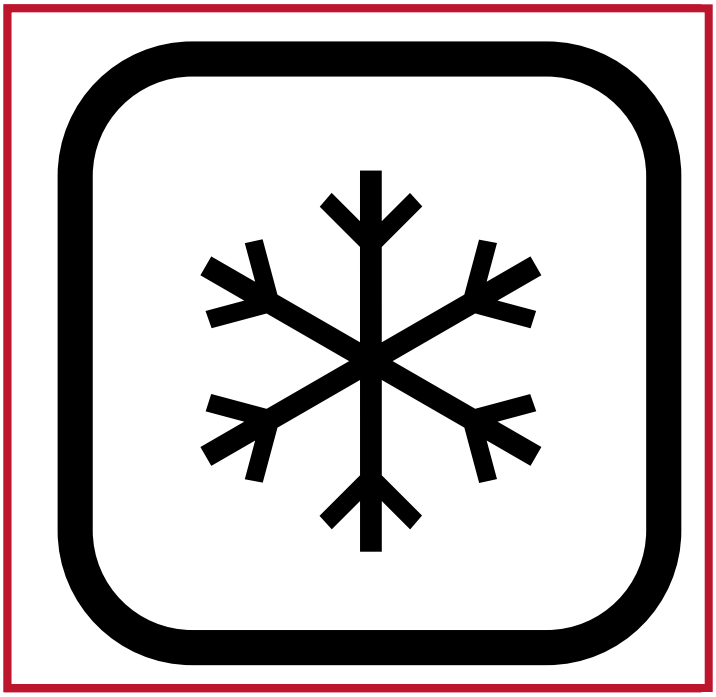
AFTER
SALES
SERVICE

FAGOR

BASIC STUDY

technical Documentation

PRODUCT: Cold

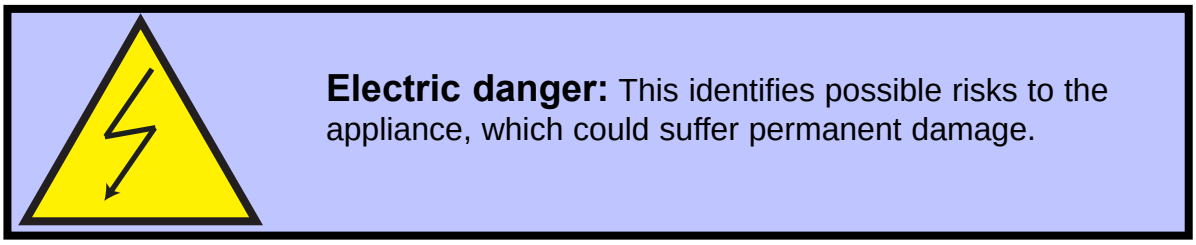


Date: 28/07/2003

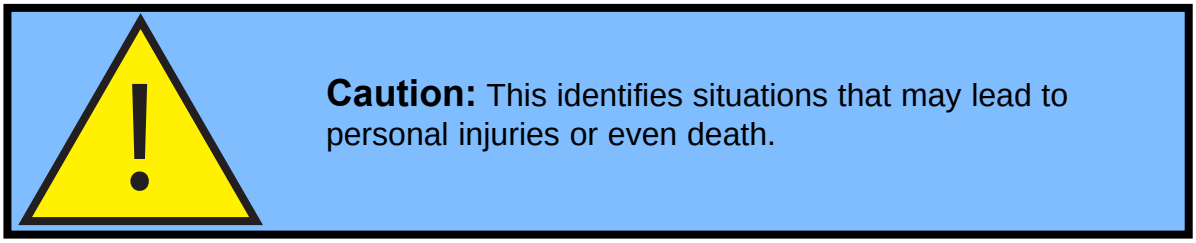
Document Nº: 3484

This document is written for those providing a technical assistance service (servicio de asistencia técnica, S.A.T.). It is designed to facilitate the repairing of the product to which it refers. It provides a documentary medium for technical consultations.

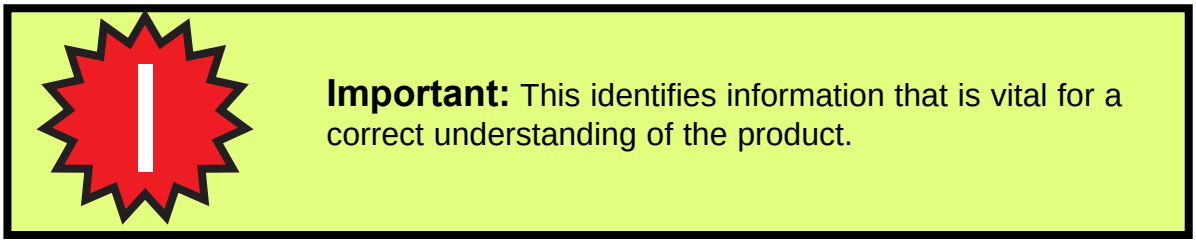
This manual gives security warnings as follows:



Electric danger: This identifies possible risks to the appliance, which could suffer permanent damage.



Caution: This identifies situations that may lead to personal injuries or even death.



Important: This identifies information that is vital for a correct understanding of the product.

Contents

1.- Basic concepts

1.1-Temperature

Materials are generally formed of molecules, which is the smallest portion of matter. Low temperature corresponds to slow molecular movement and high temperature to fast molecular movement.

The measuring units are as follows:

- Celsius scale (ºC)

- Fahrenheit scale (ºF)

- Kelvin scale (K)

In order to convert temperatures from one unit to another, the following formulae can be used:

Temperature ºF = (1.8 x Temperature ºC) + 32

Temperature ºC = (Temperature ºF - 32) / 1.8

0º Kelvin = -273 ºC (0 K corresponds to absolute zero. Molecular movement starts above this temperature)

1.2- Energy units

1.2.1- Calories

A calorie is the amount of heat required to raise the temperature of a gram of liquid water by one degree centigrade (ºC).

1.2.- Joules

This refers to the work carried out by the force of a Newton when its application point is displaced a metre in the direction of the force. (1 calorie = 4.18 joules)

1.3- Pressure

Pressure is defined as the perpendicular force exerted by a solid, liquid, or gas on a certain surface area.

Pressure = Force / Surface

The units can be: Bar, mmHg, Pascal, or Kg/cm^2

1.4- Latent heat from vaporisation and condensation

Each material has its own heat value for a change in temperature (specific heat) or a change in the state of matter (latent heat).

it can be stated as a general rule that a substance has better refrigerating properties the greater its latent heat (a smaller amount of refrigerant is needed to absorb the same heat).

1.5- Transmission of heat

Heat may be transmitted in various different ways:

1.5.1- Conduction

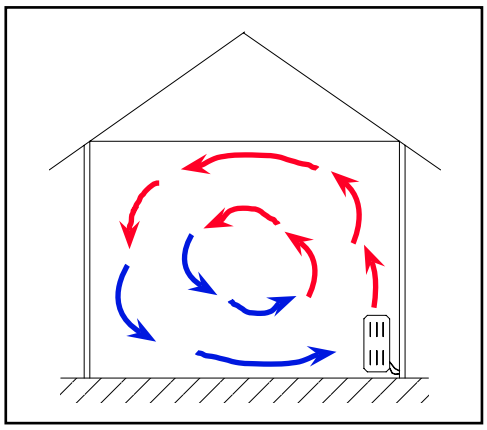
This is the method of transferring heat which occurs in solids.

1.5.2- Convection

This is the method of transferring heat which occurs in fluids or gases.

Example:

Wall convector: The fluid (the air) heats up, so it therefore has a lower density, which results in hot air rising up the wall. It cools down, its density increases, which makes it descend again, thus creating air convection currents.

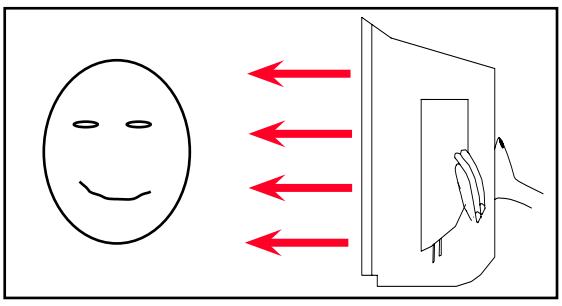


1.5.3- Radiation

This is the method of transferring heat that occurs in spaces by means of waves.

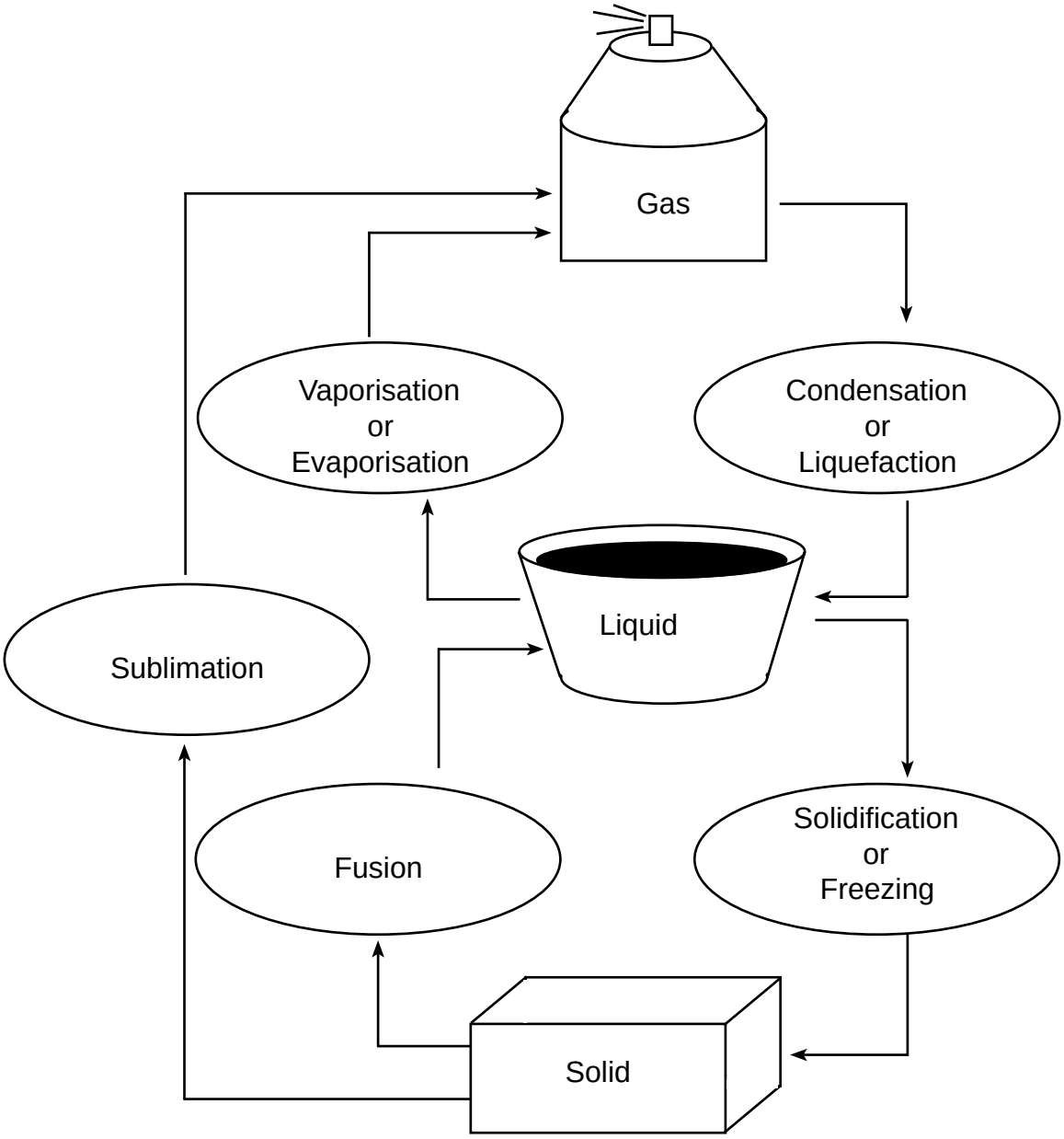
Example:

A person feels the heat of an iron on his/her cheek, due to invisible infrared rays. These rays, like light, travel in a straight line and can be deviated or stopped when they meet an obstacle. If the iron is moved closer to the cheek, the effects of radiation can be directly felt.



1.6- States of the matter

Matter may occur in different states. Depending on the conditions, it may transform itself into other states.



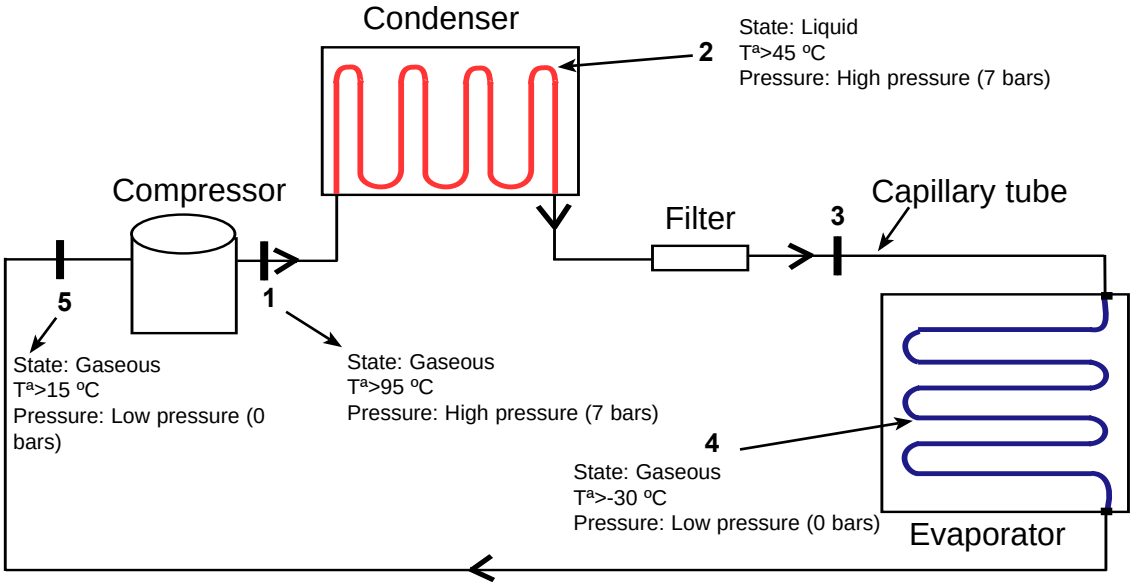
These changes in state are diectly related to changes in temperature and pressure.

2.- Refrigeration circuit

2.1.- General description

The refrigeration circuit of an electrical appliance (fridge, freezer), is mainly based on the changes of state (condensation/evaporisation) of a refrigerant. The most common refrigerants are R134a and R600a...

The refrigeration circuit of a fridge or freezer is as follows:



In order to analyse the process of the circuit, two parts are differentiated:

- High pressure circuit
- Low pressure circuit

High pressure circuit

Point 1: The piston of the compressor sucks in the refrigerant gas. The gas is compressed and increases its temperature by compression.

Point 2: The gas is sent to the condenser, where it loses part of its calories to the outer atmosphere. in this way, the gas gradually condenses (it changes from a Gas to a Liquid) as it loses calories.

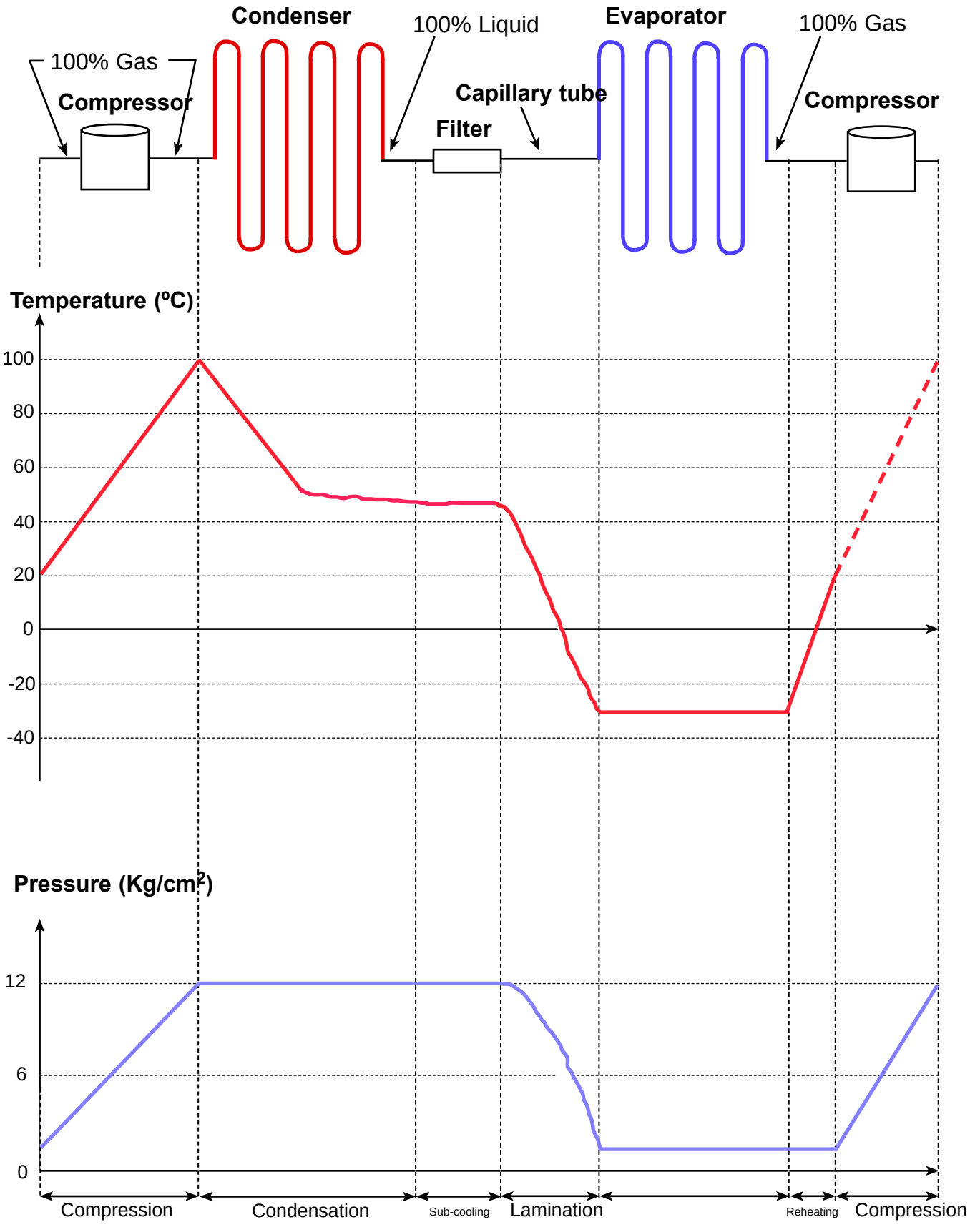
Point 3: Afterwards it passes to the capillary tube which has the function of regulating the refrigerant flow.

Low pressure circuit

Point 4: The refrigerant enters the evaporator in a liquid state (it passes from Liquid to Gas), absorbing calories from the interior of the appliance.

Point 5: The refrigerant returns to the compressor in a gaseous state to begin a new cycle.

Temperature Graphs / Pressure of the fridge circuit:



2.2.- Main components

2.2.1- Compressor

The compressor is an electric engine that sucks in and compresses the refrigerant in a gaseous state. It drives the refrigerant through the circuit, thus establishing a pressure difference between the two areas. This difference is taken advantage of in order to carry out the processes of condensation and evaporation.

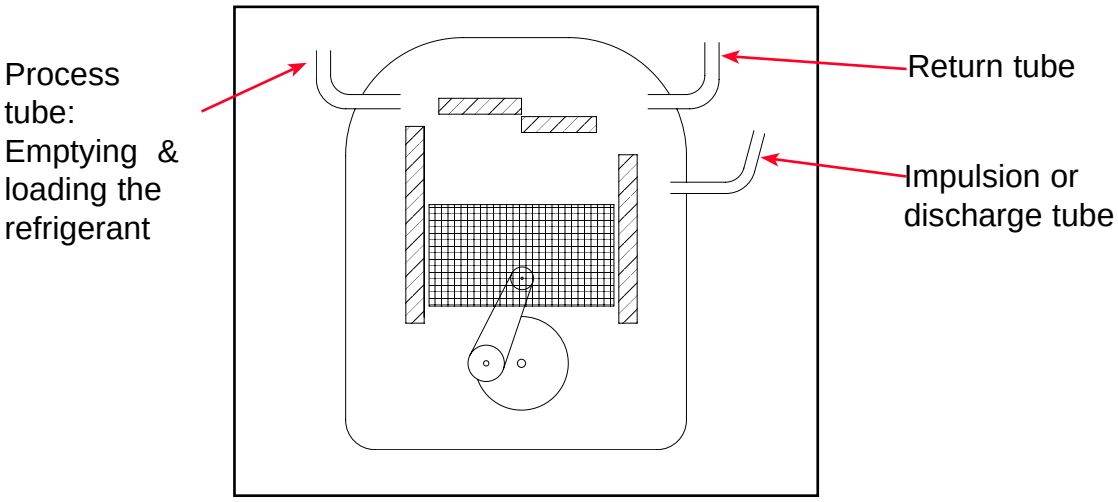
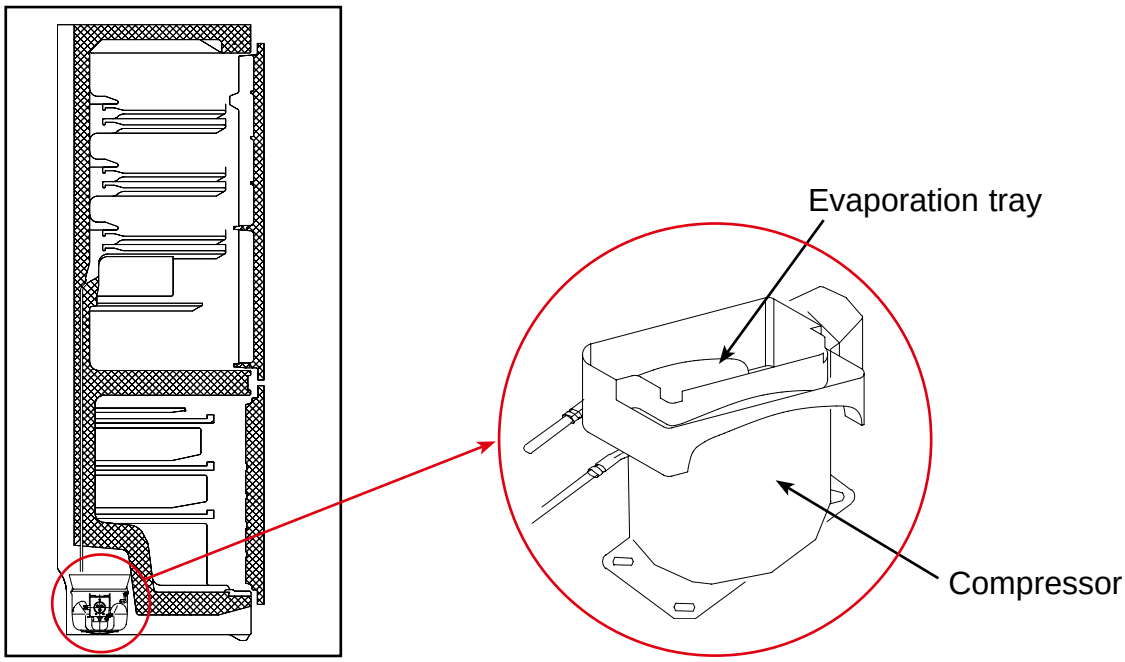


Figure 2.1: Compressor

2.2.2- Evaporation tray

This tray is placed over the compressor in such a way that when the appliance is switched off or defrosting, the frost or ice accumulated defrosts and leads off to this tray. In the running cycles, the compressor generates sufficient heat in order to,evaporate the liquid accumulated in the tray.



2.2.3- Overload protector (OLP)

The function of the overload protector (OLP) is to protect the electric engine of the compressor by interrupting the mains supply in the case of overloading or overheating.

There are two types of protectors:

- **Internal**: This protector is fixed on the coil of the stator of the compressor itself. It cannot be replaced in the case of breakdown.

- **External**: This protector is located on the outer surface of the compressor. If there is a breakdown, it can be replaced.

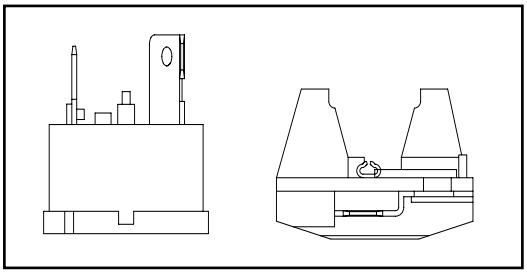


Figure 2.2: Types of external protectors

2.2.4- Start-up security

Once the compressor has started, its function is to disconnect the contacts that feed the starting coil. There are two types of starters:

- Intensity magnetic start-up relay:

It consists of a coil with a movable core with two contacts. When the current passes through the coil, a magnetic field is generated that attracts the core by closing the two contacts and feeding the start-up coil of the compressor. As soon as the compressor starts, the absorbed current drops in intensity; this reduces the magnetic field generated in the coil of the relay which in its turn disconnects the contacts that feed the start-up coil of the compressor.

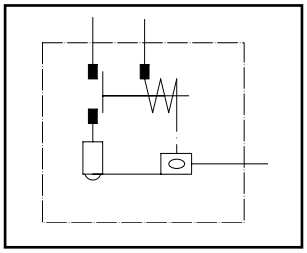
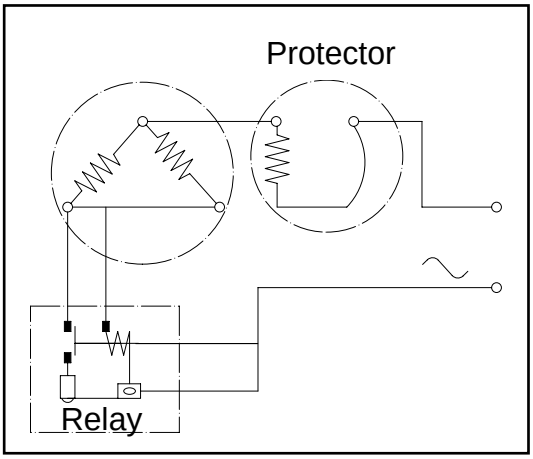


Figure 2.3: Relay



- PTC Static starting device:

The PTC (Positive Temperature Coefficient) is a resistance variable. The higher the temperature, the greater the resistance.

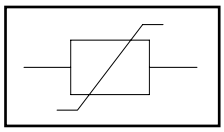
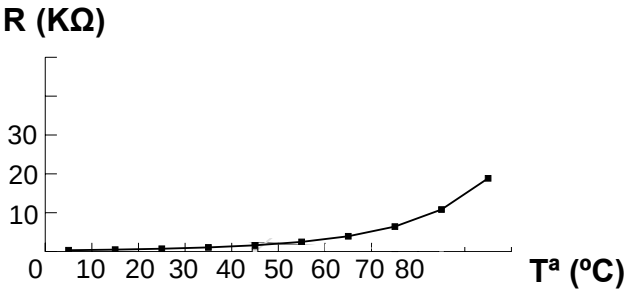
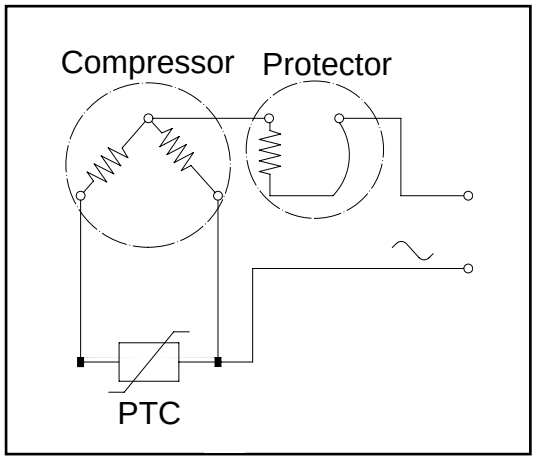


Figure 2.4: PTC





Certain compressors have the protector built-in to their interior.

2.2.5- Dehydrating fllter

The mission of the filter is to absorb residual humidity and the solid impurities that may occur in the refrigeration circuit.

1.- Deposit

2.- Mesh-bearing ring

3.- Thread mesh

4.- Sieve

5.- Granulate: (molecular sieves) Retains humidity

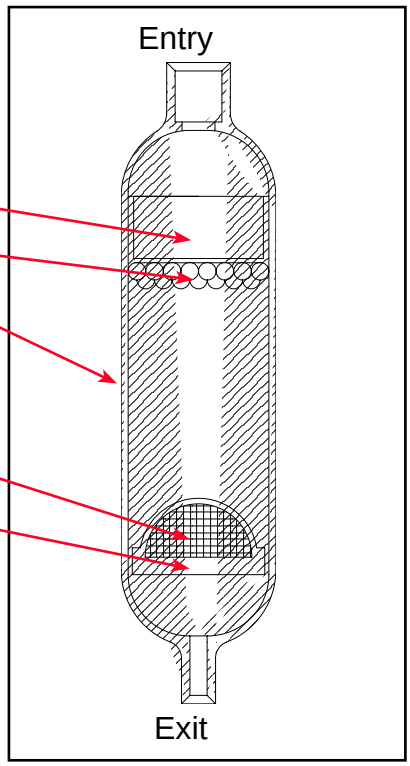


Figure 2.5: Dehydrating filter

2.2.6- Condenser

The function of the condenser is to evacuate the heat generated by the refrigerant. In this way, the refrigerant passes to a liquid state, losing part of its heat to the atmosphere.

Various types of condenser exist:

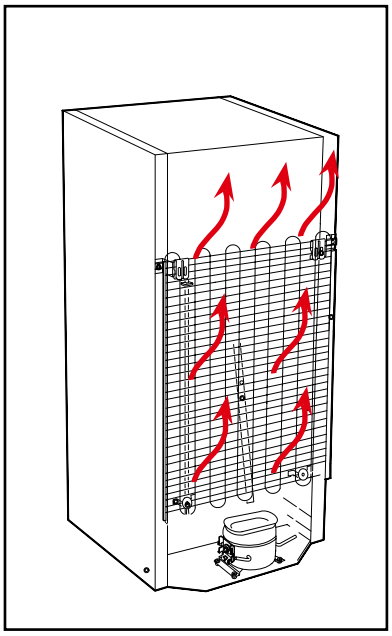
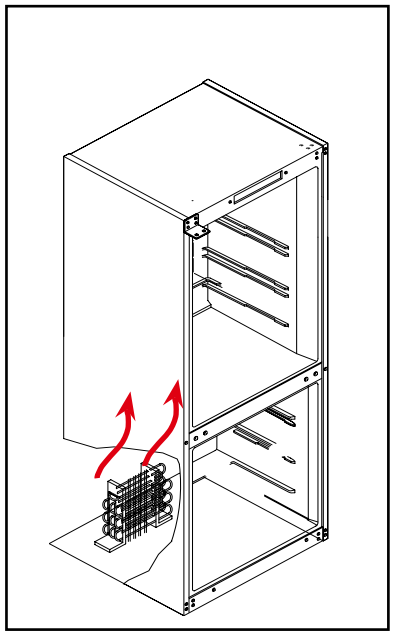


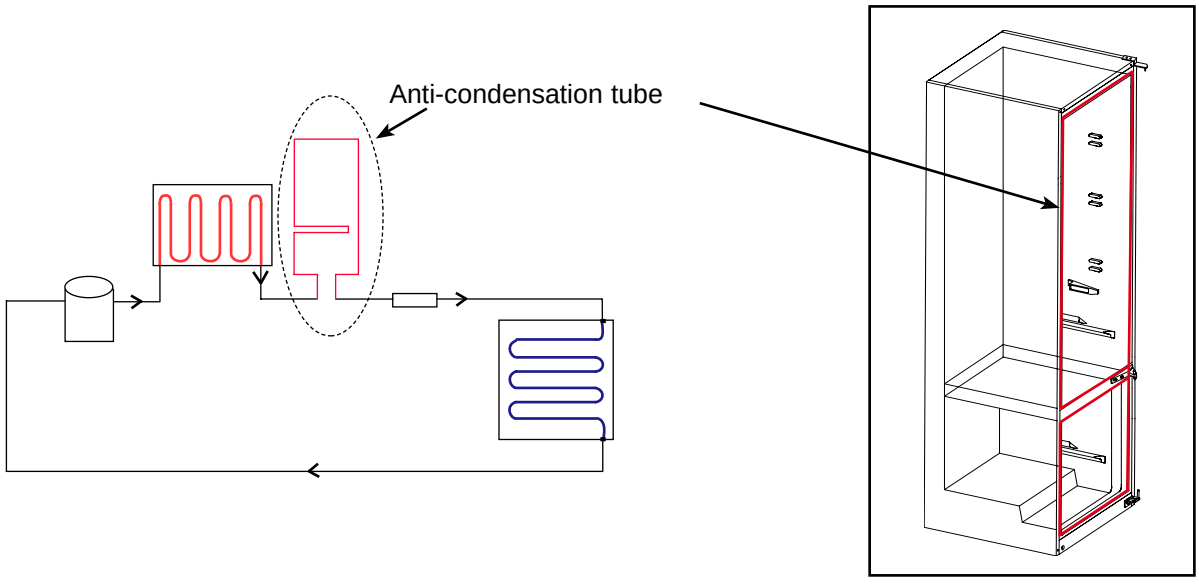
Figure 2.6: External condenser



Figurr 2.7: Internal condenser

2.2.7- Anti-condensation tube

This tube is the extension of the condenser, it passes through the door frame of the fridge or freezer. in this way possible condensation that might appear around the doors and bring in heat will be avoided.

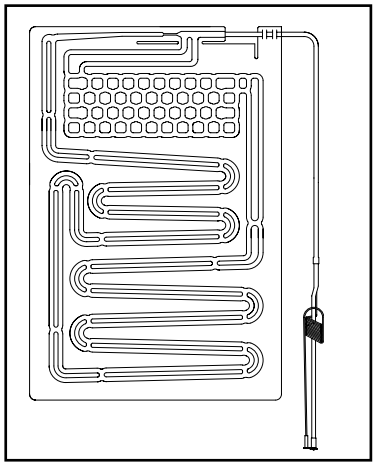


2.2.8- Evaporator

The refrigeration process occurs when the refrigerant evaporates in the evaporator. The refrigerant that passes through the capillary tube evaporates at low pressure in the evaporator. This evaporisation effect of the refrigerant absorbs the heat from the fridge unit.

There are several types of evaporator, some of which are described below:

- Refrigerator evaporator: This type of evaporator may be inside the fridge (hidden evaporador)



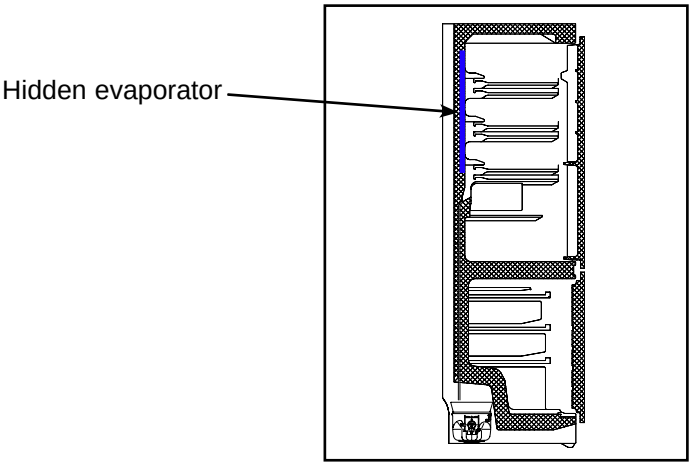


Figure 2.8: Plate evaporator

- Freezer evaporator: This type of evaporator may be inside the insulation (hidden evaporator)

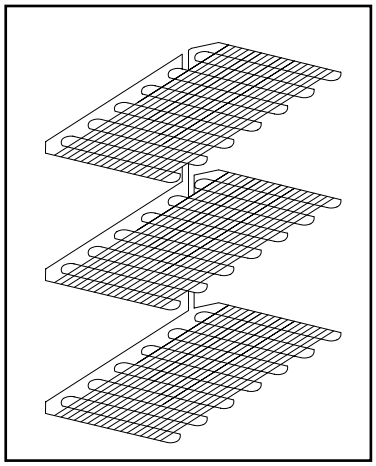


Figure 2.9: Pipe evaporator

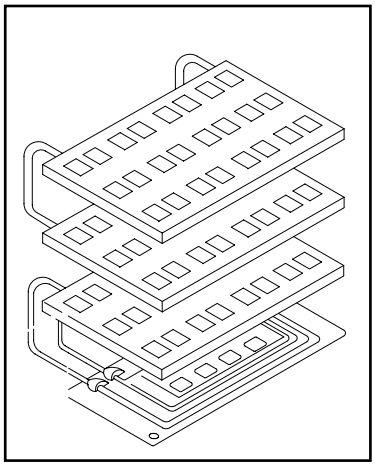


Figure 2.10: Plate evaporator

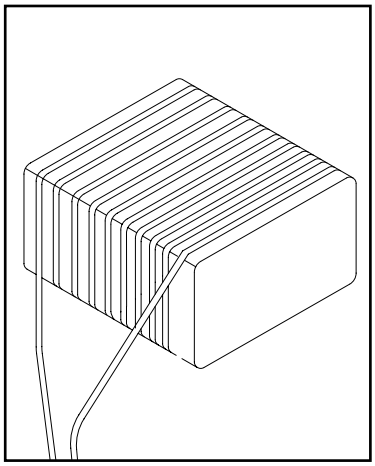


Figure 2.11: Two-door evaporator (hidden)

2.3- Regulation

Once the cold circuit has been described, a control capable of producing operation / stoppage cycles of the compressor is needed. In this way, a certain temperature should be maintained in the fridge unit or freezer.

Two types of control are currently available:

2.3.1- Electromechanical thermostat

This form of regulation consists of the electromechanical thermostat bulb in contact with the evaporator.

The capillary tube of the thermostat contains a liquid with physical temperature characteristics. In this way, when it detects temperature increases the liquid dilates, and when it detects a drop in temperature it contracts.

One part of the end of this capillary is in contact with the evaporator, which picks up variations in temperature. The thermostat is regulated by start-up and stoppage compressor temperatures.

Controlling the temperature of the evaporator in this way, a specific temperature is achieved in the fridge unit or freezer.

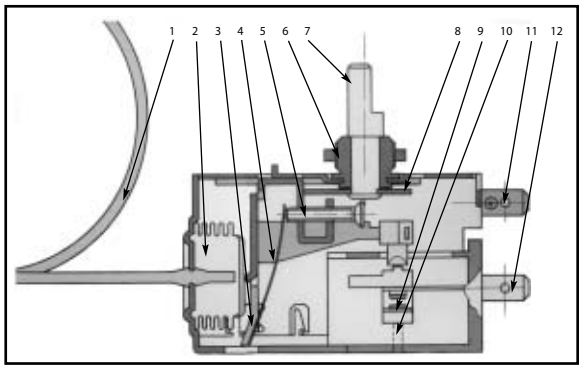


Figure 2.12: Electromechanical Thermostat

1.- Capillary
2.- Blower
3.- Main lever
4.- Main spring
5.- Regulating screw
6.- Nut
7.- Axis
8.- Adjustable cog
9.- Contact system
10.- Regulating screw
11.- Earth terminal (-)
12.- Terminal (+)

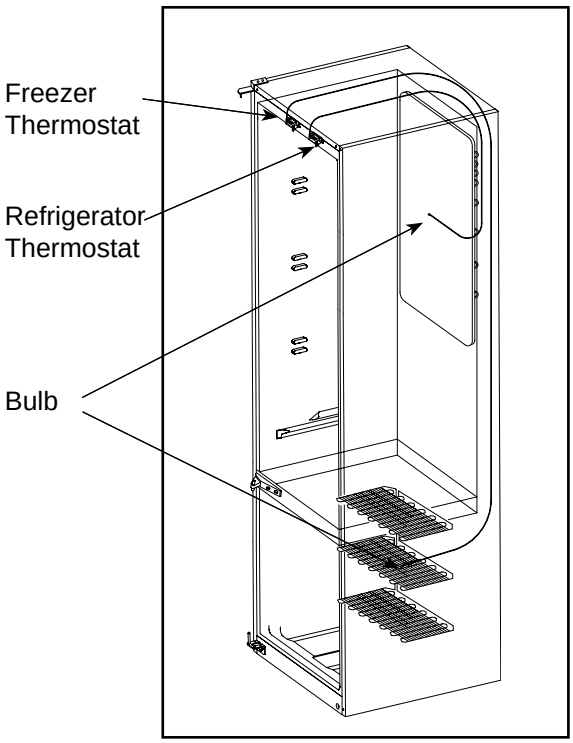


Figure 2.13: Combined type fridge

2.3.2- Electronic thermostat

This control consists of an electronic card and NTC probes. The NTC probes have variable resistance to temperature and are placed inside the fridge units or freezers.

The electronic card takes readings of the probes in such a way that depending on the demand for cold ithe compressor is activated or deactivated.

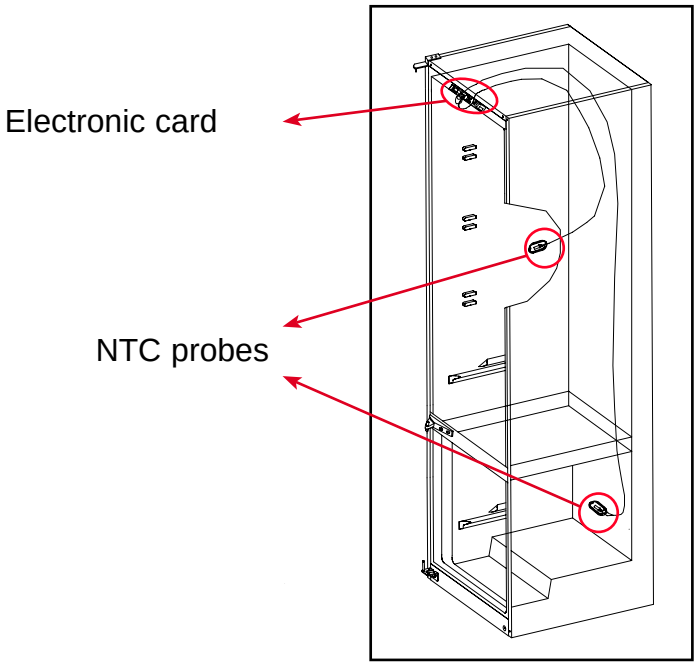
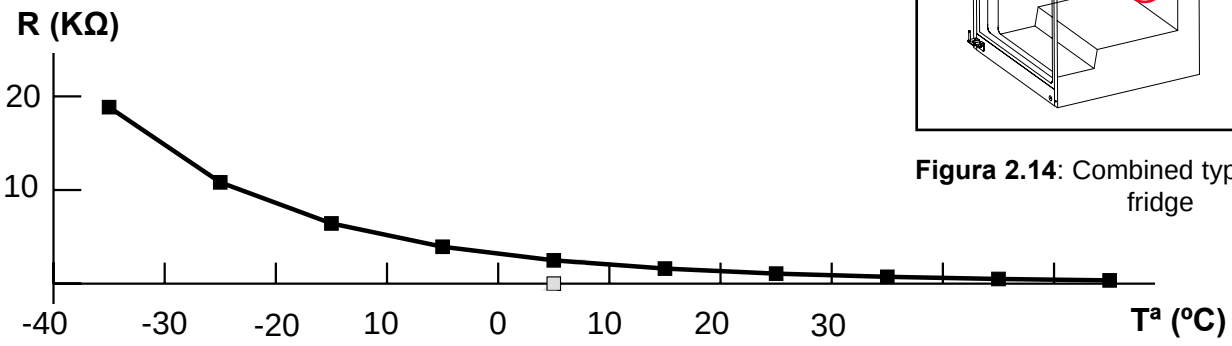


Figura 2.14: Combined type fridge



in contrast to electromechanical thermostats, this kind of probe is placed within the units. In this way the temperature changes are detected faster, owing to which the temperature within the unit can be maintained more constant.

3.- Cold technology

3.1.- Static cold

This system is based on the convection system in order to produce cold.

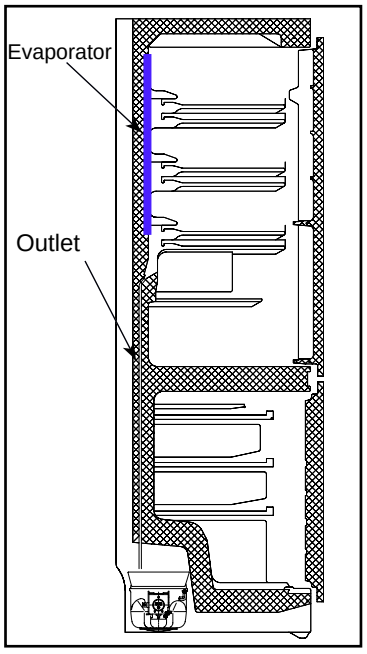
Nowadays fridge evaporators are generally hidden within the insulation. This evaporator is not accessible as it is covered by the insulant.

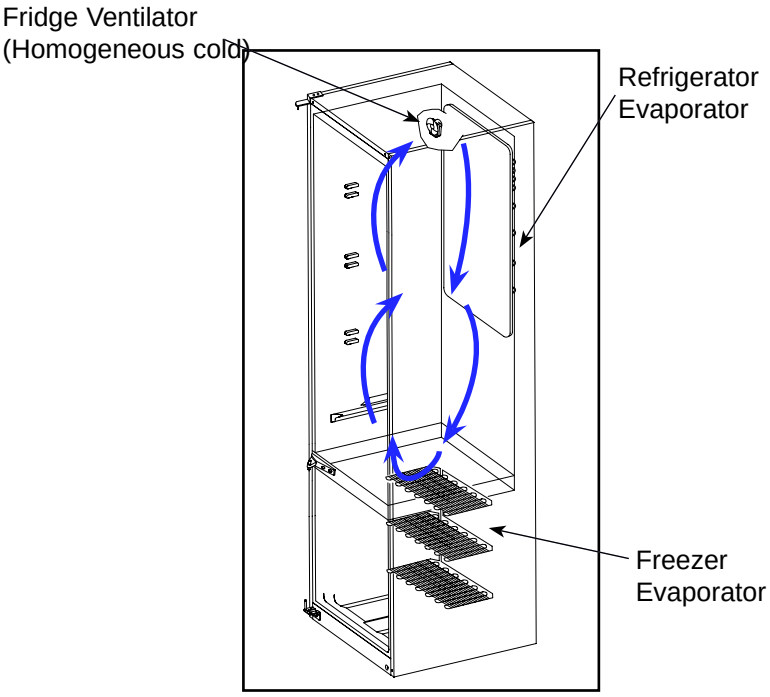
In this way, when the circuit is operating the evaporator is absorbing the heat from the fridge unit. Frost therefore acumulates on the back wall. When the circuit is in stoppage mode, the frost accumulated defrosts, filtering down the outflow to the evaporation tray.

The coldest zone is the lower area, and the hottest the higher area, due to the convection effect.

In this system, the fridge unit may have a ventilator. This fulfils the following functions:

- It evens out the temperatures within the fridge unit (Homogeneous cold)
- It minimises the possible condensations that may occur in the fridge unit.





In the freezer unit the evaporator may be accessible. In this unit the ice is accumulative, which means that the user must defrost the unit every so often. We recommend defrosting the freezer at least twice a year.

The period or frequency of defrosting varies depending on the environmental conditions and the use of the apparatus.

3.2.- Dynamic cold

This system is better-known as **No-Frost**. It is based on the absorption of all the heat and humidity from the unit by forcing air, using a ventilator, through the evaporator. In this way, dry cold air reaches all compartments of the fridge.

The evaporator or battery is hidden. The battery gradually accumulates ice. Every so often, a defrosting resistance is activated, which defrosts all the accumulated ice, evacuating the water by means of an outlet to the evaporation tray.

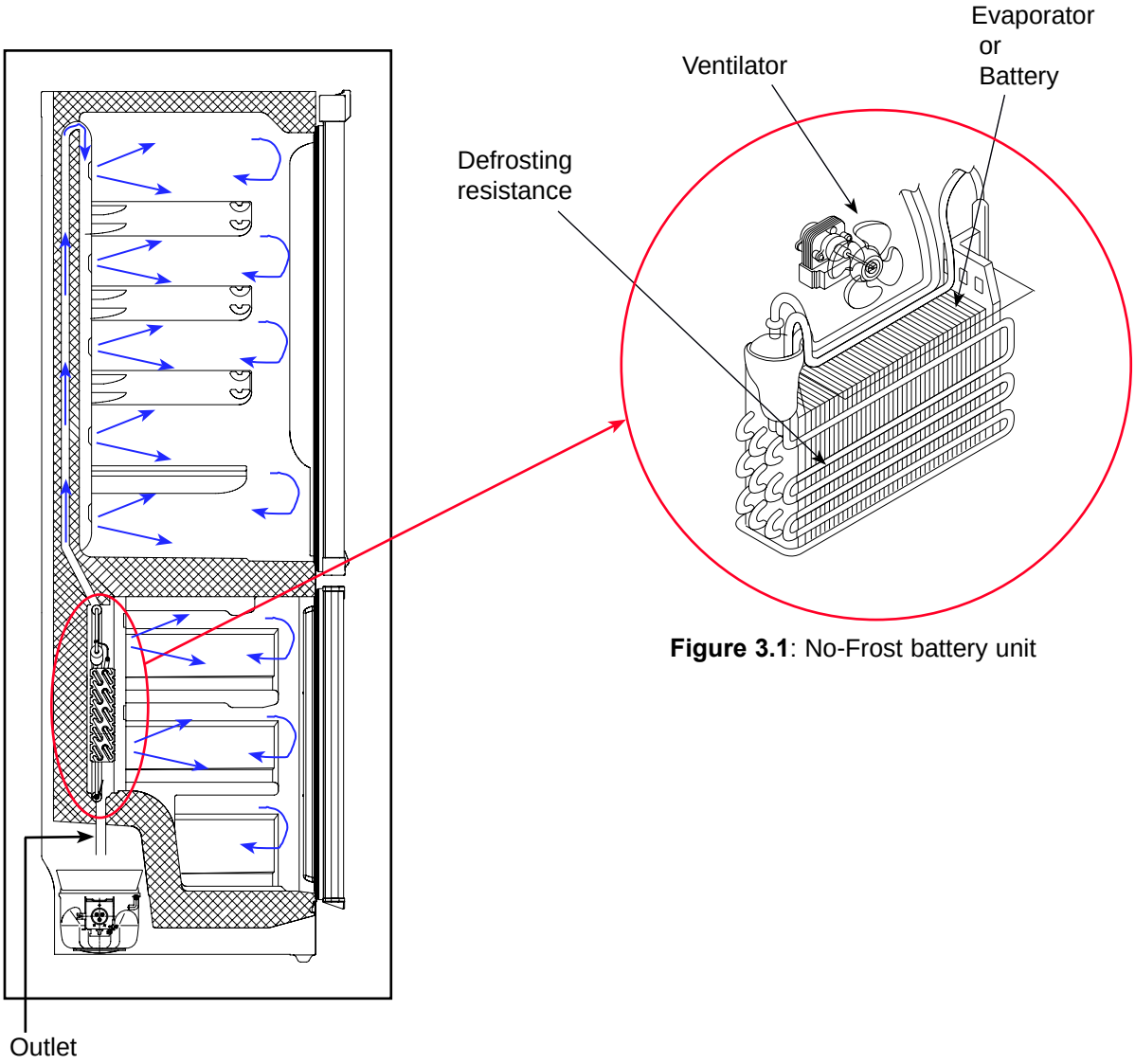


Figure 3.1: No-Frost battery unit

There are various types of control for the activation of defrosting resistance (electronic thermostat, timer...)

This system is recommended in areas of high temperature and humidity.

4.- Refrigerants

The most commonly used refrigerants are the following.

- R12
- R134a
- R600a

4.1- R12

The chemical name of R12 is Diclorodifluoromethane (C Cl_2 F_2). For many years it was the only fluid used in the operation of household fridges. It has the special property of evaporating at -29,8 ºC (at atmospheric pressure).

It damages the ozone layer and contributes to the greenhouse effect; for this reason it is now no longer used.

If R12 comes into contact with a flame, Phosgene is produced.

4.2- R134a

The chemical name of R134a is Tetrafluoroethane (CH_2 F - CFl_3). It has the special property of evaporating at -26,5 ºC (at atmospheric pressure).

It does not damage the ozone layer but it contributes to the greenhouse effect, due to which it has been banned in some countries.

* When in contact with a flame it produces toxic vapours of hydrofluoric acid (an irritating vapour).

* The refrigerant can cause burns if in contact with the skin or eyes.

* The inhalation of refrigerant can produce asphyxia.

Repair work with this refrigerant should follow the criteria below.

In all cases:

1.- Wear eye protection and protective gloves.

2.- Do not smoke in the proximity of the refrigerant.

3.- Protect the refrigerant from sources of heat in order to avoid excessive pressure.

4.- If the refrigerant comes in contact with the eyes, wash with plenty of water and go quickly to the nearest hospital.

5.- In the case of a leak or accidental spillage, ventilate the area.

6.- In the case of breathing problems, go quickly to the nearest hospital.

A specific area must be reserved (walls or half walls), for use when work is done only with circuits containing only isobutane.

Importane:

In order to look for leaks in circuits using R134a, R12 detectors cannot be used, as these detect Chlorine and R134a does not contain this. R134a absorbs humidity, due to which the “soapy water” method cannot be used, especially in the aspiration circuit (low pressure).

4.3- R600a

The chemical name of R600a is Isobutane or methylpropane (C_2 H_{10} o $CH(CH_3)_3$). It has the special property of evaporating at -11,7 ºC (at atmospheric pressure).

Isobutane has the advantage of neither contaminating the ozone layer nor contributing to the greenhouse effect, compared to refrigerants like R134a.

This refrigerant is inflammable. Appliances that use it can be identified as follows:

- R 600a is marked on the plate of characteristics
- R 600 a is marked on the compressor
- Inflammable symbol on the compressor

Repair work with isobutane refrigerant must follow the criteria below,

In all cases:

1.- Provide good ventilation in the place where the repairs will be carried out.

2.- Check there is no flame, source of heat, or electric arc present.

3.- Do not smoke

4.- Wear eye protection and protective gloves. Do not wear clothes made from synthetic fibres.

In the workshop:

A specific area (walls or half walls) must be reserved for use when work is being done only with circuits containing isobutane.

In the user's home:

Use a building with an outside exit for repair work. If necessary the fridge should be moved. Do not carry out repairs in closed spaces. Ventilate by opening doors and windows.

Warnings:

The oil used for R600a refrigerant circuits may be inflammable in large quantities due to its solubility with Isobutane.

The refrigerant may cause burns if it comes into contact with the skin or eyes.

Inhaling the refrigerant may produce asphyxia.

5.- General characteristics

5.1- Types of fridge

5.1.1- Combined type

These fridges are defined as having the freezer unit below and the fridge unit above. The units can be regulated independently.

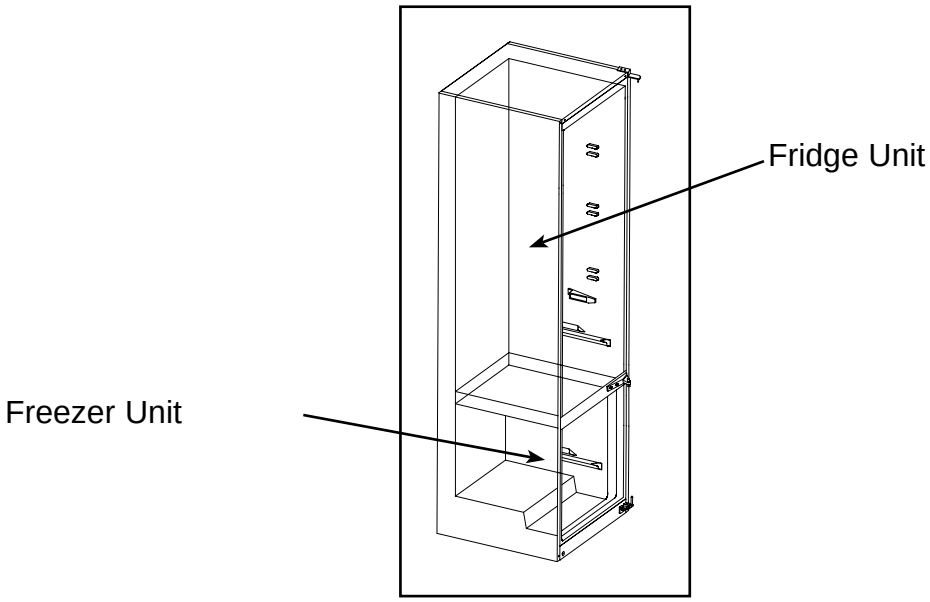


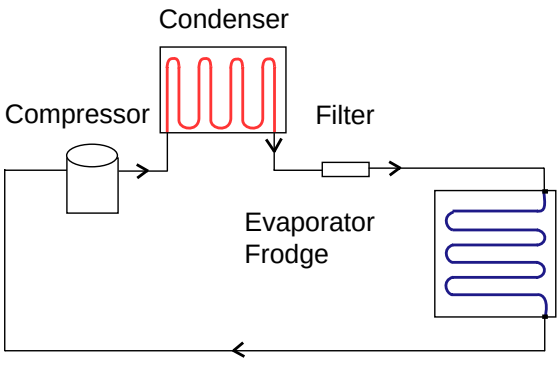
Figure 5.1: Combined fridge

There are several categories of combined type fridges:

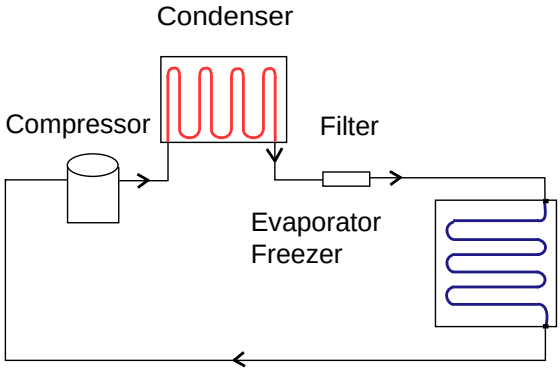
- Using 2 compressors

Two totally independent circuits.

Cold circuit of the Fridge:



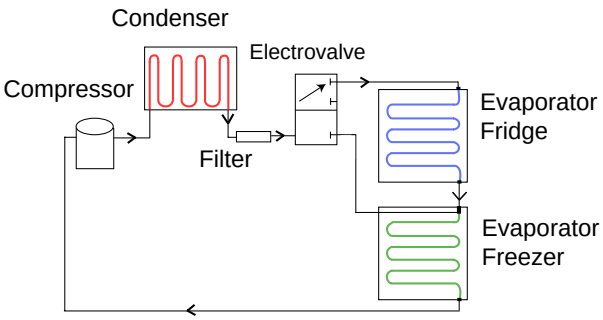
Cold circuit of tbe Freezer



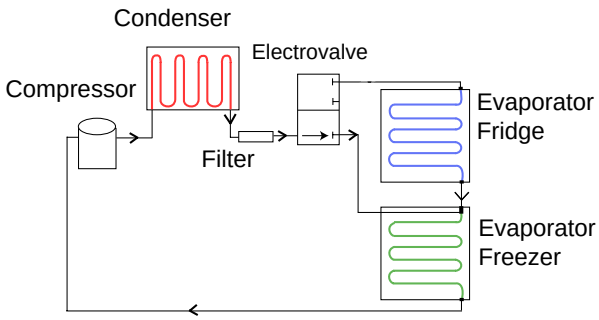
- Using 1 compressor + 1 electrovalve

A series circuit, depending on whatever unit, requires cold. According to priority, the refrigerant will pass through the whole circuit or only through the freezer unit.

Fridge Priority:



Freezer Priority:



5.1.2- Two doors

These fridges are defined as having the freezer unit above and the fridge unit below. They have a compressor. The two units cannot be regulated independently.

Cold circuit:

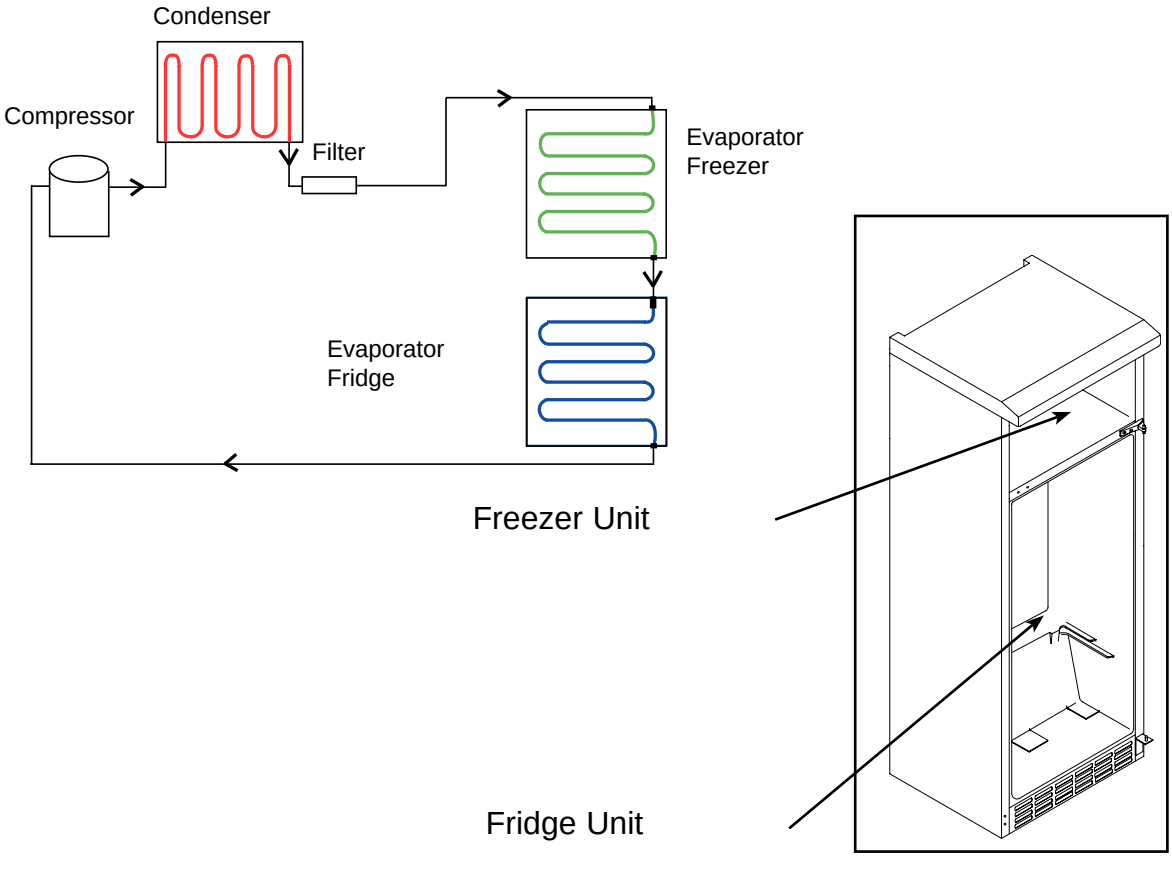


Figure 5.2: Two doors

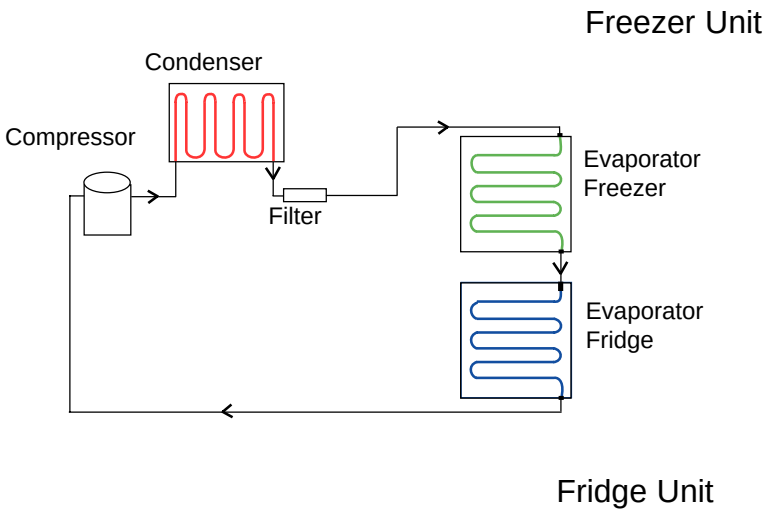
5.1.3- One door

There are various types of fridge with one door:

- With freezer unit

These fridges are defined as having the freezer unit within the fridge unit. They have a compressor. The two units cannot be regulated independently.

Cold circuit:



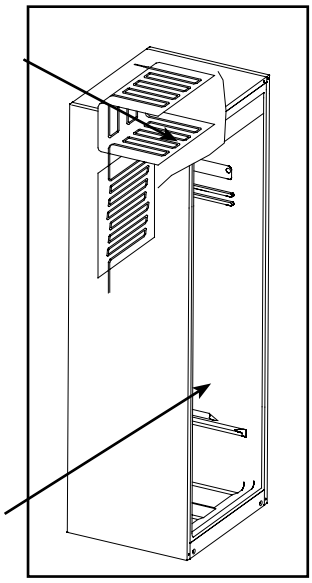
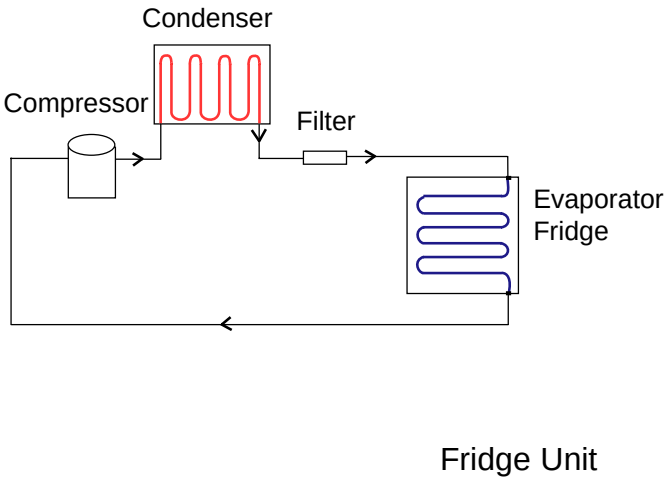


Figure 5.3: One door

- Cooler

These fridges are defined as having only a fridge unit. They have a compressor.

Cold circuit:



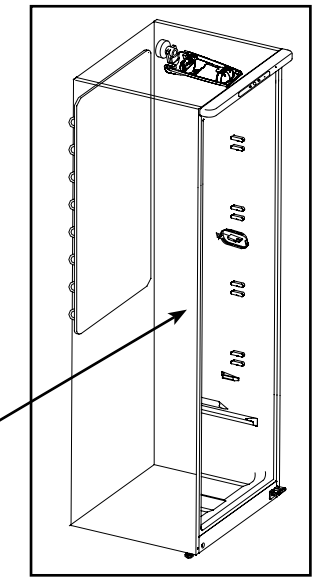
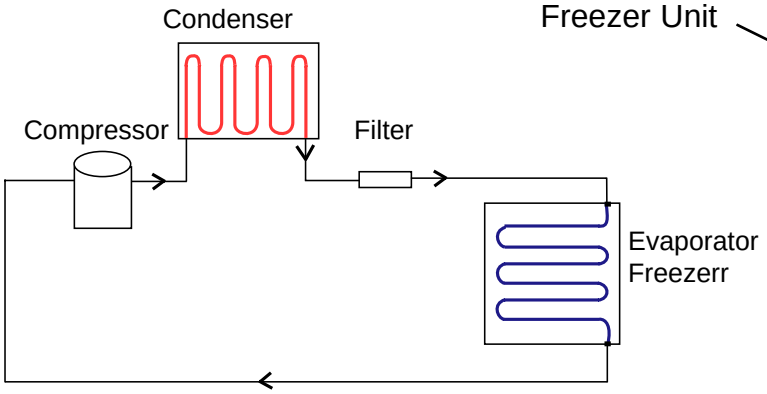


Figure 5.4: Cooler

5.2- Types of freezers

5.2.1- Vertical freezer

Cold circuit:



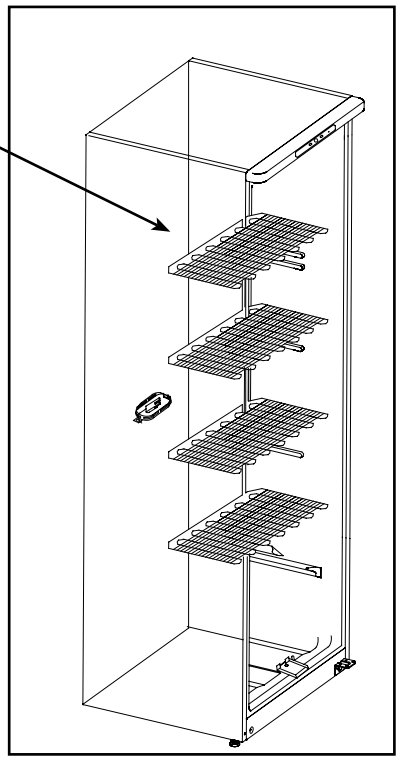
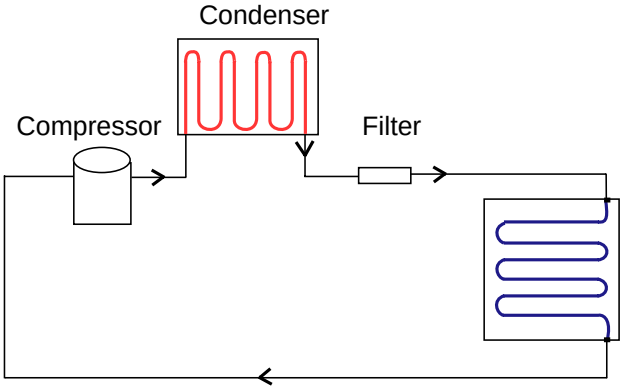


Figure 5.5: Vertical freezer

5.2.2- Horizontal freezer

Cold circuit:



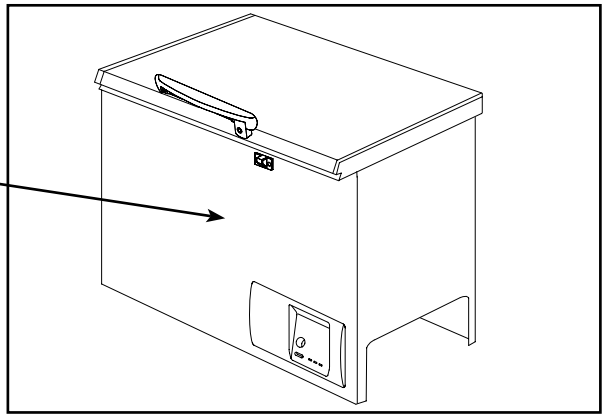
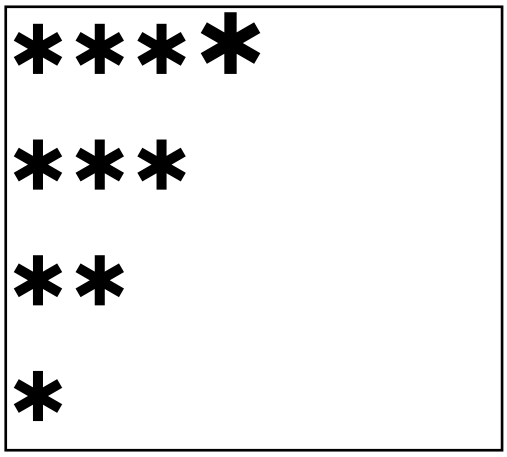


Figure 5.6: Horizontal freezer

5.3- Meaning of the stars

The stars refer to the cold production level in the freezer units.



4 stars (Freezer)

3 Stars (Preserves frozen food)

2 Stars (Fridge)

1 Star (Fridge)

✱✱✱✱: Four-star appliances are the only ones capable of freezing fresh food, provided that this is placed in the four-star area. This is important because most home freezers have one area for freezing and the remainder for keeping products that have previously been frozen. This type of apparatus can produce a temperature of - 18 ºC.

✱✱✱: Three-star appliances conserve food that has previously been frozen for as long as the label of the foodstuff indicates. This type of apparatus can produce a temperature of -18 ºC, but it should on no account be used for freezing fresh food.

✱✱: Two-star appliances reach -12 ºC in the evaporator (ice-cube production department) but cannot freeze food.

✱: One-star appliances reach -6 ºC in the evaporator (ice-cube production department) but cannot freeze food.

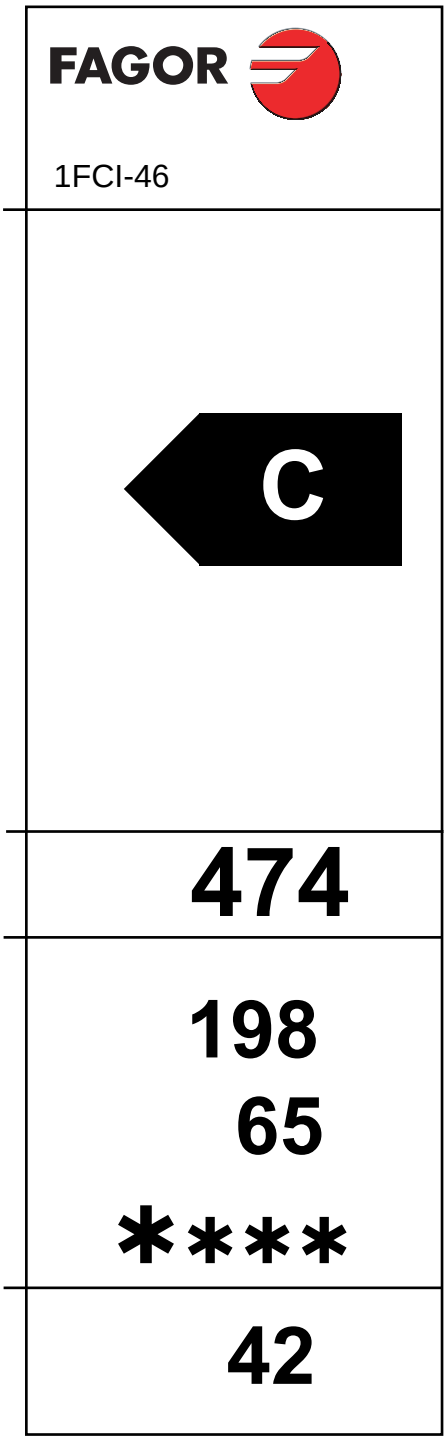
5.4- Climatic type

For both fridges and freezers, the type determines the climate for which each apparatus is designed in order to work correctly.

Type	Operating room temperature
SN	from +10 ºC to 32 ºC
N	from +16 ºC to 32 ºC
ST	from +18 ºC to 38 ºC
T	from 18 ºC to 43 ºC

In the north of Europe “SN” appliances can be recommended, but in the south however, “ST” or “T” (Subtropical or Tropical) appliances should be used.

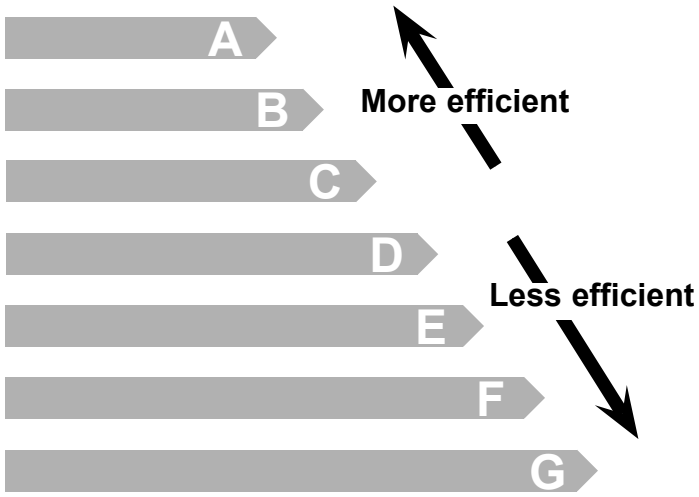
5.5- Energy label



1.- Manufacturer (name or trademark)

2.- Model (Model identification)

3.- Type of energy efficiency



4.- Energy consumption per year in KWh

5.- Useful volume in litres of all the fridge compartments.

6.- Useful volume in litres of all the freezing compartments.

7.- Classification by stars of the freezing compartment

8.- Noise level in decibels

Figure 5.7: Energy label

All the appliances exhibited at the point of sale should have their energy label visibly displayed as from 30 September 1996. Moreover, all the values appearing on this label should comply with standard EN 60456.

5.6- Plate of charactistics

The following variables appear on the plate of characteristics of the fridge or freezer:

♦ Fridge/Freezer			**FAGOR** Tax ID ESF20020517		
Class ST	Model	**FC-47 EV**		Type **DUO-23 I**	
220-240V		**50Hz**			**190W**
Freezing capacity **16 Kg/24h**		Energy consumption **KWh/24h**		Operating noise **dB**	
Volume	TOTAL	Freezer	Fridge	Comp. of low temp.	C€ N
Gross	342 L	94 L	248 L	L	
Net	320 L	76 L	244 L	L	
CODE Nº **904015907**		CODE Nº **020423205**		**R600A** REFR.-FRIOR. 35 g FREEZ.-CONG. 55 g	

Figure 5.8: Plate of characteristics

Type: Factory name

Code Nº: Equivalent to the model of the appliance.

Class: Subtropical (ST)

Freezing capacity: Nº of kilos of fresh food it can freeze in 24 hours.

Series Nº: Indicates the date of manufacture. Example: **02042320**

year month

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España (Spain)