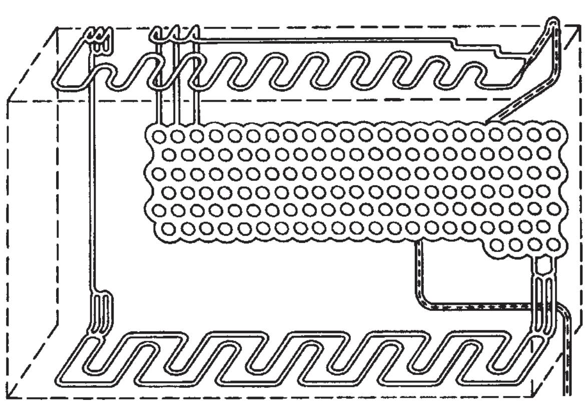

Figure 17 - Rollbond Type Evaporator

Most later models have a fin attached to the aluminum tubing that extends the surface area over which air is circulated by a fan. Variations of this type are: shredded-fin, spiral-fin, and spine-fin.

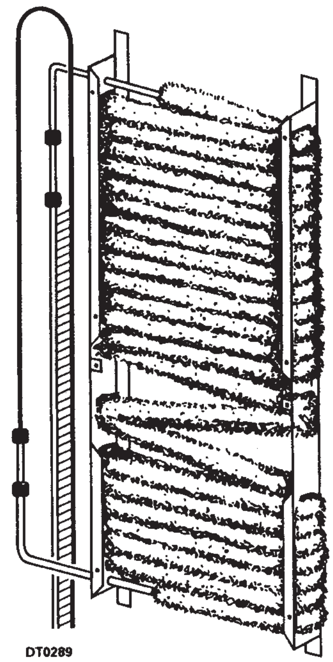

Figure 18 - Spine-Fin Type Evaporator

Evaporators in some upright freezer models, made of steel tubing with welded steel wires, serve a dual purpose as refrigerated shelves within the cabinet liner. Usually, each refrigerated shelf can be replaced separately.

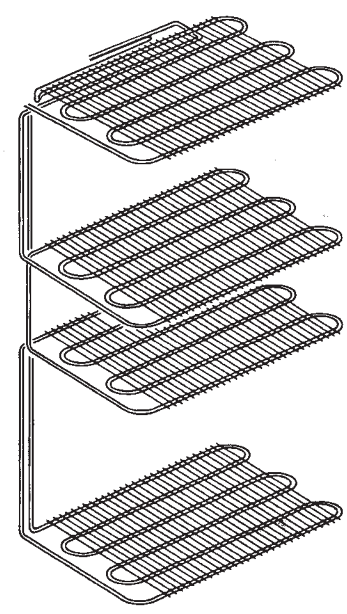

Figure 19 - Refrigerated Shelves

SYSTEM CONFIGURATIONS

All refrigeration systems in refrigerators and freezers consist of a compressor, condenser, dryer, heat exchanger, and an evaporator. Most of these components are different in size, shape, and appearance as needed for the various model applications. However, all systems of recent years are configured in three categories: manual defrost, cycle defrost, and automatic defrost.

Manual Defrost

The refrigeration system in most small refrigerators (and freezers) has a single evaporator that must be manually defrosted. The evaporator also serves as the frozen food compartment. Air circulation over the evaporator and within the cabinet is by natural convection. As warm air rises and cool air falls, heat is removed from the fresh food as well as from the frozen food. Earlier models generally have sheet-and-tube type evaporators, but most later models have the rollbond type. An accumulator, located at the outlet of the evaporator, prevents liquid refrigerant from entering the suction tube when the frost accumulation is heavy. The condenser used in this system is usually the natural draft type.

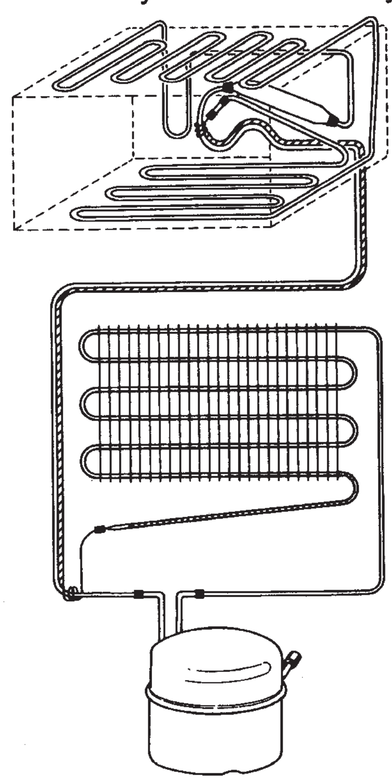

Figure 20 - Manual Defrost System

Cycle Defrost

On some intermediate size refrigerators, the refrigeration system has two evaporators connected in series that separately remove heat from the freezer and fresh food compartments. The freezer evaporator must be manually defrosted but the fresh food evaporator is defrosted during each off cycle of the compressor. This is accomplished by the temperature control which will not close the circuit to the compressor until the temperature of the fresh food evaporator is well above 32°F. Although, the off cycle time is not long enough to have any adverse effect on the freezer temperature. The condenser in this system is usually the natural draft type. However, an auxiliary condenser, connected in series with the main condenser, may also be required to help evaporate defrost water in the drain pan.

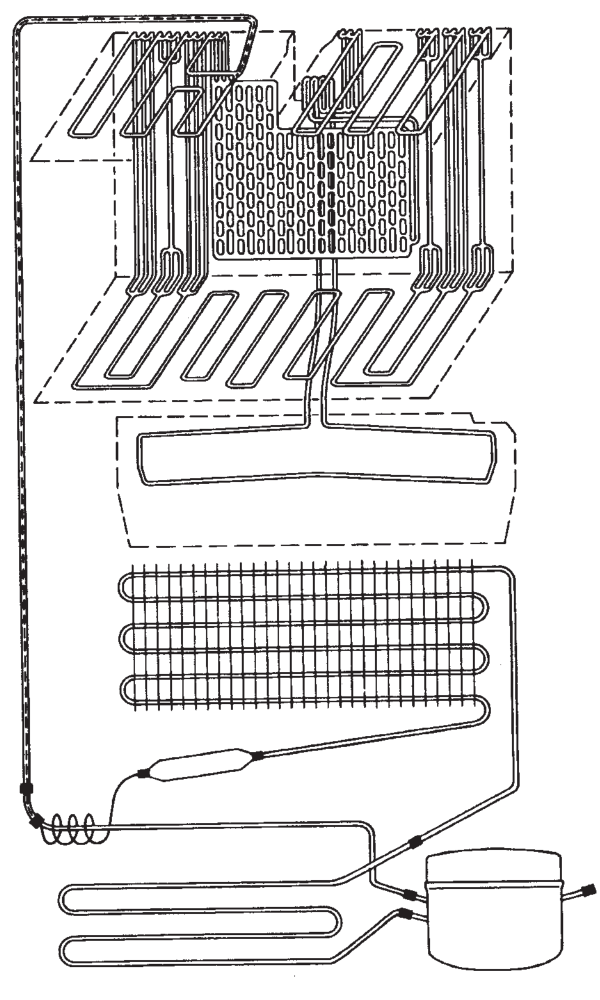

Figure 21 - Cycle Defrost System

Automatic Defrost

The refrigeration system in most larger refrigerators and some upright freezers has a single evaporator that is automatically defrosted at programed intervals. The evaporator is located in the freezer compartment but partitioned by a cover that isolates the evaporator. Air circulation, over the evaporator and throughout the fresh food and freezer compartments, is provided by a fan. A greater amount of air is circulated within the freezer compartment than in the fresh food compartment to provide optimum temperatures in both compartments. Most systems of this type have two or more condensers connected in series. The main condenser is usually the forced draft type. In addition, a condenser loop (sometimes two loops) are provided to warm the front of the outer case and mullion. An auxiliary condenser may also be attached to the bottom of the drain pan.

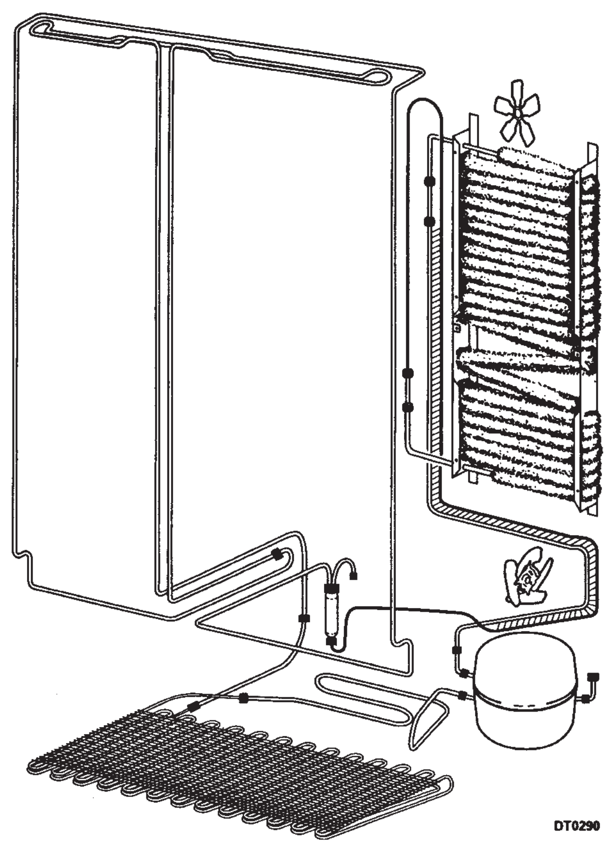

Figure 22 - Automatic Defrost System

DIAGNOSIS

Success in satisfying the consumer should begin with paying close attention to the consumer's complaint. Ask questions to find out exactly why the consumer is dissatisfied. Then, write the complaint on the invoice and keep it in mind until the call is completed. It could be that the product is not actually at fault but, rather, a lack of understanding how to use the product or how it should perform. Thus, consumer satisfaction is dependent upon a correct diagnosis.

Preliminary Examination

On every call, when the consumer complains of "poor performance", a preliminary examination should first be made to determine if the cause is external to the refrigeration system. Most often, the cause is not within the refrigeration system. Many complaints require only an explanation or reassurance that the product is operating according to specifications. Answers to the following questions will provide guidance for an accurate diagnosis:

1. Food Temperatures — Are the fresh food and freezer temperatures normal?

2. Temperature Control Settings — Are the controls set for the desired temperatures?

3. Room Ambient — Is the room temperature too warm or too cool?

4. Door Gaskets — Are they both sealing adequately?

5. Frost Accumulation — Does the evaporator have a heavy frost accumulation? Is the defrost system operating properly?

6. Evaporator Fan — Is the fan operating? Are the air supply and return ducts unobstructed?

7. Unusual Heat Load — Are the lights off when the doors are closed? Is the icemaker stalled?

8. Usage — Is the consumer usage heavy or light? Is the freezer compartment almost full or empty? Is all food in the fresh food compartment covered?

9. Condenser — Is it clogged with dust? Is the fan operating? Are clearances at the top, rear, and sides of the cabinet sufficient for air circulation? Are air baffles or the rear access cover missing?

10. Compressor — Is it operating? Is the sound level normal?

Preliminary Conclusion
If the cause of a "poor performance" complaint is not discovered during the preliminary examination, the refrigeration system should then be carefully examined.

KNOWLEDGE EXERCISE

For each of the following statements, select only one response.

1. Compressors in refrigeration systems are rated by their ability to remove heat and stated as:
   _____ a. Wattage.
   _____ b. Horsepower.
   _____ c. Voltage and Amperage.
   _____ d. British Thermal Units per hour (BTU/hr.).

2. Heat always:
   _____ a. Is dependant upon conduction.
   _____ b. Warms the surrounding space.
   _____ c. Flows from a warmer substance to a cooler substance.
   _____ d. Flows from a cooler substance to a warmer substance.

3. The operation of a refrigeration system is dependent upon two changes of state:
   _____ a. Evaporation and condensation.
   _____ b. Condensation and liquefaction.
   _____ c. Evaporation and vaporization.
   _____ d. Condensation and fusion.

4. The difference in pressures within a refrigeration system is provided by the:
   _____ a. Dryer.
   _____ b. Evaporator.
   _____ c. Condenser.
   _____ d. Compressor.

5. The coldest object in a normally operating refrigerator is the:
   _____ a. Condenser.
   _____ b. Evaporator.
   _____ c. Ice cubes in the ice bin.
   _____ d. Food in the freezer compartment.

6. Rotary type compressors have a:
   _____ a. Low pressure case with terminals on the top.
   _____ b. Low pressure case with terminals on the side.
   _____ c. High pressure case with terminals on the top.
   _____ d. High pressure case with terminals on the side.

7. The purpose of a dryer in the refrigeration system is to remove:
   _____ a. Dirt and oil.
   _____ b. Dirt and moisture.
   _____ c. Moisture and acid.
   _____ d. Nitrogen and water.

8. The heat exchanger consists of the capillary and the:
   _____ a. Suction tube.
   _____ b. Evaporator.
   _____ c. Condenser.
   _____ d. Dryer.

