Modern refrigeration and air conditioning system skill training equipment

Training Manual

Content

Project 一 "Modern Refrigeration Training Device" Wiring Terminal and Module Interface Definition

1. Definition of air-conditioning module wiring terminal interface

Serial number (Panel terminal)	Wiring definition	Module terminal	Remarks	
1	N（Zero line）	N terminal（Blue）	AC 220V	
2	PE（Ground wire）			
3	L（Fire Wire）	L terminal（Red）		
4	U（R）Run side	N terminal（Blue）	Compressor capacitor end（Yellow、Blue）	Air-conditioning compressor
5	V（S）Start end	Compressor capacitor end（Yellow）		
6	W（C）Public	RY01terminal（Green）	C Public	
7	R run side	N terminal（Blue）	Outdoor fan capacitor terminal（Black、Blue）	Air conditioner outdoor fan
8	S Start end	Outdoor fan capacitor terminal（Black）		
9	C Public	RY01terminal（Green）	C Public	
10	Air conditioner reversing four-way valve	N terminal（Blue）	Air conditioner reversing four-way valve	
11		RY02terminal（Red）		
12	R run side	N terminal（Blue）	Indoor fan capacitor terminal（Green、Blue）	Air conditioning indoor fan
13	S Start end	Indoor fan capacitor terminal（Green）		
14	C Public	RY03terminal（Black）	C Public	
15	Indoor temperature sensor（Green）			
16				
17	Pipe temperature sensor（Yellow）			
18				

2. Refrigerator module terminal interface definition

<table>
<tr><th>Serial number (Panel terminal)</th><th>Wiring definition</th><th>Module terminal</th><th colspan="3">Remarks</th></tr>
<tr><td rowspan="2">20</td><td rowspan="2">M Run Terminal</td><td rowspan="2">N terminal（Blue）</td><td rowspan="2">PTC Starter</td><td>M Run Terminal</td><td rowspan="3">Refrigerator compressor</td></tr>
<tr><td>S Starting end</td></tr>
<tr><td>21</td><td>C Public</td><td>RY01terminal（Green）</td><td colspan="2">C Public</td></tr>
<tr><td>22</td><td rowspan="2" colspan="2">thermostat（Red、Green）</td><td rowspan="2" colspan="3">String refrigerator compressor RY01terminal（Green）</td></tr>
<tr><td>23</td></tr>
<tr><td>24</td><td rowspan="2">Door light</td><td>N terminal（Blue）</td><td rowspan="2" colspan="3">220V Door light</td></tr>
<tr><td>25</td><td>L terminal（Red）</td></tr>
<tr><td>26</td><td rowspan="2" colspan="5">Changing greenhouse defrost sensor（Blue）</td></tr>
<tr><td>27</td></tr>
<tr><td>28</td><td rowspan="2" colspan="5">Refrigerator defrost sensor（Blue）</td></tr>
<tr><td>29</td></tr>
<tr><td>30</td><td rowspan="2" colspan="5">Freezer temperature sensor（Yellow）</td></tr>
<tr><td>31</td></tr>
<tr><td>32</td><td rowspan="2" colspan="5">Variable greenhouse temperature sensor（Red）</td></tr>
<tr><td>33</td></tr>
<tr><td>34</td><td rowspan="2" colspan="5">Refrigerator temperature sensor（Green）</td></tr>
<tr><td>35</td></tr>
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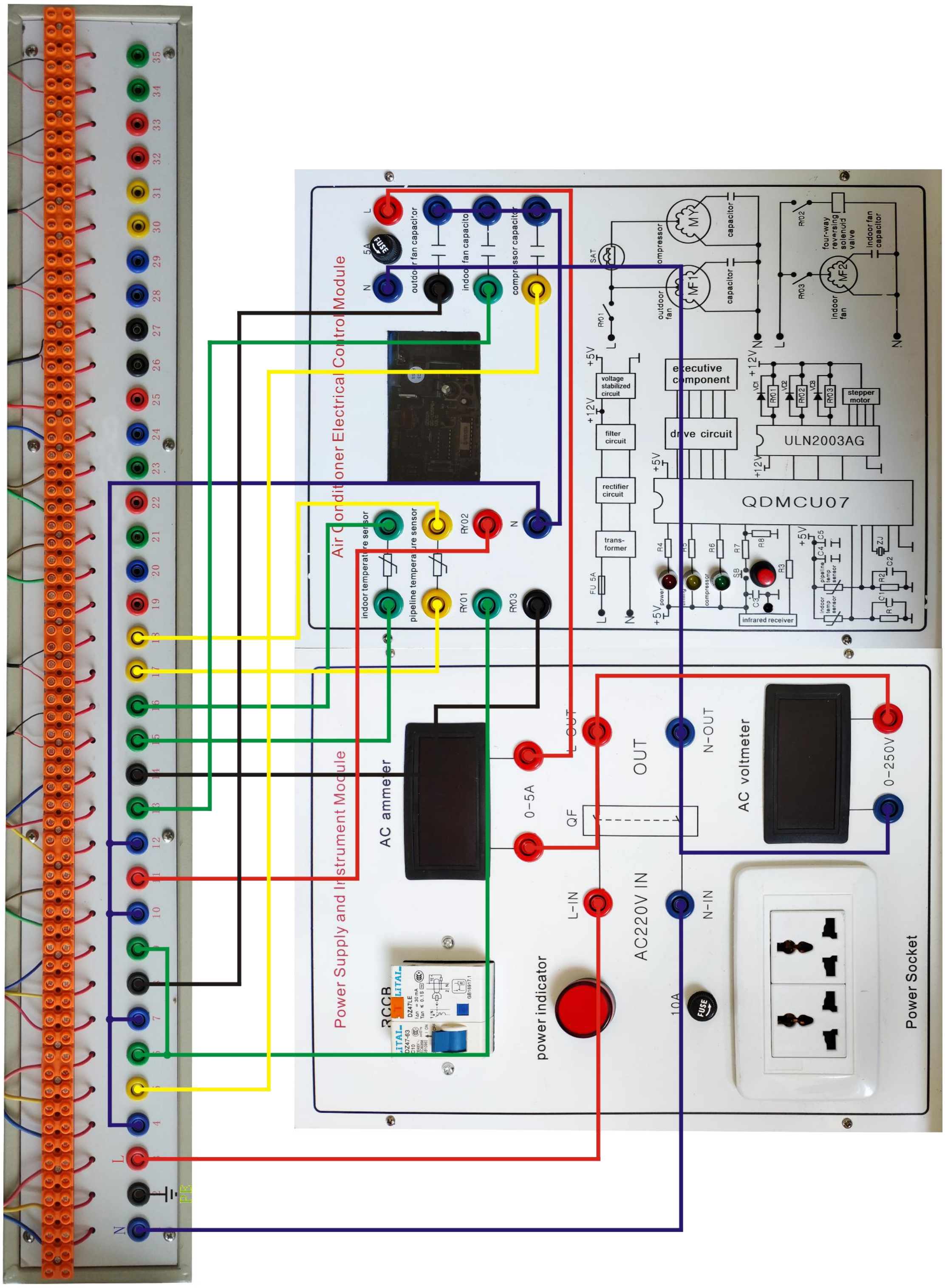
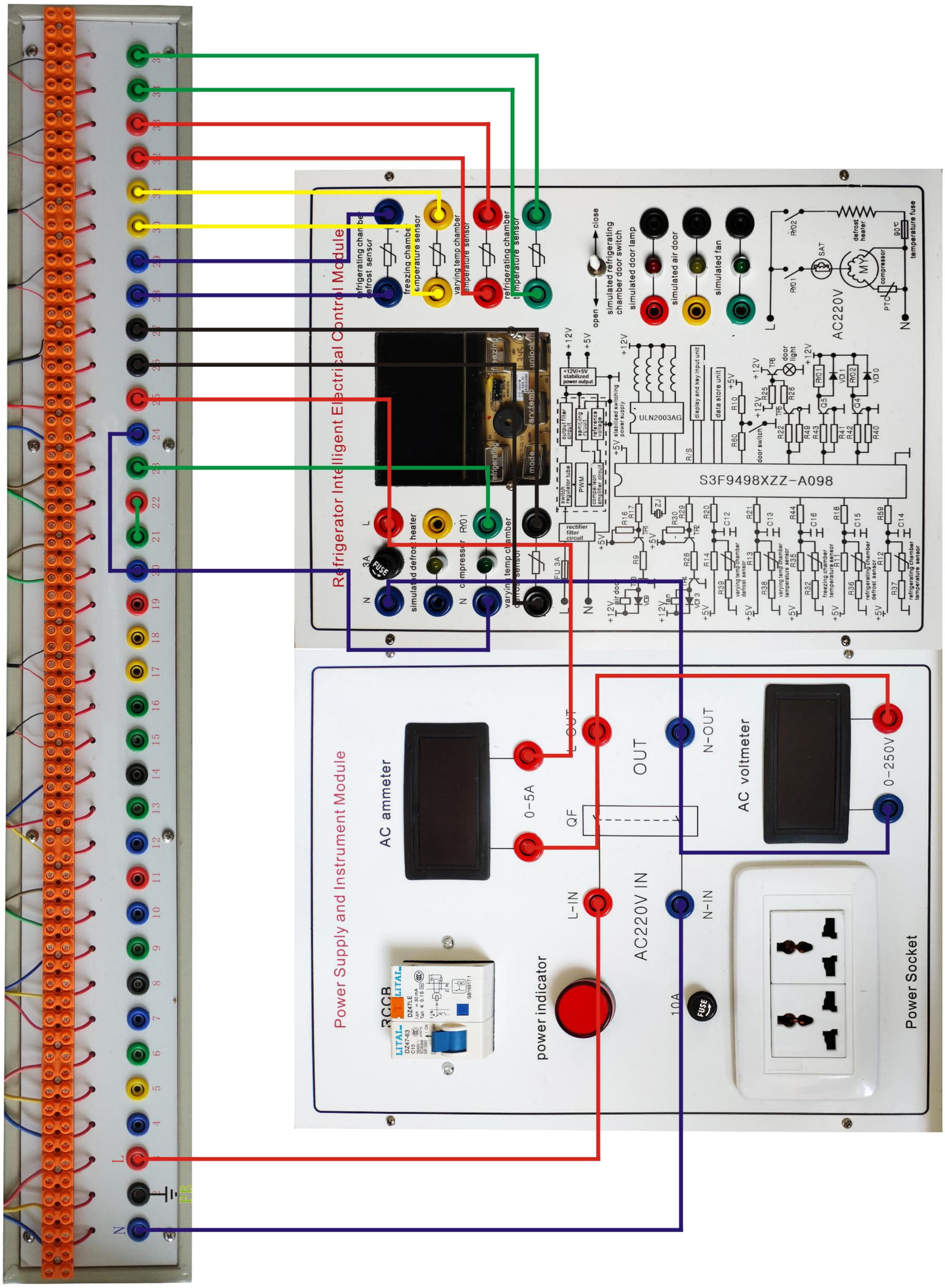
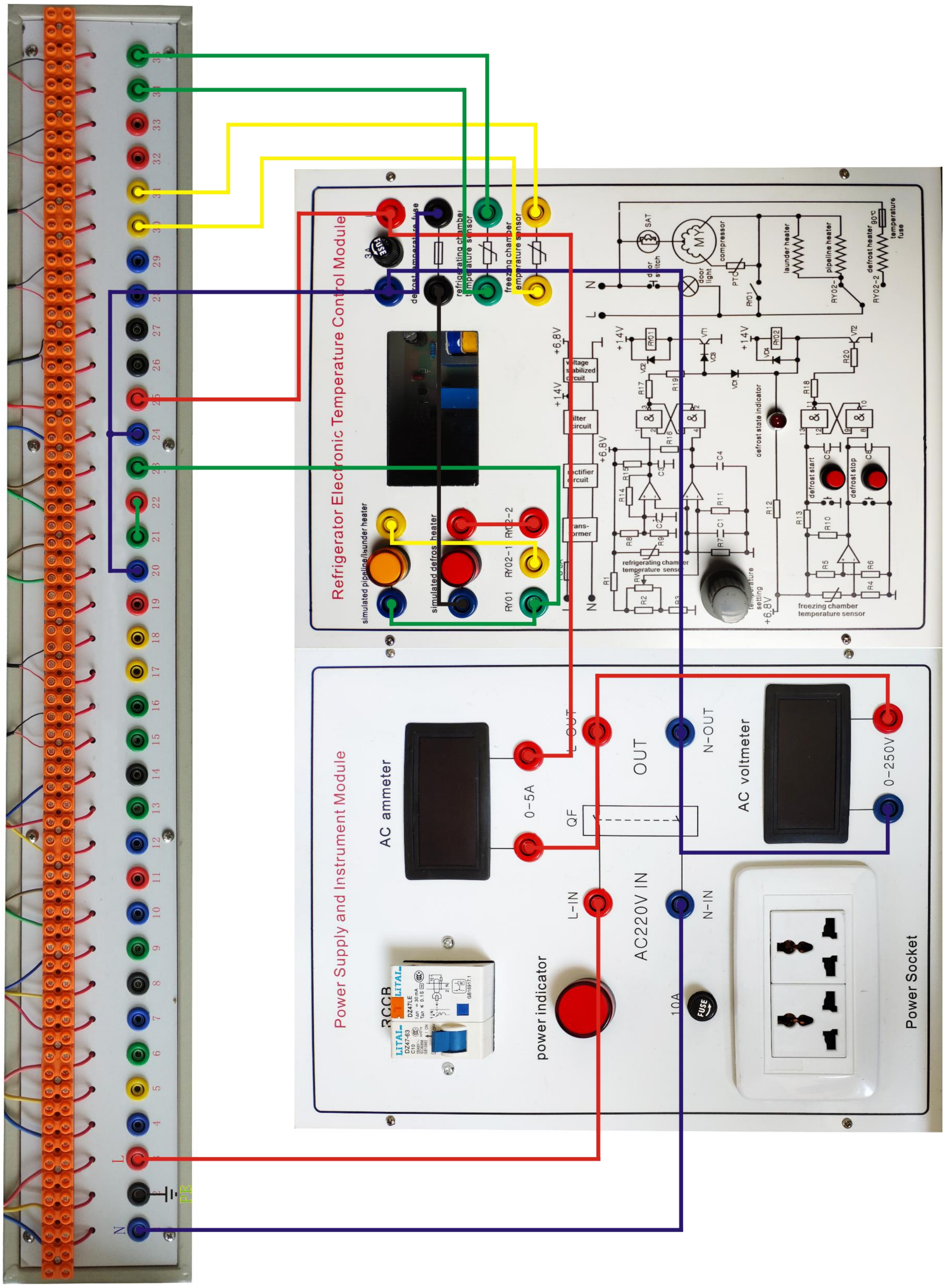
3. Electrical wiring connection of air conditioner electrical control module



4. Refrigerator intelligent control electrical control module electrical wiring connection



5. Electrical circuit connection of refrigerator electronic temperature control electrical control module



Project 2 Equipment introduction and use of special tools for refrigeration

This project mainly introduces the structural performance of the "training device" and the use of special refrigeration tools. The user is familiar with the structural performance of "refrigeration and air-conditioning equipment assembly and debugging" and the operating skills of special refrigeration tools. Applied talents with refrigeration professional theory and practical operation skills lay a good foundation.

Through the training of this project, you should be able to achieve:

①Learn the basic knowledge of refrigeration, electrical and electronic technology, and lay a theoretical foundation for being familiar with "training devices"

②Master the operating skills of special refrigeration tools through practical training of refrigeration special tools.

The main tasks of this project:

① Familiar with "training device"

② Master the operating skills of special refrigeration tools.

Task 1: Familiar with "Modern Refrigeration and Air Conditioning System Skill Training Device"

1. Task description

The "training device" is a teaching device that simulates a refrigerator and an air conditioner, which integrates fluid mechanics, thermodynamics, heat transfer, and mechanical, chemical, electrical, electronic, and electrical control technologies. Students in school can master the operation skills of assembly and maintenance of refrigeration equipment such as refrigerators and air conditioners in a teaching environment that is very close to the actual production situation of refrigerators and air conditioners. This task mainly introduces the structure, composition and technical parameters of the "training device".

Through training in this task, you should be able to achieve:

① Familiar with the basic knowledge of refrigeration and electrical and electronic technology.

② Master the structure, composition and system flow of the "training device".

2. Related knowledge

1. Basic knowledge of refrigeration technology

（1） Basics of Thermodynamics

1) Basic parameters of the state of matter

There are many ways to obtain low temperature in refrigeration technology, and the overall class is divided into physics and chemistry. At present, physical methods are used in refrigeration technology. The physical method of refrigeration is achieved by using physical changes of substances, which are called refrigerants or refrigerants.

In the refrigeration system, the refrigerant continuously undergoes state changes, that is, in various different thermal states. The macroscopic physical quantities used to describe the thermal state of the refrigerant are called thermal state parameters, or state parameters for short. State parameters include temperature (T), pressure (P), specific volume (v), specific enthalpy (h), specific entropy (s), thermodynamic energy (U), etc. The three parameters of temperature, pressure and specific volume are also called It is the basic parameter of the thermal state of the refrigerant. Referred to as basic parameters.

①Temperature is a physical quantity that expresses the degree of coldness and heat of an object, and is a measure of the average kinetic energy of molecular motion inside an object. Objects have temperature, the higher the temperature, the faster the molecular motion; conversely, the lower the temperature, the slower the molecular motion. When objects with different heat and cold are in contact with each other, one object emits heat and the other absorbs heat, and the heat is transferred from the hot object to the cold object. It is inaccurate to judge the cold or hot degree of an object based on human feelings, and it is easy to produce illusions. For example, at the same temperature in winter, people will feel cold when the wind speed is high, and cold when the humidity is high, so the temperature should be measured with an instrument. In order to make the temperature measurement accurate and consistent, there must be a scale. Referred to as temperature scale, it specifies the basic and measurement unit for measuring temperature. At present, the Celsius temperature scale and thermodynamic temperature scale are commonly used in daily life and refrigeration technology, but the Fahrenheit temperature scale is also used in the technical instructions of some imported equipment.

(A) Celsius temperature scale t (also known as the international Baidu temperature scale), in ℃. It is pure water with a freezing point of 0°C and a boiling point of 100°C under a standard atmospheric pressure. The interval is equally divided into 100 cells, and each cell is located at 1°C, which is recorded as 1°C. The Celsius temperature scale is decimal, which is simple and easy to calculate. Many countries such as our country adopt it. The corresponding thermometer is a Celsius thermometer.

(B) Thermodynamic temperature scale T (also known as Kelvin temperature scale), in K. It stipulates that the triple point of pure water is used as the base point. In order to facilitate memory, the freezing point of pure water under a standard atmospheric pressure is set as 273.15K, and the boiling point is 373.15K. The average is divided into 100 cells, and each cell is 1 degree Kelvin, which is recorded as 1K. In thermodynamics, it is stipulated that when the movement of molecules inside an object ends, its thermodynamic temperature is zero degrees, that is, T=0K.

(C) The Fahrenheit temperature scale (Fahrenheit, symbol °F) stipulates: Under standard atmospheric pressure, the melting point of ice is 32°F and the boiling point of water is 212°F.

There are 180 equal divisions in the middle, each divided into 1 degree Fahrenheit, Recorded as 1°F.

The value of Celsius temperature scale t and the value of thermodynamic temperature scale T can be converted as follows:

T=T—273.15≈T－273

The Celsius temperature scale t and Fahrenheit temperature scale F can be converted as follows:

F=1.8t+32℃

In the formula: t—Celsius temperature (℃)

T—thermodynamic temperature (K)

F—Fahrenheit temperature (°F)）

According to national regulations, when the temperature is above zero, the temperature value is preceded by a "+" sign (can be omitted); when the temperature is below zero, the temperature value is preceded by a "-" sign (cannot be omitted).

There are many types of thermometers used to measure temperature. Commonly used in refrigeration engineering are mercury thermometers, thermocouple thermometers, alcohol thermometers, digital thermometers and semiconductor thermometers. They are all measured in degrees Celsius.

② Pressure. In refrigeration technology, pressure refers to the vertical force per unit area, also called pressure, expressed by p. According to molecular physics, the pressure of gas is caused by frequent collisions of a large number of gas molecules on the container wall of the squadron in random movement. The international unit of pressure is Pa [scal] (pa), 1 Pa (pa) = 1N/㎡, which means that the vertical force per square meter is 1N, namely:

Pressure = pressure / pressure area（P=F/S）

The unit of pressure is also: one type of kilogram force, such as kilogram force/cm^2 (kgf/cm^2); the other is the height of the liquid column, such as millimeters of mercury (mmHg) or millimeters of water (mmH2O); and atmospheric pressure (atm) And bar and so on. The conversion relationship of each pressure unit is:

1 atmospheric pressure (atm) = 760mmHg = 0.101325 megapascals (MPa) = 1.0333 kg/cm^2

(kg/c²) = 1.0133 bar (bar) 1bar = 105Pa, in actual applications, the pressure is divided into gauge pressure and absolute pressure.

The gauge pressure is expressed by the value on the pressure gauge, and is based on a large pressure (0), which is the difference between the actual pressure of the gas being measured and the local atmospheric pressure. If the pressure is lower than the atmospheric pressure, it is a negative value, which is called the degree of vacuum (B). The gauge pressure is used for observation during the operation and operation of the refrigeration system.

Absolute pressure is the actual pressure value of the gas, which is equal to the sum of gauge pressure and atmospheric pressure, that is

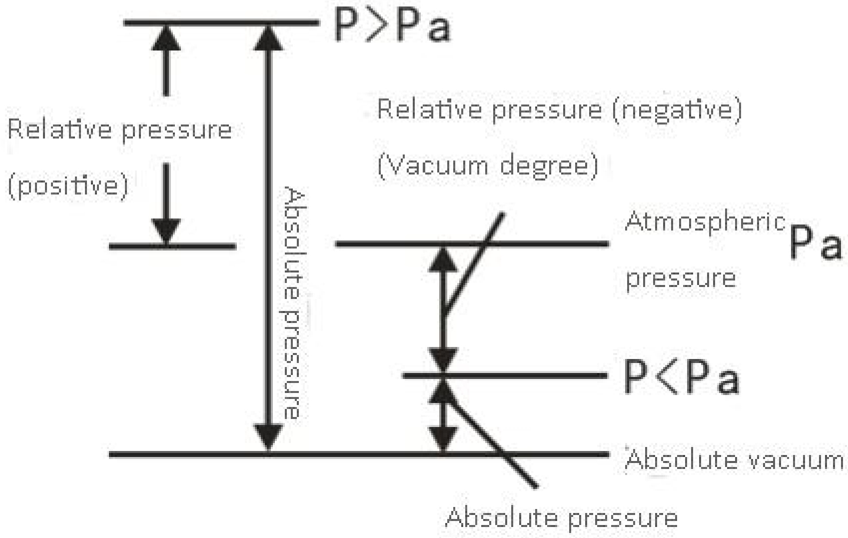
$$Pa=Po+Pg$$

Where: Pa—absolute pressure;

Po—atmospheric pressure;

Pg-gauge pressure.

The relationship between absolute pressure, gauge pressure and vacuum is shown in Figure 1-2.



③Mass volume (specific volume) refers to the volume occupied by a unit mass of refrigerant, denoted by v, and its unit is m³/kg (m³/Kg), or liters/kg (L/Kg). The specific volume of refrigerant vapor is an important parameter that determines the cooling capacity of the compressor. For example: 1kgR22, at standard atmospheric pressure (101325Pa absolute pressure), when the temperature is 0℃, its vapor volume is 47.04L, and its specific volume is 47.04L/kg; when the temperature is 30℃, its liquid volumetric 0.8542L, the specific volume is 0.8542L/kg

Mass volume is the physical quantity of the density of matter molecules. For gas, the distance between molecules is large, the mass volume is large, and the density is small, and the compressibility is large; on the contrary, the mass volume is small, the density between molecules is large, and the compressibility is small. Refrigeration technology is also commonly used to the reciprocal of mass and volume-density (p), namely

$$V=1/p \text{ Or } v\cdot p=1$$

Density refers to the mass of the refrigerant per unit volume, the unit is kg/m^3. For example, when 1/kgR22 is at standard atmospheric pressure (the absolute pressure is 101325Pa) and the temperature is 0℃, the gas density is $21.26kg/m^3$; when the temperature is 30℃, the liquid density is $1170.7kg/m^3$. The density of liquid is greater than that of gas. Oil separators and gas-liquid separators in refrigeration equipment use this property to achieve separation.

④Specific enthalpy and specific entropy are the state parameters often used in the calculation of refrigeration thermal power. The specific enthalpy h is the characterization of the energy of the refrigerant. When the refrigerant is heated, its specific enthalpy value increases, such as when the compressor piston does work on the refrigerant , Its specific enthalpy will increase; conversely, when the refrigerant is cooled, its specific enthalpy will decrease; when the refrigerant vapor expands to do work, its specific enthalpy will also decrease. Specific enthalpy is the synthesis of the energy possessed by an object in a certain state. The specific entropy s, like the specific enthalpy h, is a state parameter, and it is a derived state parameter. If the specific enthalpy is regarded as the "heat content", then the specific entropy can express the degree of heat of the ship's hull when the state of the refrigerant changes, or the ratio of the heat added to the substance from the outside to the thermodynamic temperature of the substance heated.

⑤The thermodynamic energy U is also called internal energy, which is the general term for the molecular energy inside the refrigerant. The internal kinetic energy depends on the mass of the substance molecule and its average speed. The movement of material molecules increases, and the internal kinetic energy increases; when the movement weakens, the internal kinetic energy decreases. The internal kinetic energy will increase due to friction, impact, pressure, solar radiation, electricity, chemical action or combustion. The internal potential energy depends on the average distance and attractive force between molecules. When a substance receives external energy to expand or change its state, such as a liquid state becoming a gaseous state, the received external energy increases the distance between molecules, which is converted into the internal potential energy of the substance.

1) Basic laws of thermodynamics

The law of thermodynamics is the thermodynamic basis of refrigeration engineering.

① The first law of thermodynamics, that is, the application of the law of conservation and transformation of energy in thermodynamics. The law of conservation and transformation of energy is one of the basic laws of nature. It can be summarized as: all matter in nature has energy. Energy can neither be destroyed nor created, but it can be transformed from one form to another. And in the process of energy conversion, the total amount of energy remains unchanged. Applying this law to the process of energy conversion involving thermal phenomena is the first law of thermodynamics. It can be expressed as: heat can be converted into work, and work can also be converted into heat. When a certain amount of heat disappears, it must be accompanied by Corresponding amount of work: When a certain amount of work is consumed, a corresponding amount of heat is inevitably produced. In other words: thermal energy can be transformed into mechanical energy, and mechanical energy can be transformed into thermal energy. During their transfer and conversion, the total amount remains unchanged. As shown in Figure 1-3.

Figure 1-3 The first law of thermodynamics

The first law of thermodynamics tells us: The conversion between heat and work is expressed by the following formula:

$$Q=AL$$

Where: Q-calories consumed（J Or kJ）

L-work obtained（kg·m）

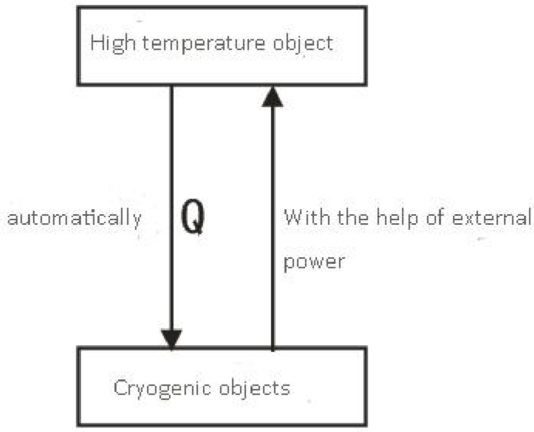


Figure 1-4 The second law of thermodynamics

A—heat work equivalent[kJ/(kg·m)]

The first law of thermodynamics states the mutual conversion relationship between thermal energy and mechanical energy.

②The second law of thermodynamics. Heat can be automatically transferred from high-temperature objects to low-temperature objects, but not from low-temperature objects to high-temperature objects. To transfer heat from a low-temperature object to a high-temperature object, external work must be used, that is, a certain amount of electrical or mechanical energy is consumed, as shown in Figure 1-4.

The second law of thermodynamics tells us that if two objects with different temperatures are in contact, heat is always transferred from the high-temperature object to the low-temperature object, and it is impossible to reverse it. If it is to be reversed, a certain amount of external work must be consumed. The second law of thermodynamics explains the direction and necessary conditions of energy conversion.

1） Common terms

① Sensible heat. In the process of material heat absorption or heat release, only the kinetic energy of the material molecules is increased or decreased, even if the temperature of the material increases or decreases, and other states remain unchanged, the heat energy absorbed or released is called sensible heat. For example, after water absorbs heat, the temperature rises from 20°C to 35°C. The heat absorbed by the temperature change is sensible heat. Sensible heat can be felt by touch or can be measured with a thermometer.

②Latent heat. In the process of material heat absorption or heat release, only the potential energy of the material molecule is increased or decreased, even if the material state changes but its temperature does not change, the heat energy absorbed or released is called latent heat. For example, if water is heated to 100°C to boil under normal pressure, the heat absorbed by the water is latent heat. Similarly, the heat released by water vapor at 100°C liquefied into water at the same temperature under normal pressure is also called latent heat. Latent heat cannot be felt by touch, nor can it be measured with a thermometer.

Matter has three states: solid, liquid, and gas. The changes between these three states are accompanied by the transfer of heat. Only the heat that changes the temperature of the substance without changing its shape is sensible heat; the heat that changes the shape of the material without changing the temperature is latent heat. ; Latent heat includes heat of vaporization, heat of liquefaction, heat of dissolution and heat of solidification. The changes in the three states of matter are shown in Figure 1-5. According to the law of conservation of energy, under the same conditions, the heat of vaporization of the same substance is equal to the heat of liquefaction, heat of dissolution, and heat of solidification. The heat of vaporization of the boiling point of several liquids at one atmospheric pressure is shown in Table 1-1.

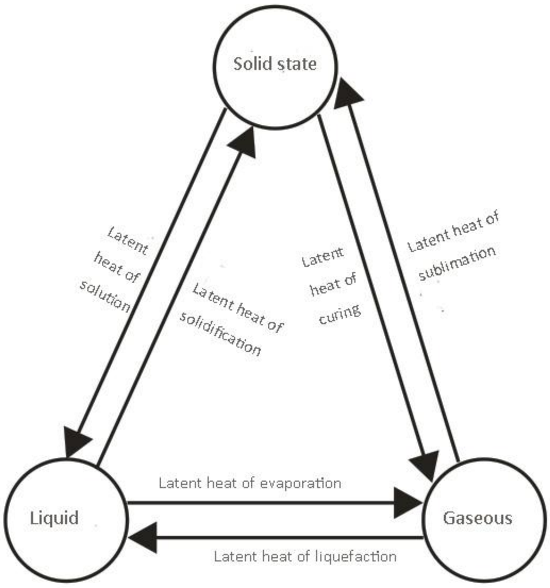


Figure 1-5 Changes in the three states of matter

Table 1-1 The heat of vaporization when a liquid is boiling at one atmospheric pressure

Substance	Water	Ammonia	R12	R22	Methyl chloride	Sulfur dioxide

Heat of vaporization/（kj/kg）	2256.8	1369.1	167.5	234.5	427.1	397.8

The various calorific values of 1kg water at atmospheric pressure are shown in Figure 1-6.

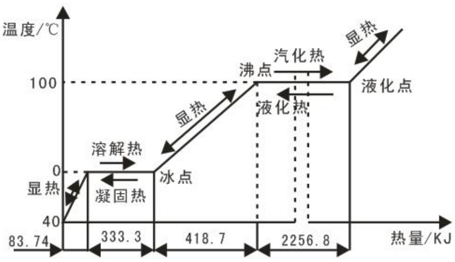


Figure 1-6 Various calorific values of 1kg of water at one atmospheric pressure

Experiments show that the heat of vaporization required for the same substance to vaporize at different pressures is different, and the heat of vaporization required for the same object to vaporize at different temperatures is also different. Generally speaking, the increase in pressure or the decrease in vaporization temperature will cause vaporization. Heat increase.

The heat of vaporization of several Freon refrigerants at different temperatures is shown in Table 1-2.

Table 1-2 The heat of vaporization of several Freon refrigerants at different temperatures

The refrigerant	R12	R22	R114	R502
Latent heat of vaporization（-20℃时）（kJkg）	163.50	220.94	142.98	163.29
Latent heat of vaporization（0℃时）/(kJ/kg)	151.10	206.96	137.96	150.02

③Quality hot melt (compared to hot melt) refers to the heat absorbed when the temperature of 1g of a certain substance rises by 1℃. The quality of different substances is different. Its legal unit of measurement is J/(kg·K), and the common unit is KJ/(kg·℃) or J/(g·℃), which can generally be checked from various physics manuals. Out. The mass heat capacities of several common substances in refrigeration technology are shown in Table 1-3.

Table 1-3 The quality of several substances

Refrigerant	Copper	aluminum	steel	Water	Wood	Air	Ice	R12 (30℃)	R22 （30℃）
Material heat capacity/ （KJ/(kg·℃)	0.389	0.879	0.575	40187	2.5	1.005	2.09	1.005	10424

With the concept of mass heat capacity, heat can be calculated. For example, when a substance changes in temperature, the amount of heat that needs to be absorbed or released is equal to the product of the substance's mass heat capacity, mass, and temperature change value. which is:

$$Q=c.m(t2—t1)$$

In the formula: c-mass hot melt[k.J/(kg·℃) or（J/(g·℃)]；

m—mass（kg or g）；

t1，t2—respectively the initial temperature and final temperature of the substance（℃）；

Q—heat（KJ or J）

When the material absorbs heat, the temperature rises t2>t1, Q>O; when the material releases heat, the temperature drops t2<t1, Q<O.

2) Changes in physical state

Solid, liquid, and gas are the three states of matter. Under normal circumstances, iron is a solid, water is a liquid, and oxygen is a gas. The change of an object from one state to another is called a phase change or a change in the state of matter. Changes between these states are accompanied by heat transfer. The absorption and release of heat are the conditions for the material to increase or decrease in temperature, or to change the shape of the material between solid, liquid and gas.

① Vaporization and liquefaction. We can see in our daily life that we splash water on the ground, and soon the ground slowly becomes dry again. This is because the water turns into water vapor and runs into the air. This process is usually called evaporation. In addition, we can also see the situation of boiling water. Put a basin of water on the stove to boil. The temperature of the heated water continues to rise. At the same time, steam continues to escape from the surface of the water, which is also the process of evaporation; But when the water is heated to 100°C, the situation changes significantly. At this time, the surface of the water continues to roll and a large amount of steam bubbles are generated from the water. This phenomenon appears as boiling. During the boiling process, although the furnace continues to heat up, the temperature of the water in the container remains constant at 100°C. Evaporation and boiling are both processes in which substances change from liquid to vapor, and both become vaporization processes, but there is a clear difference between the two. Generally speaking, evaporation is proceeding at any pressure and temperature, but the liquid confined to the surface turns into vapor, and boiling can only proceed when it reaches a certain temperature corresponding to this under a certain pressure, and a large amount of from the inside of the liquid Produce steam. For example, under one atmospheric pressure, the water will boil when the temperature reaches 100°C; at 47.07kPa absolute pressure, the water will boil at 80°C.

The process of liquefaction and vaporization is exactly the opposite. When the vapor is cooled to a certain temperature under a certain pressure, it will change from the vapor state to the liquid state. This cooling process is a liquefaction process or a condensation process. In daily life, there are many examples of liquefaction (condensation). For example, if you remove the lid of the pot containing hot water, there will be many drops of water on the lid. At this time, the vaporized water vapor encounters colder The re-condensation of the pot cover is like: when the outdoor temperature is very low in winter, there will be condensation on the glass of the room. At this time, the water vapor in the indoor air will condense into water when it meets the colder glass window.

② Saturation temperature and saturation pressure. The constant temperature maintained when a liquid boils is called the boiling point. Also known as the saturation temperature at a certain pressure. A certain pressure corresponding to the saturation temperature is called the saturation pressure at the changed temperature. For example: the saturation temperature of water at one atmosphere pressure is 100°C, and the saturation pressure at 100°C in a flood is one atmosphere.

There is a certain correspondence between saturation temperature and pressure. For example, at sea level, water does not boil until 100°C, while in plateau areas, water boils below 100°C. Generally speaking, when the pressure increases, the corresponding saturation temperature also increases; when the temperature increases, the corresponding saturation pressure also increases.

The main feature of the refrigerant is that it has a low boiling point, so that the refrigerant can vaporize and absorb heat at a low temperature to obtain a low temperature.

③Overheating and too cold. In refrigeration technology, it refers to refrigerant vapor when overheating. Overheating refers to the phenomenon that the actual temperature of the refrigerant vapor is higher than the corresponding saturation temperature at a certain pressure. Similarly, when the temperature is constant, the vapor whose pressure is lower than the corresponding saturation pressure at the temperature is also overheated. For example, when the evaporation temperature of R22 refrigerant is -16℃, the corresponding saturation pressure should be 285.43KPa. If the temperature does not change and the pressure is lower than 285.43KPa, the steam is superheated steam; if the pressure does not change, the temperature is higher than -16 ℃, also called superheated steam. The difference between the temperature of the superheated steam and the saturation temperature is called the degree of superheat. For example, if the temperature of superheated steam under atmospheric pressure is 105℃, its superheat degree is:

105℃-100℃=5℃

In refrigeration technology, subcooling is for the refrigerant liquid. Subcooling refers to the phenomenon that the temperature of the refrigerant liquid is lower than the corresponding saturation temperature under the pressure under a certain pressure. For example, when the saturation temperature of R22 refrigerant is 30°C, the corresponding saturation pressure is 1191.9KPa. If the R22 refrigerant liquid with a pressure level of 1191.9KPa is cooled to 25°C, then the refrigerant liquid at this time is called supercooled liquid. The value at which the temperature of the subcooled liquid is lower than that of the saturated liquid is called the degree of subcooling. For example, when the temperature of R22 refrigerant liquid at a pressure of 1191.9KPa is 25℃, the degree of subcooling is:

30℃-25℃=5℃

④ Critical temperature and critical pressure. The liquefaction of gas is related to temperature and pressure. Both increasing pressure and decreasing temperature can turn unsaturated steam into saturated steam and then liquefy. The lower the gas pressure, the lower its liquefaction temperature; as the pressure increases, the gas liquefaction temperature also increases. When the temperature rises above a certain value, the gas cannot be liquefied even if the pressure is increased. This temperature is called the critical temperature. At this temperature, the minimum pressure for gas liquefaction becomes the critical pressure. The gas whose temperature is below the critical point is called steam. The refrigerant vapor only has the conditions for liquefaction when the temperature drops below the critical point. The critical temperature and critical pressure of several refrigerants are shown in Table 1-4 for reference.

Table 1-4 Critical temperature and critical pressure of several refrigerants

Substance name	R12	R22	R600a
Critical temperature/℃	112.04	96.14	134.98
Critical pressure/MPa	4.14	4.974	3.66

The research on critical temperature and critical pressure is of special significance in refrigeration technology. For example, the general requirements for refrigerants include high critical temperature, low critical pressure, and easy liquefaction.

⑤ Humidity and dew point. In nature, the air always contains more or less water vapor, this kind of air is called moist air. Humidity is one of the state parameters of humid air, which represents the amount of moisture in the air. At a certain temperature, when the amount of water vapor in the air reaches the maximum, this air is called saturated air.

(A) There are two ways to express humidity: absolute humidity and relative humidity. Absolute humidity refers to the mass of water vapor in $1m^3$ of humid air, in kg/m^3 or g/m^3. However, knowing the absolute humidity alone cannot tell whether the humidity is saturated or not. Relative humidity is also needed to explain. Relative humidity refers to the ratio of the mass of water vapor in the air (absolute humidity in humid air) to the mass of water vapor when the air reaches saturation at the same temperature (absolute humidity of saturated air at the same temperature), expressed as a percentage, namely The relative humidity is represented by RH. The definition of relative humidity is the percentage of the actual water vapor density (represented by d1) per unit volume of air and the saturated water vapor density (represented by d2) at the same temperature, namely RH (%) = d1×d2×100%: Another calculation method is: the percentage of the actual air water pressure (represented by p1) and the saturated water pressure (represented by p2) at the same temperature, that is, RH (%) = p1/p2×100%.

(B) The dew point is the dew point temperature, which reflects the temperature at which the water vapor reaches saturation when the amount of water vapor in the air does not change under a certain pressure, that is, the temperature at which the air starts to condense, and the surface temperature of the object is higher than the dew point temperature There will be no condensation, and condensation will occur if the temperature is below the dew point. The higher the humidity, the smaller the temperature difference between the dew point temperature and the air temperature. For example, at an atmospheric pressure, when the air temperature is 30°C and the relative humidity is 60%, the dew point temperature is 20.9°C, and when the relative humidity is 90%, the dew point temperature is 28.1°C.

The relative humidity of the air is measured with a thermometer. Common thermometers include a dew point hygrometer, a hair hygrometer, and a dry and wet bulb hygrometer. Among them, as shown in Figure 1-7.

Figure 1-7 Thermometer

2) The pressure-enthalpy diagram and the lgP-h diagram of the applied refrigerant: (also known as the Molliev Diagram)

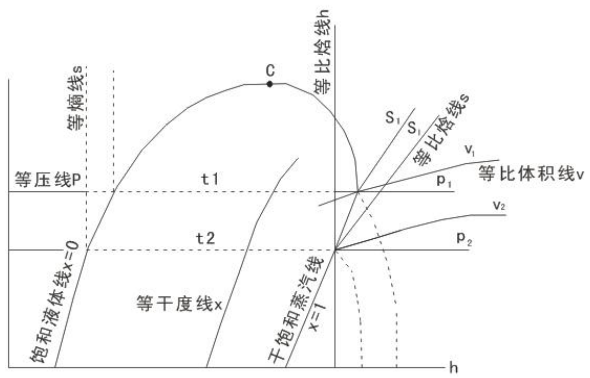


Figure 1-8 lgP-h of refrigerant

K—critical point P—isobar h—isoenthalpy t—isothermal

S—Isoentropic line v—Isospecific volume line x—Iso dryness line

Any point on the lgP-h diagram can represent a thermal state of the refrigerant. At a state point, the refrigerant has a certain pressure, temperature, specific volume, enthalpy and entropy, and the proportion of vapor, that is, dry Degree value X0 X = refrigerant vapor quality / total refrigerant mass.

Saturated liquid line（X=0）

On the lgP-h diagram, the curve connecting the points of the dry saturated liquid at different temperatures is called the saturated liquid line. Each point on the saturated liquid line represents the saturation temperature of the refrigerant saturated liquid at this point.

Dry saturated vapor line（X=1）

On the lgP-h diagram, the curve connecting the points of the dry saturated steam at different temperatures is called the dry saturated steam line. Each point on the dry saturated vapor line represents the saturation temperature of the refrigerant dry saturated vapor at this point.

The saturated liquid line and the dry saturated vapor line are thick solid lines that intersect at the critical point. These two lines divide the lgP-h diagram into three regions. The left side of the saturated liquid line is the supercooled liquid zone, and the right side of the dry saturated vapor line is the superheated vapor zone. The area in the middle of the two curves is the saturated zone, that is, the wet vapor zone. The refrigerant in this zone is saturated. The saturated steam at the point is all wet steam.

Isotherm（t）

Connect the points representing the same temperature with a dotted line to form a polyline, which is the isotherm.

The isotherm is a vertical line in the cold liquid zone, which coincides with the isenthalpy; in the wet steam zone, it is a horizontal straight line, which coincides with the isobaric line; in the superheated steam zone, it is a reverse curve to the lower right.

Contour line（v）

The curve that connects the points with the same specific volume with a dotted line is called a constant volume line.

Isentropic(h)

The curve connecting the points with the same entropy value with a solid line is called an isentropic line.

Isothermal line（x）

The curve formed by connecting points with the same dryness in the saturation zone is called the isodryness line.

In the lgP-h diagram, the direction of the arrow indicates the direction in which the value of each parameter increases. In addition, the state point on the lgP-h diagram can be determined according to any two state parameters, and several other state parameters can be found through this point.

When using the lgP-h diagram of a refrigerant, you must first determine the reference values of enthalpy and entropy selected in the diagram. Generally, the reference values of the enthalpy and entropy of the saturated liquid of the refrigerant when the temperature is 0℃ are indicated on the graph. Due to the different selection of reference values in different graphs, the standard values of the enthalpy and entropy of the refrigerant at the same temperature and pressure are also different. When several graphs are used together, special attention should be paid to the read parameters as the difference of the reference values. Fix.

（2） Basics of Heat Transfer

The two laws of thermodynamics have separately described the quantitative relationship between thermal energy and mechanical energy conversion and the direction of heat transfer, but they have not pointed out the form of heat transfer and the law of heat transfer. Heat transfer is the process of transferring heat from a high temperature problem to a low temperature object through an intermediate medium. This is a complicated process, it has three forms, namely heat conduction, heat convection and heat radiation.

In the process of heat conduction and heat convection, the heat transfer objects must contact each other, which is called contact heat transfer; when radiant heat is transferred, the objects do not have to contact each other, which is called non-contact heat transfer

There are two kinds of heat transfer problems to be solved in refrigeration technology: one is to strive for enhancement of heat transfer (such as the heat transfer of evaporator and condenser); the other is to strive for weakening of heat transfer (such as refrigerators, Thermal insulation in air conditioners or cold storage).

1) Heat transfer temperature difference and heat transfer resistance

If there is a temperature difference in the object, heat will be transferred from the high temperature part to the low temperature part, and the driving force for the heat transfer is the heat transfer temperature difference. In the process of heat transfer, the temperature of the medium decreases continuously, which is a process in which the heat transfer temperature difference overcomes the heat transfer resistance until the heat balance is terminated. Thermal resistance refers to the hindering effect of a substance on heat transfer, represented by W, which is inversely proportional to the heat transfer coefficient K that will be reached later, as shown in Figure 1-9.

Heat transfer heat Q, heat transfer temperature difference △t and heat transfer resistance W have the following relationships:

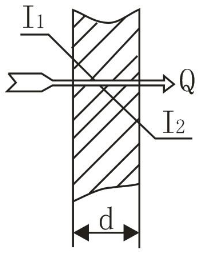


Figure 1-9 Flat wall heat transfer

$$Q=\triangle t/W \qquad W=1/K$$

Carefully observe the above relationship, similar to Ohm's law in electricity, heat transfer is equivalent to current, temperature difference is equivalent to voltage, and thermal resistance is equivalent to resistance.

2) Heat conduction

Heat is transferred from one part of the object to another part or from one of the two objects in contact with each other due to the movement of the molecules of the substance, but the material in each part of the object does not move at this time, which is called the heat transfer process. Also called heat conduction. For example: hold one end of an iron rod and place the other end on the fire to heat it up. After a period of time, hand-painting will feel burning. This is the conduction of heat. Generally speaking, metals have good thermal conductivity, and non-metals have poor thermal conductivity. The physical quantity that reflects the thermal conductivity of various materials is called thermal conductivity, and the unit is W/(m·℃).

According to the thermal conductivity, substances can be divided into good thermal conductors and poor thermal conductors (ie, thermal insulation materials). The former are steel, aluminum, copper, etc., and the latter are foamed plastic, cork, air, etc. In refrigeration engineering, some parts need to use good heat conductors to accelerate heat exchange, such as condenser coils and heat sinks, often use copper tubes and aluminum plates; some parts of the oil need to use heat insulating materials to prevent heat For example, the refrigerator box often uses polyurethane foam. The thermal conductivity of several commonly used materials is shown in Table 1-6

Table 1-6 Thermal conductivity of several common materials

material	N/[w/(m·℃)]	material	N/[w/(m·℃)]	material	N/[w/(m·℃)]
Red copper	383.79	Frost	0.5815	water	0.5815
aluminum	197.71	air	0.069	Scale	2.326
steel	45.36	paint	0.2326	Polyurethane foam	0.0116~0.0291

3) Heat convection

When the temperature of a liquid or gas changes, its density also changes. The density at low temperature is high and flows downward; the density at high temperature is low. Rising upwards, thus forming convection. The heat transfer through the convective movement of liquid or gas molecules is called convection of heat. If the convection of heat is caused by the density change of the liquid or gas itself. It is natural convection. If it is caused by the external force of oil (such as the rotation of a fan or the suction of a water pump), it is forced convection. The heat transfer of thermal convection is determined by the heat transfer time, convection speed, heat transfer area and convective matter.

4) Heat radiation

The heat energy of an object does not use any other substance as a heat transfer medium (that is, no contact between objects). The transfer method in which a high-temperature object emits heat directly to a low-temperature object is called thermal radiation. For example, the heat energy transmitted from the sun to the earth is carried out in the form of radiation.

All high-temperature objects have radiant heat to the surrounding low-temperature objects. The amount of radiant heat depends on the temperature difference between the two objects and the properties of the material. The surface of the object is black and rough, and its ability to emit and absorb radiant heat is stronger; the surface of the object is white and smooth, and its ability to emit and absorb radiant heat is weak . Therefore, it is best to make the surface of refrigerators and cold storages white and smooth to reduce the absorption of solar radiation heat.

5) Conditions and methods of refrigeration

Refrigeration refers to the use of artificial methods to create a cold environment. Refrigerators and air conditioners are examples of refrigeration applications.

① Cooling conditions The law of thermodynamics has told us that heat is always automatically transferred from high-temperature objects to low-temperature objects, just as water flows from a high place to a low place. To transfer the heat from the low-temperature object to the high-temperature object, it must be achieved at the expense of a certain amount of energy. In practical applications, in order to make refrigeration equipment continuous, economical and efficient cooling, the following aspects should be considered:

(A) Continuously supply the easily volatile refrigerant to the refrigeration equipment, that is, recompress, cool, liquefy and recycle the refrigerant that has completed the cooling effect.

(B) Timely release the heat absorbed by the refrigerant, that is, release the heat from the evaporator to the surrounding environment in time.

(C) Effectively use the heat of evaporation of the refrigerant, that is, select an appropriate location to allow the liquefied refrigerant to evaporate effectively.

(D) Choose a refrigerant with safe and good characteristics.

②Refrigeration method In refrigeration technology, the refrigeration method can be roughly divided into three situations:

(A) Cooling: reduce the high temperature object to normal temperature

(B) Refrigeration: keep the temperature of the object lower than normal temperature

(C) Freezing: absorbing heat from the object, making the water of the object frozen

(3) Refrigeration principle

In our daily life, we all have this feeling. When alcohol is applied to the skin, the skin will feel cold. This is not because of the temperature of the alcohol, but because the alcohol absorbs heat from the skin when it evaporates. The house is very hot in summer. At this time, just sprinkle some water on the ground. As the water evaporates, the house will be cooler. These phenomena indicate that the substance absorbs the heat of the surrounding objects when it evaporates, and the surrounding objects lose heat and their temperature drops, so they receive the cooling effect.

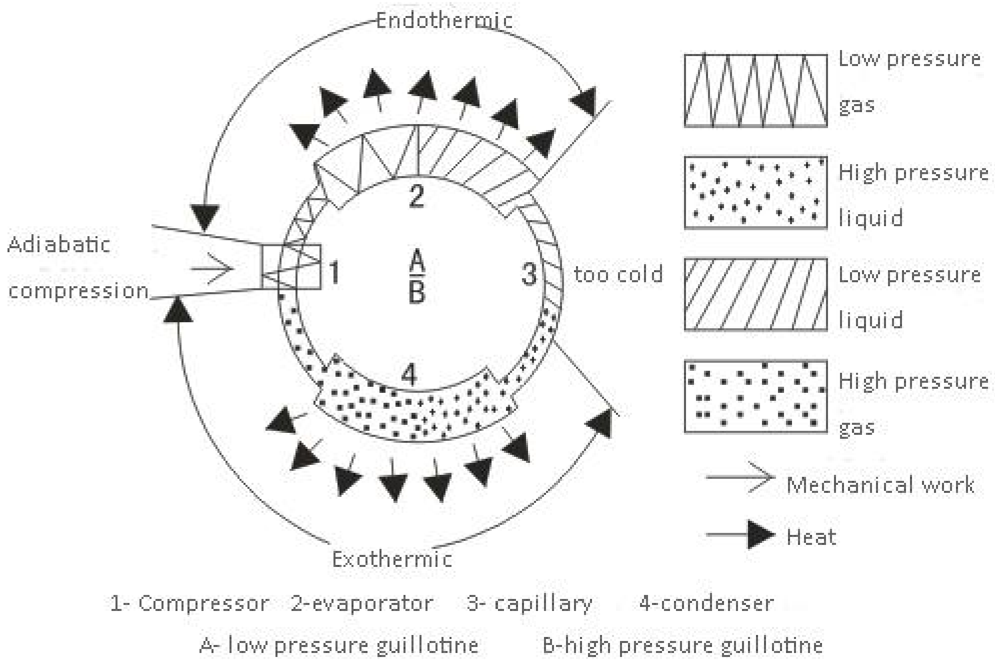


Figure 1-10 Working principle of the refrigeration system

Refrigerators and air conditioners are cooled by the principle of evaporative heat absorption. Its working principle is shown in Figure 1-10. The refrigerant evaporates and absorbs heat in the evaporator in a low-pressure liquid state, which reduces the temperature in the box, while the low-pressure liquid refrigerant evaporates and absorbs and becomes a low-pressure gas refrigerant, which is absorbed by the compressor and compressed into a high-pressure gas state into the condenser , Natural convection releases heat to become a high-pressure liquid refrigerant, expands and reduces pressure through capillary throttling, becomes a low-pressure liquid, sprays into the evaporator, and then absorbs heat. Such a round and round makes the earth illusory, so that the temperature in the box keeps dropping, achieving the purpose of refrigeration.

The state change of the refrigerant in the refrigeration system is displayed on the pressure-enthalpy diagram, as shown in Figure 1-11. A is the superheated steam that comes out of the evaporator and is sucked in by the compressor, B is the superheated steam discharged from the compressor and enters the condenser, C is the superheated steam in the condenser that becomes dry saturated steam due to heat release, and D is After cooling in the condenser, all liquefied liquid, E is the supercooled liquid that enters between the capillary tubes, F is the wet saturated vapor that enters the evaporator through the capillary tubes, and G is the fully evaporated dry saturated vapor in the evaporator. F→A is the equal pressure process in the evaporator, F→G is the evaporation process, G→A is the superheated vapor (the degree of superheat is called superheat), and A→ is the adiabatic process in the compressor (the isoentropic process)), B→E is the equal pressure change in the condenser, B→C is the exothermic process, C→D is the condensation process, D→E is the supercooled vapor (the degree of supercooling is the degree of subcooling), E→F It is the decompression process of the capillary tube (equal enthalpy process), P1 is the vapor pressure (low pressure), and P2 is the condensation pressure (high pressure). The refrigeration in the refrigeration system is constantly changing according to Figure 1-11.

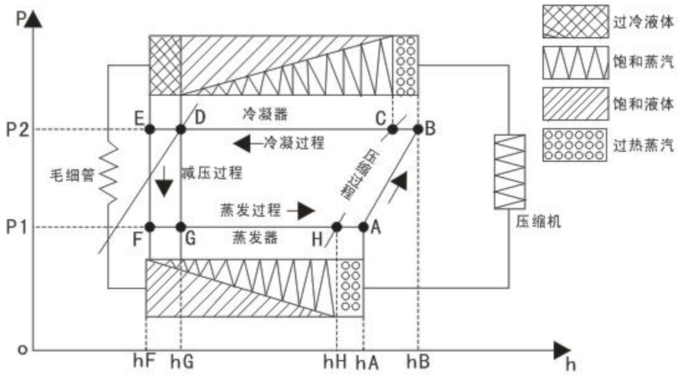


Figure 1-11 State change of refrigerant in refrigeration system

The principle of refrigeration can be analyzed by a refrigeration cycle in the pressure-enthalpy diagram. The compressor sucks the superheated gaseous refrigerant that has absorbed heat in the evaporator into the cylinder and compresses it to the high-pressure end. The compressor rotates at a high speed and the compression process is very short. There is almost no heat transfer between the refrigerant and the outside during the compression process. This process is called adiabatic compression, and its specific entropy does not change. The pressure of the refrigerant increases after compression, as shown in Figure 1-11, from P1→P2, the volume decreases, and the temperature of the refrigerant rises with the change of pressure and specific volume. In Figure 1-11, this process uses isoentropy AB indicates that since mechanical energy is consumed during compression and there is no heat exchange during adiabatic compression, the increase in specific enthalpy is equivalent to the work consumed. In Figure 1-11, hB-hA is the specific enthalpy of compression work conversion. The refrigerant heat increases. This process is carried out in the compressor, and the refrigerant becomes high-temperature, high-pressure superheated vapor. The high-temperature, high-pressure superheated steam in the condenser gradually dissipates heat into the air, and its specific enthalpy gradually decreases. Point B in

Figure 1-11 gradually moves to the left. When it reaches point C, the superheated steam heats up and condenses into a saturated gas state. As the refrigerant continues to radiate heat in the condenser, its conversion changes accordingly, and when it reaches the end of the condenser, it cools into a saturated liquid, which is point D in Figure 1-11. Due to the throttling effect of the capillary tube, a constant high pressure is maintained in the condenser, the refrigerant can be liquefied under high-pressure cooling conditions, and its specific enthalpy is reduced from hB to hG. When the refrigerant passes through the capillary tube, due to the heat exchange between the capillary tube and the low-pressure tube, the liquid high-pressure refrigerant achieves a supercooling effect. The liquid saturated refrigerant loses more heat, increases its supercooling degree, and improves the cooling efficiency, as shown in Figure 1. -11 as shown in DE. When the liquid refrigerant passes through the capillary tube, its pressure decreases from P2 to P1, and the temperature decreases. Since capillary throttling is carried out in an instant, its heat is not exchanged with the outside world, and the specific enthalpy value remains unchanged. This process is equal-specific enthalpy expansion, as shown in E-F in Figure 1-11. This is the change in the throttling and pressure reduction of the refrigerant in the capillary tube. The throttled and pressure-reduced refrigerant becomes a low-pressure liquid subcooled liquid. After entering the evaporator, the space suddenly increases and the suction at the low-pressure end of the compressor causes the refrigerant volume to expand rapidly, and the liquid boiling absorbs heat, as shown in Figure 1-11 Shown in hF-hH. It becomes a saturated gas, which is the F-H section in Figure 1-11. Due to the heat exchange of the evaporator, the saturated gas absorbs more heat at the end of the evaporator, that is, hH-hA in Figure 1-11, making itself overheated. In this process, the refrigerant maintains a constant evaporation pressure P1 and evaporation temperature, so this process is an isothermal expansion process. In the superheated section (H-A), the temperature of the refrigerant rises and the superheated refrigerant enters the cylinder, avoiding the cylinder liquid hammer phenomenon caused by the liquid refrigerant. In this way, the refrigerant works in the refrigeration system for a cycle, and the refrigeration purpose is achieved by repeated cycles in this way.

2. Basic knowledge of electrician and electronic technology

(1) Circuit and circuit diagram

For a certain need, a combination of electrical components in a certain way is called a circuit. In other words, the circuit is the closed loop through which the current flows. The circuit consists of four parts: power supply, load wire and control device. A power source is a device that converts non-electric energy into electrical energy. For example, dry batteries are a power source that converts chemical energy into electrical energy, and a generator is a power source that converts mechanical energy into electrical energy. A device that consumes electrical energy in a circuit when it is loaded. Its function is to convert electrical energy into other forms of energy into incandescent lamps to convert electrical energy into light energy. The wire connects the power source and the load to form a path, and guides the movement of the current for energy transmission. Most commonly used wires are made of copper or aluminum. The function of the control device is to control or distribute electric energy, rational use of electricity, safe use of electricity, etc., for example, it is used to turn on or off the power when switching, and to control the transfer of energy.

The functions of the above four parts in the circuit can be summarized as: power depends on the power source, power consumption is the load, the output has wires, and the control switch is used.

(2) Current, voltage and power

After the circuit is turned on, there are charges that move directionally in the circuit. The directional movement of charge forms an electric current. Electric current is measured by current intensity. The unit of current intensity is ampere [ampere], abbreviated as ampere, represented by the letter A. The so-called current intensity (ie current) is the amount of charge passing through the cross section of the conductor per unit time, that is

$$I=\frac{q}{t}$$

In the formula: q-the amount of charge, the unit is coulomb (C);

t—time, in seconds (s);

i—Current, the unit is ampere (A).

(3) Inductance, resistance and capacitance

① The inductive type measures the physical quantity of the coil's self-inductive magnetic passing ability. When a current is applied to a coil, a magnetic field will be generated around the coil, and magnetic flux will pass through the coil. The greater the current flowing into the coil, the stronger the magnetic field, and the greater the magnetic flux passing through the coil. Experiments have proved that the magnetic flux passing through the coil is proportional to the current flowing into the coil. Their ratio is called the self-inductance coefficient, also known as the inductance. It is represented by the letter L, and its unit is Henry [Li], abbreviated as Henry, with letters H said. The collective term is also in millihenry (mH) and microhenry (μH). $1H=10^3mh=106\mu H$

②The resistance encountered by the current flowing in the object is called resistance. It is represented by the letter R. Its unit is ohm [m], referred to as ohm, and is represented by the letter Ω, usually in kiloohms (kΩ), megaohms (MΩ)) As the unit. $1M\Omega=10^3k\Omega=106\Omega$. The power consumed by the resistor in use must not exceed the rated power value, otherwise it will be burnt out. How much current (I) the resistor can pass through can be calculated based on its rated power (P) and resistance (R), namely:

$$I=\sqrt{\frac{p}{R}}$$

③Capacitance is a physical quantity that measures the capacity of a conductor to store charges. When a certain voltage is applied to two insulated conductors, they will store a certain amount of electricity. One conductor stores positive charges, and the other conductor stores negative charges of equal magnitude. The higher the applied voltage, the more current is stored. The stored electricity is proportional to the voltage added, and their ratio is called capacitance. Usually voltage is represented by U, charge is represented by q, and capacitance is represented by C. Its unit is method (F), usually in microfarad (μF), nanofarad (nF), and picofarad (pF). 1F=106μF=109 nF=1012 pF. The main indicators of capacitance are capacitance, withstand voltage, dielectric loss and stability. The capacitance and withstand voltage are generally marked on the shell of the capacitor, and the dielectric loss and stability must be measured with an instrument. Note here: The maximum voltage that the capacitor can withstand during normal operation is not allowed to exceed its nominal withstand voltage, otherwise breakdown will occur. Also note that the electrolytic capacitor has positive and negative poles, and the polarity cannot be wrongly connected during use.

(4) The relationship between current, voltage and resistance

Any conductor has a certain resistance. When a voltage is applied to both ends of the conductor, a current is generated in the conductor. When the temperature of the conductor is constant, the current through the conductor is proportional to the voltage applied to both ends of the conductor, and inversely proportional to the resistance, that is :

$$I=\frac{U}{R}$$

In the formula, I—current, in amperes (A);

U—Voltage, the unit is volts (V);

R—Resistance, the unit is ohm (Ω)

This law between current, voltage and resistance becomes Ohm's law. From the expression of Ohm's law, we know that as long as we know any two of the three quantities of current, voltage, and resistance, three unknown quantities can be calculated. When using Ohm's law, you need to pay attention: the three quantities of current, voltage, and resistance must be the three quantities on the same component.

(5) Thermistor

A component whose resistance value changes significantly with temperature is called a thermistor. According to its temperature characteristics, thermistors can be divided into:

①Positive temperature coefficient thermistor, referred to as PTC. According to its resistance-temperature characteristics, it can be divided into two types: switch type and slow change type.

a. Switching thermistor, when the temperature is below the critical temperature, the resistance value of the thermistor is basically unchanged, when the critical temperature is reached, the resistance value increases sharply.

b. The resistance change of the slow-change type thermistor is not as steep as the switch type. In the temperature range of -20~+80℃, the relationship between the logarithm of the resistance value and the temperature changes linearly.

② Critical negative temperature coefficient thermistor, referred to as CTR. The temperature coefficient of this thermistor is negative, but there is a critical temperature. After the critical temperature is exceeded, the resistance drops sharply.

③Negative temperature coefficient thermistor, referred to as NTC. Within the operating temperature range of this thermistor, the resistance value decreases with increasing temperature.

(6) PN junction and diode

In pure silicon or germanium, doped with a small amount of phosphorus, antimony, arsenic, etc., its free electrons will greatly increase at room temperature, forming a semiconductor that relies on electrons to conduct electricity, called electronic semiconductor, also called N-type semiconductor. If pure silicon or germanium is doped with a small amount of impurities such as boron, gallium, indium, etc., its free electrons will be greatly reduced at room temperature, while the holes will be greatly increased, and the holes will be positively charged. Semiconductors that conduct electricity by holes are called hole-type semiconductors, also called P-type semiconductors. When the P-type semiconductor and the N-type semiconductor are closely attached together with a special process, a PN junction is formed at their interface. On the P-type semiconductor and the N-type semiconductor forming the PN junction, the electrode leads are respectively drawn out and sealed with a tube case to form a diode. The diode is essentially a PN junction. The compliance of the diode is shown in Figure 1-12. The arrow indicates the direction of the forward current. The left end is the positive electrode, which is the anode; the right end is the negative electrode, which is the cathode. When in use, the positive pole is connected to the positive voltage and the negative pole is connected to the negative voltage. When the voltage across the diode is positive voltage, the forward current flows through the diode; when the negative voltage across the diode is applied, the current flowing through the diode is very small, which is the reverse leakage current.

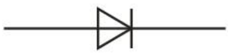


Figure 1-12 Symbol of the diode

Since the resistance of the diode is very small when it is on, it can be regarded as a short circuit; when the diode is off, the reverse resistance is very large and can be regarded as an open circuit. The diode is like a switch. When the diode is turned on, it is equivalent to the switch is turned on; when the diode is turned off, it is equivalent to the switch is turned off. Therefore, diodes are widely used in rectifier circuits and pulse digital circuits.

(7) Zener diode, light emitting diode and infrared light emitting diode

Zener diodes are special diodes, their appearance is similar to ordinary diodes, the forward characteristics of the two are the same, but the reverse characteristics are different. The reverse current of the ordinary diode gradually increases with the increase of the reverse voltage. When the breakdown voltage is exceeded, the diode will be broken down and damaged; but when the reverse voltage of the Zener diode is less than the breakdown voltage, the reverse current is extremely small . When the reverse voltage increases to the breakdown voltage, the reverse current increases sharply. After that, as long as the reverse voltage increases slightly, the reverse current will increase a lot. At this time, the Zener diode is in a reverse breakdown state, as shown in Figure 1-13, Uz is the breakdown voltage on the way. Since the Zener diode is manufactured by a special process, when its power does not exceed the allowable value, the breakdown is reversible, that is, the breakdown can be restored after removing the applied voltage. Therefore, generally in use, the Zener diode must be connected in series with an appropriate current-limiting resistor before connecting to the power supply. When the Zener diode is working, the input voltage value is slightly higher than the rated voltage value of the component, and there is no voltage regulation effect if it is lower than it; but too high, although the voltage regulation effect will be better, but the power consumption Also big. Zener diodes generally can provide a stable voltage operating point or stable DC current in the circuit, but when a higher precision voltage value is required, the Zener diode alone will not work, and other methods must be adopted.

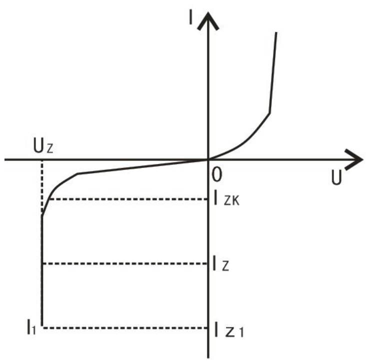


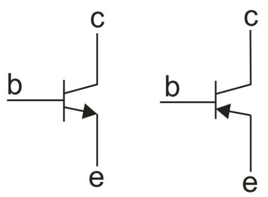
Figure 1-13 Voltage-ampere characteristics of Zener diode

The light-emitting diode is also a special diode. When a forward voltage is applied to both ends of a light-emitting diode, the light-emitting diode can emit red, yellow, green light, etc., which can be used as an indicator according to the material used in the internal PN junction and the color of the transparent plastic used in the shell.

The structure and process of infrared light-emitting diodes are basically the same as that of light-emitting diodes. They are both a light-emitting diode that directly converts electrical energy into light energy and has a PN junction, but the materials used in the two are different. The light-emitting diode emits visible light; and the invisible light emitted by the infrared light-emitting diode is infrared light. The materials used to manufacture infrared light-emitting diodes are mainly gallium arsenide (GaAs), gallium aluminum arsenide (GaALAs) and so on. The tube voltage drop of the infrared light-emitting diode is related to the material and the current flowing. The low-power infrared light-emitting diode made of gallium arsenide has a tube voltage drop of 1~1.3V, and its reverse breakdown voltage is very low, the lowest is only 5V , The highest is only 20~30V, and the forward working current is 30~60mA. When using infrared light-emitting diodes, pay attention to that, during the working process of the tube, no parameter is allowed to exceed the limit value, and the polarity of the tube cannot be connected wrong. In order to prevent overcurrent, a protective resistor must be connected in the circuit.

(8) Triode

The triode has three electrode leads and two PN junctions. It is one of the basic devices that make up the circuit. It has the function of current amplification and is also the core device of the electronic circuit. The triode is a semiconductor substrate made of two PN junctions very close to each other. The two PN junctions divide the whole semiconductor into three parts. The middle part is the base area, and the two sides are the emitter area and the collector area. The arrangement is PNP and There are two types of NPN, and their symbols are shown in Figure 1-14. The three corresponding electrodes are base b, emitter e and collector c.



（a）NPN type（b）PNP type

Figure 1-14 Transistor symbol

Three working states of triode:

Cut-off state: When the voltage applied to the emitter junction of the transistor is less than the on-voltage of the PN junction, the base current is zero, the collector current and the emitter current are both zero, and the transistor loses the current amplification function at this time, the collector and the emitter It is equivalent to the off state of the switch, which is called the triode in the off state.

Amplified state: When the voltage applied to the emitter junction of the transistor is greater than the conduction voltage of the PN junction and is at an appropriate value, the emitter junction of the transistor is forward biased, and the collector junction is reverse biased. At this time, the base current It controls the collector current. The triode has a current amplification effect, and its current amplification factor β=△I♩△Ib, at this time the triode is in an amplifying state.

Saturated conduction state: When the voltage applied to the emitter junction of the transistor is greater than the conduction voltage of the PN junction, and when the base current increases to a certain extent, the collector current no longer increases with the increase of the base current. But it does not change much near a certain value. At this time, the triode loses its current amplification effect, the voltage between the collector and the emitter is very small, and the collector and emitter are equivalent to the on-state of the switch. This state of the triode is called the saturated conduction state.

(9) Digital integrated circuit

With the rapid development of semiconductor technology, digital circuits have been integrated on a single crystal silicon wafer. After oxidation, light agent, diffusion, epitaxy, evaporation and other processes, the transistor, resistor, capacitor and connection are made into integrated circuit blocks, usually called integrated blocks. It is widely used in refrigerators, air conditioners, and microcomputer control. Before understanding digital integrated circuits, you need to clarify concepts such as pulse signals, logic gate circuits, and logic algebra.

All currents and voltages with abrupt, periodic, non-sinusoidal waveforms become pulse signals. There are many types of pulse signals, such as square pulses, sharp pulses, triangular pulses and sawtooth pulses. The pulse waveform is ever-changing, but all have sudden components (except for the power supply). The circuit consists of two main components, one is a switch, and the other is an inert switch. The function of the switch is to destroy the stable state of the circuit and produce a sudden change. Inert components control the transition process. In triode pulse digital circuits, the triode is used as a switch, and inert components often use capacitors.

A gate circuit is a switch circuit with one or more input terminals and one output terminal and conforms to a certain regularity of causality, as shown in Figure 1-15. A door can only be opened when certain conditions are met between the input signals, so it is called a gate circuit, also called a logic circuit. The gate circuit has a wide range of applications in automatic control and automatic detection devices, and is the basic unit of digital circuits and computers.

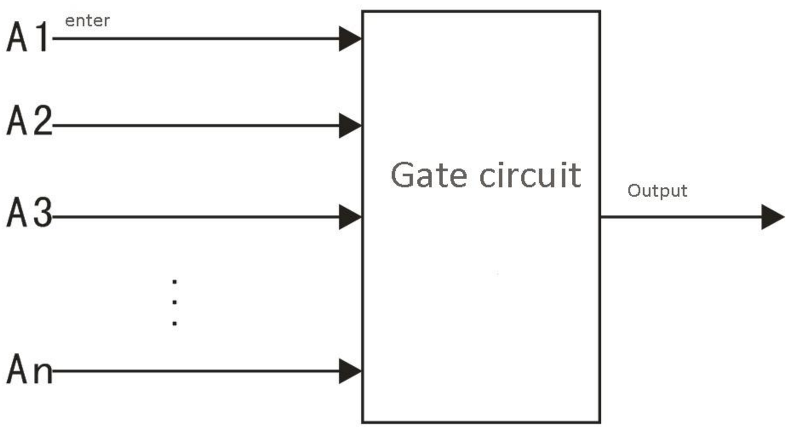


Figure 1-15 Gate circuit

There are three basic gate circuits: AND gate, OR gate and NOT gate. It can be composed of switches, diodes, transistors and resistors, or digital integrated circuits.

① The logic circuit that realizes the AND operation is called the AND gate, and the simple AND gate circuit is shown in Figure 1-16. Switches A and B are connected in series with indicator E. When switches A and B are closed at the same time, indicator E is on; and when either switch A or B is off, indicator E is off. Then the relationship between the switches A, B and the indicator E is called the relationship of and, denoted as E=A·B. Turn the switch on, the light is on, and the top is in the 1 state, and the switch off and the light is off are defined as the 0 state. According to the above regulations, the truth table of AND gate is shown in 1-7. It can be seen from the truth table that the relationship between variables A and B is similar to multiplication in ordinary mathematics.

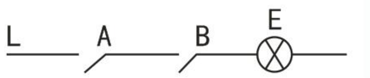


Table 1-7 AND gate truth table Figure 1-16 AND circuit

A	B	E=A▪B
0	0	0
0	1	0
1	0	0
1	1	1

② The logic circuit that realizes the OR operation is called the OR gate, and the simple OR gate circuit is shown in Figure 1-17. When switch A or B is closed, or both A and B are closed, the indicator light E will be on; only when A and B are all open, the indicator light E will go out. This kind of gate circuit is called an OR gate. The relationship of the OR gate is similar to the addition and subtraction operations in ordinary mathematics. It should be noted here that logical addition has no carry, that is, 1+1=1, not 1+1=2. The logical relationship of OR gate circuit can be expressed as E=A+B. The true value of the OR gate is shown in Table 1-8.

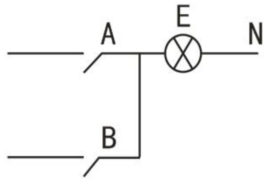


Figure 1-17 OR gate circuit

Table 1-8 OR gate truth table

A	B	E=A+B
0	0	0
0	1	1
1	0	1
1	1	1

③The logic circuit that realizes the negation operation is called the negation gate, and the simple negation circuit is shown in Figure 1-18. When switch A is closed, indicator E will go out; only when A is disconnected, indicator E will be on. The logical relationship is when A=1, then E=0; when A=0, then E=1. Generally denoted as E=A.

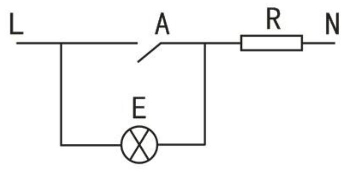
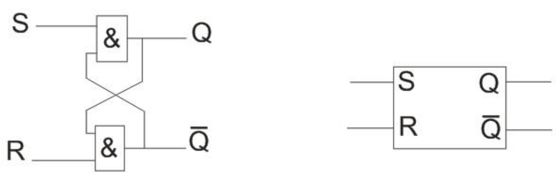


Figure 1-18 NOT circuit

On the basis of AND gates, OR gates, and NOT gates, NAND gates, NOR gates and more complex NAND gates, exclusive NOR gate circuits can also be formed.

④ Trigger. In relatively modern household appliances, one often encounters a touch electronic switch. Press once to input a signal and the switch is turned on; press again to input another signal and the switch is turned off, that is, input two switching signals to complete one Switch action. This kind of switch circuit has two stable working states, namely on and off. When the outside world gives it a signal, it can turn from one stable state to another stable state. This kind of switching circuit is called a bistable circuit, also called a trigger. Since the flip-flop has two states of 1 and 0, the flip-flop can represent a 1-bit binary number. In this way, two flip-flops can represent a two-digit binary number. By analogy, a binary 8-digit number can be used for eight triggers. To represent. Therefore, a flip-flop can be used to form a register for counting. The flip-flop has a memory function, that is, the output state depends not only on the input state, but also on the circuit state at the previous moment. This type of circuit is called a sequential logic circuit. The basic unit of a sequential logic circuit is various types of flip-flops. There are RS Flip-flops, D flip-flops, JK flip-flops and T flip-flops. The circuit and symbols of the RS flip-flop are shown in Figure 1-19. R and S are the input level,Q and $\overline{Q}$ are the output level.1 represents the high point and 0 represents the low level. When S=1 and R=0, Q=1, $\overline{Q}$ =0，this state is 1 state; when S=0, and R=1, Q=0, $\overline{Q}$ =1, then state is 0 state , Or called reset. The characteristics of the RS trigger are: when a pulse is added to the R terminal (terminal 0), no matter what the original trigger state is, it will become Q=0, $\overline{Q}$ =1; if a pulse is added from the S terminal (terminal 1), Then Q=1 and $\overline{Q}$ =0. The truth table of RS flip-flop is shown in Table 1-9.



（a）Circuit （b）symbol

Figure 1-19 RS trigger

Table 1-9 RS trigger truth table

Input		Output	
S	R	Q	
0	0	constant	
0	1	1	0
1	0	0	1

1	1	不变

3. Modern refrigeration and air-conditioning system skill training device

1. The structure of the "training device"

The "training device" is composed of aluminum alloy guide rail type installation platform, heat pump type air conditioning system, household refrigerator system, electrical control system, etc. Its appearance structure is shown in Figure 1-20.

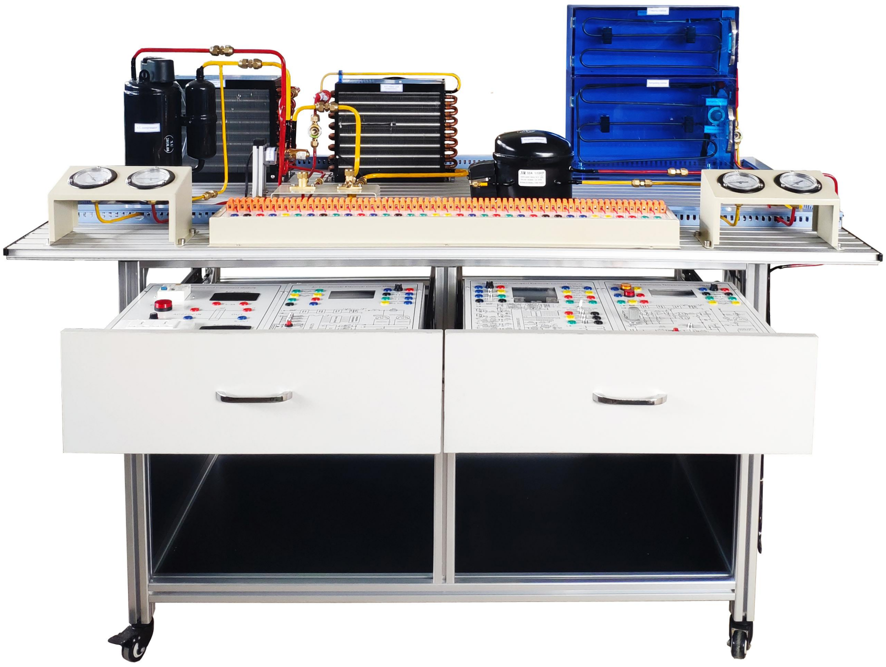


Figure 1-20 Appearance structure diagram of training device

2. Composition of "training device"

The "training device" consists of a training platform, refrigeration system, electrical control system, etc.

(1) Training platform

The training platform is made of profiles as the main frame and sheet metal plates as paving materials. The table area is 150cm×80cm, and it is made up of 11 pieces of 20mm×73mm profiles. There are two drawers underneath to place training modules. Below the drawer is a storage cabinet where you can place some special tools, refrigerant cylinders, etc. The feet are four small universal wheels with brakes to facilitate the movement of the equipment.

(2) Refrigeration system

The refrigeration system is mainly divided into three major subsystems: electronic temperature control refrigerator system, intelligent temperature control refrigerator system and heat pump air conditioning system. All are composed of compressor, heat exchanger, throttling device and auxiliary equipment. The detachable (assembled) structure is adopted, and the components are connected to a loop through the pipe threaded connection method, and finally a complete refrigeration system is formed.

1) Electronic temperature control refrigerator system

Composed of refrigerator compressor, 17-speed steel wire condenser, capillary tube, hand valve, aluminum composite plate inflatable evaporator, refrigerated evaporator, sight glass, vibration-resistant pressure gauge, analog refrigerator box (plexiglass), electric Refrigerator door lights and other components.

2) Intelligent temperature control refrigerator system

Composed of refrigerator compressor, 17-speed steel wire condenser, capillary tube, hand valve, aluminum composite plate inflatable evaporator, refrigerated evaporator, sight glass, vibration-resistant pressure gauge, analog refrigerator box (plexiglass), electric Refrigerator door lights and other components.

3) Heat pump air conditioning system

It consists of air-conditioning compressor, indoor exchanger (including finned exchanger, fan, net cover, temperature sensor), outdoor heat exchanger (including finned heat exchanger, fan, net cover), electromagnetic four-way valve, filter It is composed of air conditioner, capillary tube, one-way valve, air-conditioning valve sight glass, and vibration-resistant pressure gauge.

(3) Electrical control system

Adopting modular structure, it is divided into power supply and instrument module hanging box, air conditioner electrical control module hanging box, refrigerator electronic temperature control electrical control module hanging box, refrigerator intelligent temperature control electrical control module hanging box according to different functions. At the same time, there is a wiring area on the training platform, which serves as the connection transition area between the electrical training unit box and the controlled component. The wiring area adopts a covered terminal block to improve operation safety.

1) Power supply and instrument module hanging box

The power supply and instrument module hanging box consists of one-way power switch (with leakage and short circuit protection), power indicator, digital AC voltmeter (measurement range 0-250V), digital AC ammeter (measurement range 0-5A), double It is composed of three-pin sockets. As shown in Figure 1-21

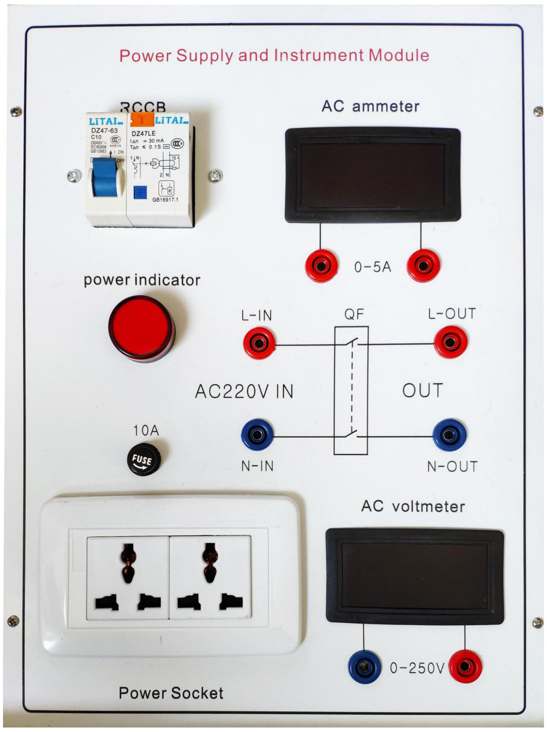


Figure 1-21 Power supply and instrument module hanging box

2) Hanging box for air-conditioning electrical control module

The air-conditioning electrical control module hanging box is composed of a general heat pump air-conditioning main board, electrical control schematic diagram, terminal, fuse holder, corresponding indicator light, reset button, 1μF/450V CBB capacitor, compressor starting capacitor, etc. As shown in Figure 1-22.

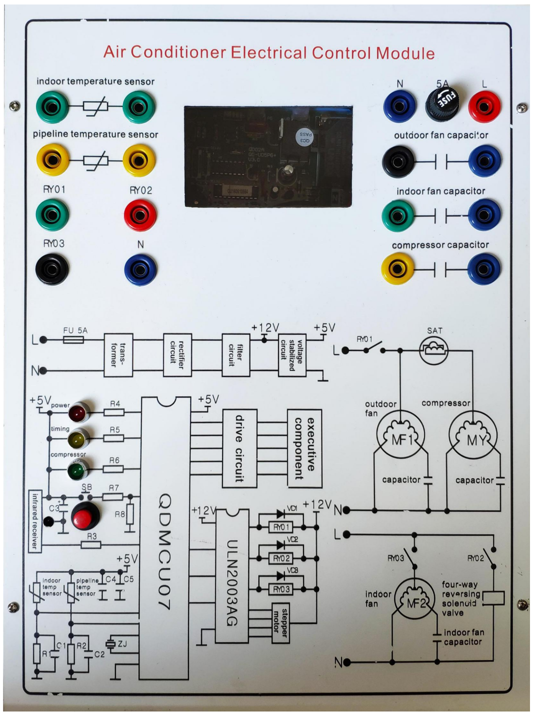


Figure 1-22 Hanging box of air conditioner electrical control module

3) Refrigerator electronic temperature control electrical control module hanging box

Refrigerator electronic temperature control electrical control module hanging box is composed of refrigerator electronic temperature control main board, control circuit schematic diagram, wiring terminals, fuse holder, corresponding indicator light, reset button, potentiometer, etc. As shown in Figure 1-23.

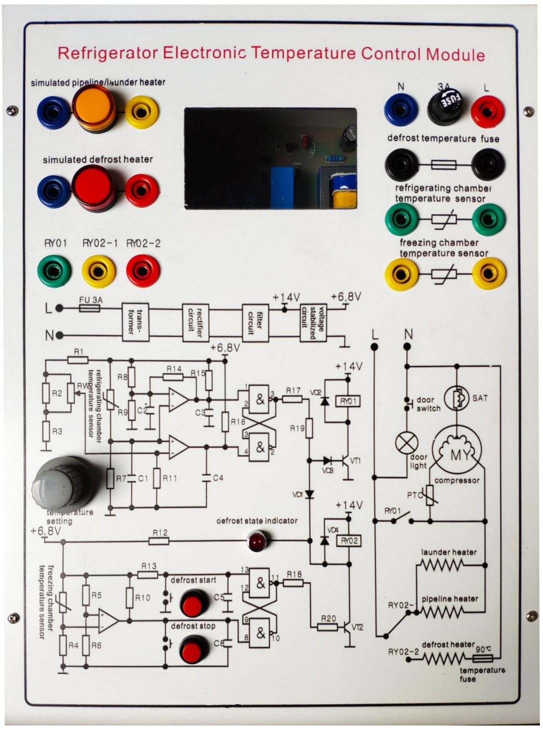


Figure 1-23 Refrigerator electronic temperature control electrical control module hanging box

4) Refrigerator intelligent temperature control electrical control module hanging box

Refrigerator intelligent temperature control electrical control module hanging box is composed of intelligent temperature control main board, intelligent temperature control control display board, intelligent temperature control electrical schematic diagram connection, wiring terminal, fuse holder, corresponding indicator light, button switch, etc. As shown in Figure 1-24.

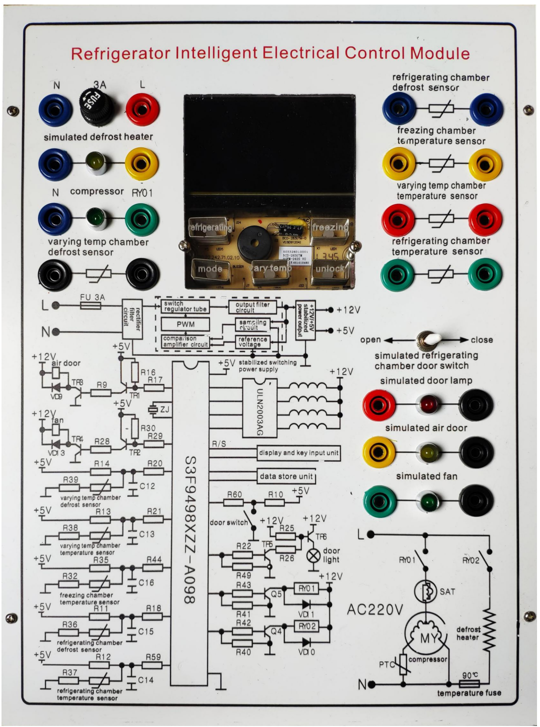


Figure 1-24 Refrigerator intelligent electrical control module hanging box

3. "Training device" technical parameters

The "training device" is a set of semi-open equipment, which can choose to form different refrigeration systems according to one's own needs, and can form up to three sets of refrigeration systems. The main technical parameters are as follows:

① Input power: single-phase AC220 (1±10%) V 50Hz

②Working environment: temperature -10℃~40℃, relative humidity ≤85% (25℃), altitude <4000m.

③ Device capacity: ≤1.5kV·A.

④ Compressor of air conditioning system: input power of 585W

⑤Refrigerator system compressor: input power 65W

⑥Type of refrigeration system: air conditioning system R22, refrigerator system R12.

⑦Dimensions: 1500mm×800mm×1250mm.

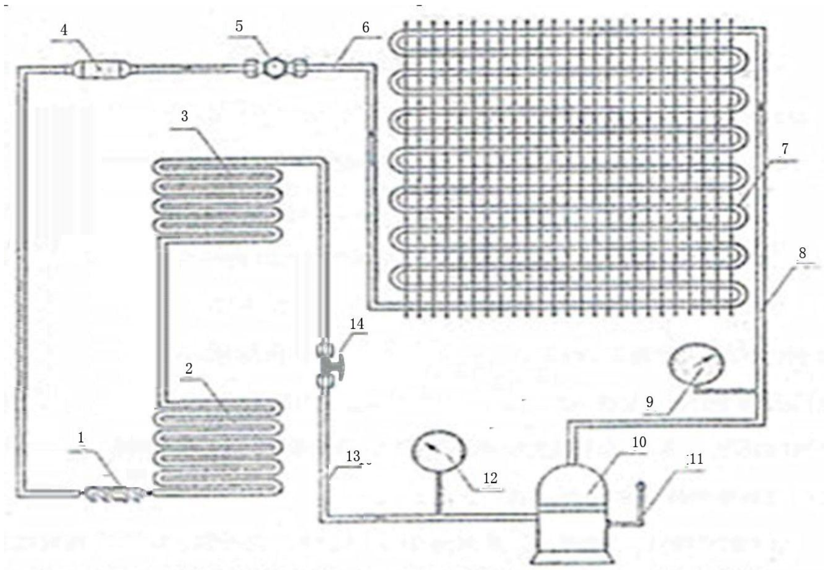
⑧Safety protection: With leakage voltage and leakage current protection, it meets national safety standards.

The working units in the "training device" are all placed on the training platform, which favors the disassembly and installation of various components, pipeline installation and electrical wiring. Among them, in order to facilitate electrical wiring, wiring slots are set around the training platform. The connection between the modules and between the modules and the training platform adopts safe wire connection, which meets the requirements of comprehensive training to the greatest extent.

4. "Training device" system process

(1) "Training device" refrigerator system

The refrigerator system is composed of a compressor, a vibration-resistant pressure gauge, a steel wire condenser, a sight glass, a filter drier, a capillary tube, a refrigerated evaporator, a refrigerated evaporator, and a hand valve. The flow chart of the refrigerator electronic temperature control system is shown in Figure 1-25.



1- Capillary	8-High pressure exhaust pipe
2-Freezer evaporator (coil evaporator)	9-High pressure guillotine pressure gauge
3- Refrigerator evaporator (coil type evaporator)	10- Compressor
4- Dry filter	11-Process liquid filling port
5- sight glass	12- Low pressure side pressure vacuum gauge

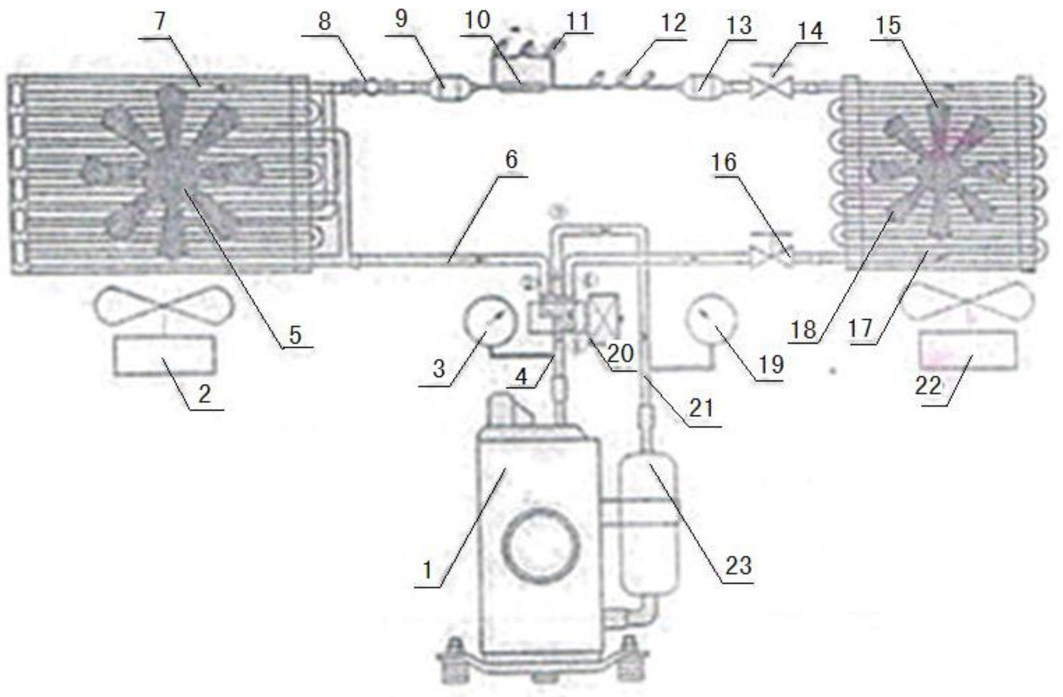
6- Condenser outlet	13- low pressure return air pipe
7-Wire Condenser	14-hand valve

Figure 1-25 Flow chart of electronic temperature control cooling system of refrigerator

The refrigerant used in the refrigerator refrigeration system is R12. The gaseous R12 is compressed into high-temperature and high-pressure steam and sent to the condenser through the high-pressure exhaust pipe 8. In the case of natural cooling, the high-temperature and high-pressure gaseous refrigerant condenses into a liquid refrigerant, and flows through the condenser outlet 6 through the visual liquid Mirror 5, dry filter 4 to capillary 1, under the throttling and pressure reduction of capillary 1, the refrigerant absorbs the heat of the cooled object in the freezer compartment evaporator 2 and boils and evaporates, and then enters the refrigerator compartment evaporator 3, The heat sucked in from the freezer compartment and the refrigerated items becomes a gaseous refrigerant, which is sucked back by the compressor 10 for the next cycle. This cycle is repeated to exchange the heat of the items placed in the freezer compartment evaporator 2 and the refrigerating compartment evaporator 3. The low-pressure side pressure vacuum gauge 12 and the high-pressure side pressure gauge 9 are respectively connected to the low-pressure return port and the high-pressure exhaust port of the compressor to monitor the pressure changes of the high and low pressure sides of the system.

(2) "Training device" air conditioning system

The air-conditioning system adopts a heat pump split air-conditioning system with simple structure and clear levels. Its main components are compressors, pressure gauges, electromagnetic four-way valves, outdoor heat exchangers, sight glasses, filters, capillary throttling components, and air conditioning valves . Indoor heat exchanger, gas-liquid separator, etc. The structure of the air-conditioning system and the flow chart of the refrigeration operating system are shown in Figure 1-26.



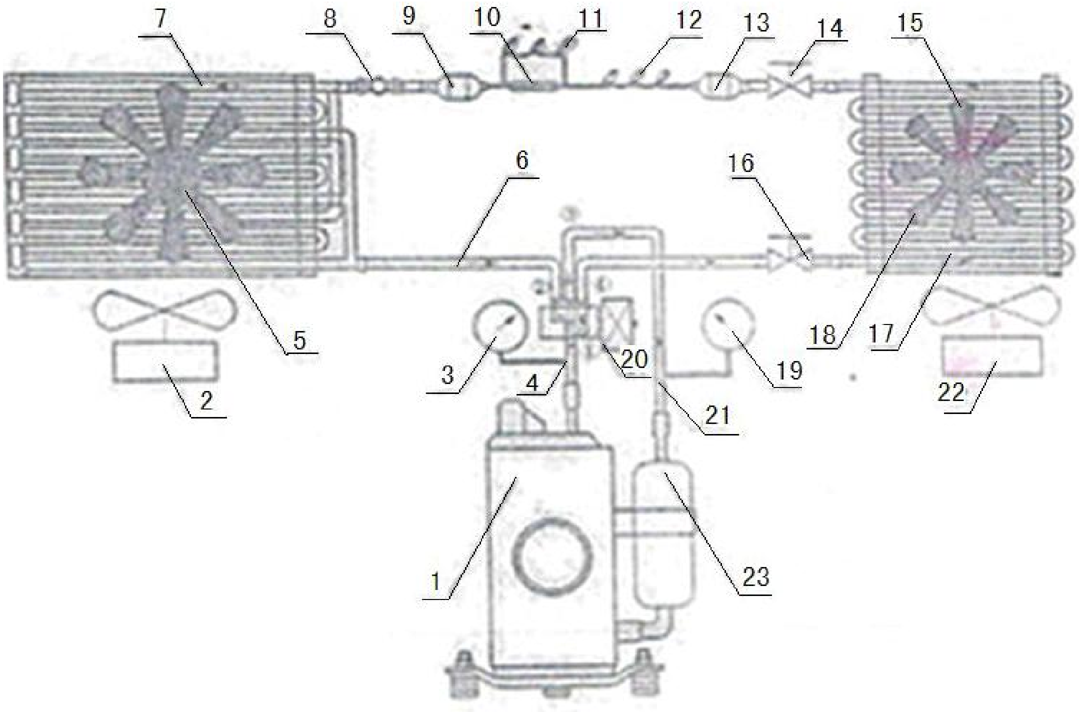
1- Compressor	9-filter	17-Outlet of indoor heat exchanger
2-Outdoor heat exchanger fan	10- Check valve	18-Indoor heat exchanger
3- High pressure side pressure vacuum gauge	11-Capillary	19- Low pressure side pressure vacuum gauge
4-High pressure exhaust pipe	12-Capillary	20- solenoid four-way valve
5- Outdoor heat exchanger	13-Filter 2	21-Compressor return port
6- Outdoor heat exchanger imports	14-Air conditioning valve 1	22-Indoor heat exchanger fan
7-Outdoor heat exchanger outlet	15-Indoor heat exchanger inlet	23-Compressor gas-liquid separator
8-Sight glass	16-Air conditioning valve	

Figure 1-26 The structural composition of the air-conditioning system and the system flow chart of the refrigeration conditions

①Under the refrigerating condition of the air conditioner, the low-temperature, low-pressure refrigerant gas enters the compressor 1 from the compressor return port 21 and the compressor gas-liquid separator 23, and is compressed by the compressor 1 to become high-temperature, high-pressure refrigerant gas , Through the high-pressure exhaust pipe 4, enter the ① end of the electromagnetic four-way valve 20. At this time, the coil of the electromagnetic four-way valve 20 is not energized. The end of the electromagnetic four-way valve 20 is connected to the end ② and the end ③ to the end ④. The ② end of the electromagnetic four-way valve 20 enters the outdoor heat exchanger inlet 6 to the outdoor heat exchanger 5. After the forced convection of the outdoor heat exchanger 5 and the outdoor heat exchanger fan 2 on the air, the refrigerant becomes high pressure, medium (normal)) The warm refrigerant liquid flows through the outlet 7 of the outdoor heat exchanger, and the refrigerant can be seen from the sight glass 8.

The liquid refrigerant passes through the filter 9, the one-way valve 10, the capillary tube 12, the filter 13, and then through the connection of the air-conditioning valve 14, flows into the indoor heat exchanger inlet 15, and passes through the capillary throttling in front, low pressure, medium (normal) The warm refrigerant liquid flows into the indoor heat exchanger 18, and immediately absorbs heat and expands into a low-pressure, low-temperature gas (see the physical characteristics of R22 for details), and forced convection to the air through the indoor heat exchanger 18 and the indoor heat exchanger fan 22, Blow the cold energy into the room, the low-pressure, low-pressure gas enters through the outlet 17 of the indoor heat exchanger, flows through the air valve 16, and the end ④ of the electromagnetic four-way valve 20, flows out from the end ③ of the electromagnetic four-way valve, and enters the compressor The gas return port 21 returns to the compressor 1 through the compressor gas-liquid separator 23, and the cycle is repeated. Through the principle of thermodynamics, the indoor energy is exchanged with the outdoor capacity to achieve the cooling effect. Pressure vacuum gauges 3 and 19 are respectively connected to the high-pressure exhaust port and low-pressure return port of the compressor to monitor pressure changes on the high and low pressure sides of the system.

②When the air conditioner is in heating mode, the system flowchart is shown in Figure 1-27.



1- Compressor	9-filter	17-Outlet of indoor heat exchanger
2-Outdoor heat exchanger fan	10- Check valve	18-Indoor heat exchanger
3- High pressure side pressure vacuum gauge	11-Capillary	19- Low pressure side pressure vacuum gauge
4-High pressure exhaust pipe	12-Capillary	20- solenoid four-way valve
5- Outdoor heat exchanger	13-Filter 2	21-Compressor return port
6- Outdoor heat exchanger imports	14-Air conditioning valve 1	22-Indoor heat exchanger fan
7-Outdoor heat exchanger outlet	15-Indoor heat exchanger inlet	23-Compressor gas-liquid separator
8-Sight glass	16-Air conditioning valve	

Figure 1-27 Flow chart of the air conditioner heating mode system

The low-temperature and low-pressure refrigerant gas enters the compressor 1 through the compressor return port 21 and the compressor gas-liquid separator 23, is compressed by the compressor 1, and becomes high-temperature and high-pressure refrigerant gas, and enters the electromagnetic four through the high-pressure exhaust pipe 4. At this time, the main control board of the air conditioner drives the solenoid four-way valve 20 to be energized. Through mechanical switching, the ① end of the electromagnetic four-way valve 20 is connected to the end ④, and the end ② is connected to the end ③. The high-pressure refrigerant gas flows out of the end of the electromagnetic four-way valve 20, and flows into the indoor heat exchanger 18 through the air conditioner 16, through the forced convection of the air by the indoor heat exchanger fan, so that the heat in the indoor heat exchanger is carried by the air When entering the room, the temperature of the room rises, and the high-temperature, high-pressure refrigerant gas becomes high-pressure, medium (normal) temperature refrigerant liquid, flows into the indoor heat exchanger inlet 15, and then flows through the indoor heat exchanger inlet 15 to the air conditioning valve 14. , And then flow into the outdoor heat exchanger 5 through the filter 13, the capillary 12, the capillary 11, the filter 9, and the sight glass 8. [The high-pressure, medium (normal) temperature refrigerant liquid is throttled by the capillary 12, 11 At this time, the one-way valve 10 does not conduct in the reverse direction], the high-pressure, medium (normal) temperature refrigerant liquid flows into the outdoor heat exchanger 5, immediately absorbs heat and expands, and becomes a low-pressure, low-temperature gas, which is exposed to the outdoor by the condenser The heat exchanger fan 2 performs forced convection of the air to exchange energy. The low-pressure, low-temperature gas flows into the outdoor heat exchanger inlet 6, the electromagnetic four-way valve ②, out of the ③ end, enters the compressor return air 21, and then passes The compressor gas-liquid separator 23 returns to the compressor 1, and the cycle is repeated. Through the principle of thermodynamics, the indoor energy is exchanged with the outdoor energy to achieve a heating effect.

Task 2 Master the use of special refrigeration tools, and have the ability to independently disassemble and assemble "training devices"

1. Task description

Special tools for refrigeration are an indispensable helper in the assembly and maintenance of "training devices". Without the help of good tools, it is impossible to smoothly complete the processing of refrigeration pipes. Therefore, mastering the special refrigeration tools and using them correctly is the key to ensuring the assembly and maintenance of refrigeration equipment.

Through training in this task, you should be able to achieve:

① Master the use of special refrigeration tools.

②Master the skills of independent disassembly and assembly of "training devices".

2. Related knowledge

1. Special tools for refrigeration

Special tools for refrigeration include pipe cutters, chamfers, pipe expanders, pipe benders, repair meter valves and connecting hose assemblies, vacuum pumps, portable welding torches, etc.

(1) Pipe cutter

The pipe cutter is a special tool for cutting copper and aluminum pipes during installation and maintenance. The cutting range of the pipe cutter is usually φ3.45mm. It generally consists of a bracket, a guide wheel, a blade and a handle.

(2) Chamfering device

In the cutting process of copper pipes, it is easy to produce burrs and burrs. The chamfering device is mainly used to remove the burrs generated in the cutting process and eliminate the phenomenon of copper pipe closing.

(3) Expanding tube flaring device

The tube expander is used to expand the cup-shaped mouth and the bell mouth. The tube expander is a special tool for expanding the end of a small diameter copper tube (below 19mm) to form a bell mouth. It consists of a tube expanding fixture and a tube expanding The top cone is composed of two types of clamps: metric and imperial. The expanded top cone is divided into eccentric expanded top cone and positive expanded top cone.

In actual operation, when pipes of the same diameter are connected, one of the pipes is usually processed into a cup-shaped mouth with a pipe expander, and then the other pipe is inserted into the cup-shaped mouth for welding.

There are two types of expanders: manual and mechanical. The commonly used manual expanders for refrigeration equipment installation and maintenance are composed of an expansion head and a manual lever. The expansion range is 3/8~1in. The expansion heads are also available in metric and imperial systems.

(4) Bender

The pipe bender is a special tool for bending copper and aluminum pipes. The bending radius should not be less than 5 times the pipe diameter, and the maximum bending is 180°. The bending part of the bent pipe should not be dented.

(5) Portable welding torch

The portable welding torch consists of oxygen cylinder, butane cylinder, welding torch, pressure reducer, filling bridge, etc. The modified equipment is easy to operate, safe and convenient. It uses liquefied petroleum gas and butane gas as fuel gas, and the maximum temperature of oxygen-supported flame is about 2500℃.

Project 3 Connection of Refrigeration System Pipelines

The refrigeration system of the "training device" refrigerators and air conditioners is a closed system, and the connection between them is connected by pipelines. In this system, the refrigerant circulates in a certain direction. Therefore, to ensure that the "training device" refrigerators and air conditioners have a good cooling effect, the entire system is required to have high air tightness. If the airtightness of the system is not good, even if the refrigerant leaks, it will affect the cooling effect of the entire equipment. At the same time, the leaked refrigerant will also pollute the surrounding environment and bring harm to people. Therefore, the quality of pipe connections in the refrigeration system must be guaranteed. This project mainly introduces the operation skills of pipe connection of refrigeration system.

Through the training of this project, you should be able to achieve:

①Understand the relevant knowledge of different forms of pipeline connections.

②Familiar with oxygen-acetylene gas welding equipment.

③Master the operating skills of oxygen-acetylene welding and pipe joint connection.

The main tasks of this project:

① Brazing of refrigeration pipelines.

②Threaded connection of refrigeration pipeline.

Task 1 Brazing of refrigeration pipes

1. Task description

In the assembly and maintenance of the "training device", the connections between copper pipes and copper pipes, copper pipes and evaporators, copper pipes and condensers, copper pipes and filter driers and capillaries are commonly used. In these connections, brazing is generally used. The so-called brazing of the refrigeration pipeline is to use the high temperature flame generated after the combustible gas and the combustion-supporting gas are mixed and ignited to weld the nozzles, and the two nozzles are cooled and solidified to form an inseparable joint.

Through training in this task, you should be able to achieve:

① Familiar with oxygen-acetylene welding equipment.

②Master the operating skills of oxygen-acetylene welding.

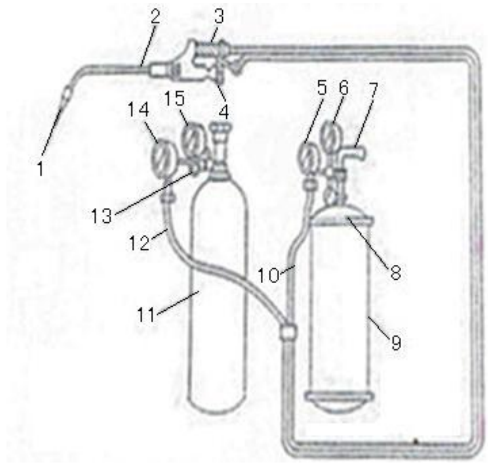
2. Related knowledge

1. Oxygen-acetylene welding equipment

In the assembly and maintenance of the "training device", a common type of acetylene welding is oxygen-acetylene welding, or gas welding for short. The equipment is mainly composed of oxygen cylinders, acetylene cylinders, pressure reducers (also known as pressure regulators), rubber gas hoses (also known as gas hoses or connecting pipes), welding torches (also known as welding guns), etc. It consists of five parts, as shown in Figure 2-1.

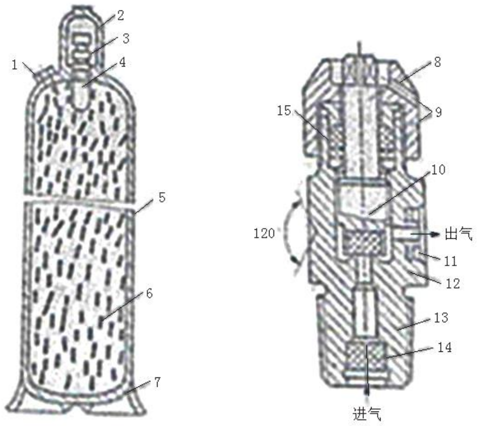
(1) Oxygen cylinder

An oxygen cylinder is a high-pressure container for storing and transporting oxygen. It is made of chromium and molybdenum. Generally, the volume of the steel cylinder is 40L, and the standard pressure is about 15MPa. There is a pressure gauge at the joint on the bottle to indicate the oxygen pressure, and a pressure reducing valve to indicate the adjusted oxygen pressure. The structure of the oxygen cylinder is shown in Figure 2-2(a). The valve structure of the oxygen cylinder installed on the cylinder is shown in Figure 2-2(b).



1- welding tip	6-High pressure meter	11-Oxygen Cylinder
2-welding torch (also called welding torch)	7-Bottle valve wrench	12-Oxygen rubber gas hose
3-handle	8-acetylene pressure reducer	13-Oxygen pressure reducer
4- Oxygen adjustment knob	9-Acetylene gas cylinder	14- low pressure meter
5- low pressure meter	10- acetylene rubber gas hose	15-High pressure meter

Figure 2-1 Oxygen-acetylene gas welding equipment



(A) Oxygen cylinder structure (B) Oxygen cylinder valve structure

1- safety plug	6-Bottle body	11-valve
2-bottle cap	7-Bottle seat	12-Safety valve device
3-bottle valve	8-stem	13-cone tail
4- filter material	9- Fastening nut	14-Filter
5- Anti-vibration rubber ring	10-switch board	15-Leak-proof gasket

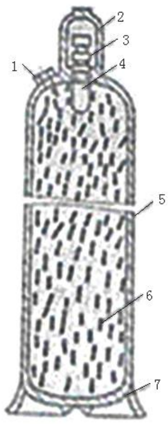
Figure 2-2 Oxygen cylinder

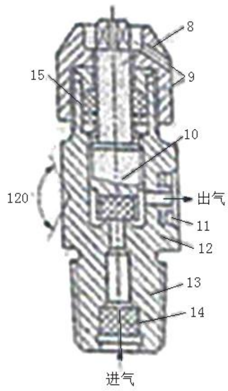
In order to correctly recognize the oxygen cylinder in use, in addition to the words on the surface of the cylinder, it is also painted with a layer of sky blue to distinguish it from other cylinders.

(2) Acetylene gas cylinder

Acetylene gas cylinder is a high-pressure container for storing and transporting acetylene gas. Generally, it is composed of safety stopper, bottle cap, bottle valve, filter material, bottle body, bottle seat and porous packing. The volume of the cylinder is 40L, and the rated working pressure is about 1.5MPa. The shape of the acetylene gas cylinder is similar to that of the oxygen cylinder, but the diameter is larger and the internal structure is more complicated than that of the oxygen cylinder. The structure of the acetylene gas cylinder is shown in Figure 2-3(a). The valve structure of the acetylene gas cylinder installed on the cylinder is shown in Figure 2-3(b).

In order to correctly recognize the acetylene gas cylinders in use, in addition to the words on the surface of the cylinder body, a layer of white is also painted to distinguish other cylinders.





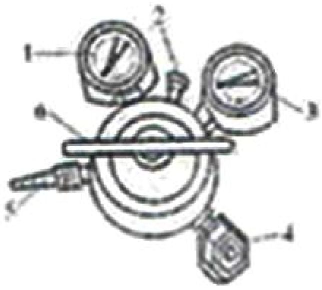
(A) Acetylene gas cylinder structure (B) Acetylene gas cylinder valve

1- safety plug	6-porous filler	11-seal
2-bottle cap	7-Bottle seat	12-Valve body
3-bottle valve	8-stem	13-cone tail
4- Filter material	9- Fastening nut	14-Filter
5-bottle	10- Valve	15-Leak-proof gasket

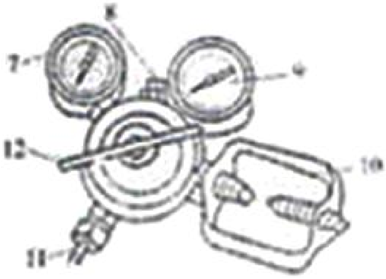
Figure 2-3 Acetylene gas cylinder

(3) Pressure reducer (also called pressure regulating valve)

The structure of the pressure reducer is shown in Figure 2-4. The pressure reducer is divided into two types: oxygen pressure reducer and acetylene pressure reducer. It is a regulating device that reduces the pressure of the high-pressure gas in the gas (oxygen and acetylene) cylinder (cylinder for short) to the pressure required for gas welding.



(A) Oxygen pressure reducer



(B) Acetylene gas pressure reducer

1- Oxygen low pressure meter	7-Acetylene gas low pressure meter
2- safety plug	8- safety plug
3- Oxygen high pressure gauge	9-Acetylene gas high pressure meter
4-Cylinder connector	10-Cylinder connector
5-Hose connector	11-Hose connector
6-Adjusting screw	12-Adjusting screw

Figure 2-4 Pressure reducer (also called pressure regulating valve)

(4) Rubber gas hose (also called gas hose or connecting pipe)

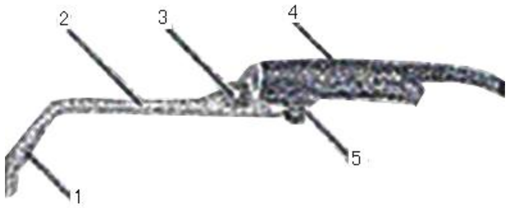
The rubber air hose is shown in Figure 2-5. There are two more rubber gas hoses, one is an oxygen rubber hose and the other is an acetylene rubber hose. The oxygen rubber gas transmission hose is red, the inner diameter is 8mm, the working pressure is 1.5MPa, and the test pressure is 3.0MPa. The acetylene rubber hose is black, with an inner diameter of 10mm and a working pressure of 0.5MPa. The length of the rubber air hose is 10~15m, not shorter than 5m, but too long will easily increase the resistance of air flow. The joints must be fastened tightly with special clamps or metal wire clamps.

1- Oxygen gas hose (connected to oxygen cylinder)	2-Acetylene gas hose (connected to acetylene gas cylinder)	3- welding torch

Figure 2-5 Rubber air hose

(5) Welding torch (also called welding torch)

The welding torch is shown in Figure 2-6. The welding torch is a tool used to mix oxygen and acetylene in the correct proportion and use the ignited high-temperature flame to weld pipe joints. When using the welding torch, you should hold the welding torch correctly, as shown in Figure 2-7.



1- welding tip	3-acetylene gas adjustment (forward "on", backward "off")	5- Oxygen adjustment knob (clockwise "on", counterclockwise "off")
2- mixing tube	4-handle	

Figure 2-6 Welding torch

Figure 2-7 Schematic diagram of handheld welding torch

2. Solder and flux

(1) Solder

Solder is also called welding rod, divided into silver copper welding rod, copper phosphorus welding rod and so on. In order to improve the quality of welding, suitable electrodes should be selected according to the material of the weldment. Copper-phosphorus electrode can be used for welding between copper pipe and copper pipe. This kind of electrode is relatively cheap, and has good flow, filling and wetting properties, and does not require flux. This is because the phosphorus of the copper-phosphorus electrode can reduce copper oxide during the brazing process and act as a flux. Copper pipe and copper pipe or steel pipe and steel pipe are welded, and silver copper electrode or copper zinc electrode can be selected. Silver-copper electrodes have good welding performance, followed by copper-zinc electrodes. Flux is required for welding.

(2) Flux

Flux is also called solder powder, flux, and flux. Flux can cause oxides or impurities on the weldment to generate slag during the brazing process. The slag covers the surface of the weldment to isolate the weldment from the air, and the weldment is placed to continue oxidation at high temperatures. If flux is not used, the oxides on the weldment will be included in the weld, which will reduce the strength of the weld and cause leakage.

Brazing flux is divided into non-corrosive flux and activated flux. Non-corrosive flux is borax, boric acid, silicic acid and so on. Activated flux is to add a certain amount of potassium fluoride, sodium fluoride or potassium chloride to the non-corrosive flux. Activated flux has a strong ability to remove metal oxides and impurities in the weldment, but the slag of the flux has a corrosive effect on the metal, and it must be completely removed after welding.

3. Basic operating skills of oxygen-acetylene welding

1. Preparation before welding

①Choose H01-1 miniature or H01-6 with different types of welding tips.

②Prepare suitable welding rod and solder.

③The following inspections should be done before the welding torch is ignited.

(A) Open the valve of the acetylene gas cylinder and observe whether the pointer of the pressure gauge is within the specified pressure range.

(B) Open the oxygen cylinder valve and check whether the pointer of the pressure gauge is within the specified pressure range.

(C) If the pressure of the acetylene gas cylinder is too high and the welding torch cannot be used, readjust it.

④Operate in the following order during ignition:

(A) Turn on the acetylene gas switch on the welding torch and light it.

(B) Turn on the oxygen switch on the welding torch.

(C) Adjust the opening of the acetylene gas and oxygen switch according to welding needs.

⑤When extinguishing a fire, follow the following sequence:

(A) Turn off the oxygen switch on the welding torch.

(B) Turn off the acetylene gas switch on the welding torch.

Generally, the oxygen pressure is 2 times greater than the acetylene gas pressure. If acetylene gas is found to return during use, the oxygen switch should be turned off immediately to avoid accidents.

Matters needing attention when using welding torch:

1. Choose suitable welding torch and welding tip according to welding type.

2. Keep the welding tip and welding torch firmly connected.

3. Do not over tighten the welding tip and welding torch.

4. The cleaning of the welding tip must use a special cleaning needle, and can not be replaced by other objects.

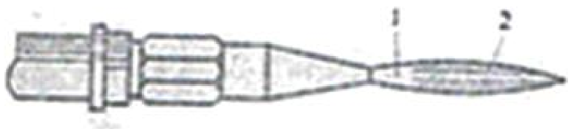
5. Remember: an important link to ensure the safety of yourself and others during safe operation.

2. Welding flame

In the process of oxygen-acetylene gas welding, three types of neutral flame, oxidizing flame and carbon-increasing low-temperature flame are often encountered.

(1) Neutral flame

When the content of acetylene gas and oxygen is moderate, the flame that acetylene gas can fully burn is a neutral flame, as shown in Figure 2-8. The temperature of the neutral flame is about 3100℃, which is suitable for welding copper pipes and copper pipes, copper pipes and copper pipes.

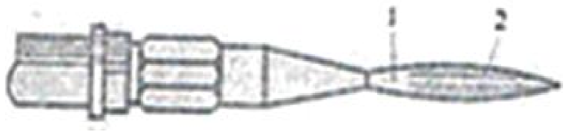


1- Bright blue heart	2- Go to the blue outer flame

Figure 2-8 Neutral flame

(2) Oxidation flame

When the oxygen content exceeds the acetylene gas content, the sprayed flame is an oxidizing flame, as shown in Figure 2-9. The flame of the oxidizing flame is short, slightly purple, and the flame is straight. The temperature of the flame is around 3500°C. Because the oxygen supply in the oxidation flame is large and the oxidation is strong, it will cause the burning of the weldment, causing the weld to produce pores and slag. It is not suitable for the welding of refrigeration pipelines, but is suitable for the welding of pipe and tube parts.

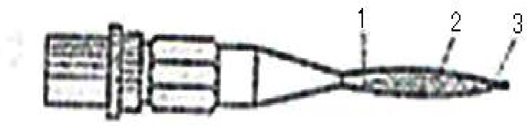


1 Some bright blue flame hearts with slightly darker neutral flames	2-Sky blue (slightly purple) outer flame (shorter)

Figure 2-9 Oxidation flame

(3) Carbon increasing low temperature flame

When the acetylene gas content exceeds the oxygen content, some of the acetylene gas in the gas after the flame has not burned is a carbon-increasing low-temperature flame, as shown in Figure 2-10. The low-temperature recarburization flame is long and soft, and the temperature is about 2700℃. It is suitable for welding aluminum or aluminum alloy, copper and steel pipes.



1- Bright blue flame heart	2- Shiny blue inner flame	3-Sky blue outer flame

Figure 2-10 Carbon increasing low temperature flame

3. Welding of pipes of different materials

Due to the different pipe materials, there are different requirements for welding flame, welding rod, and flux. According to the teaching requirements, the welding of copper and copper pipes, the welding of copper and steel pipes, and the welding of aluminum and aluminum pipes can be selected for practice.

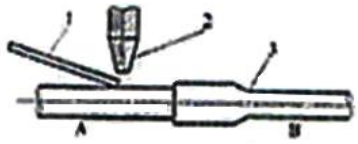
(1) Welding of copper tube and copper tube

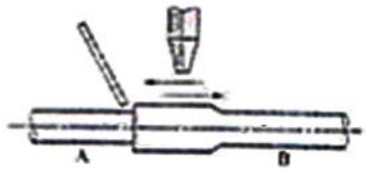
The welding steps of copper pipe and copper pipe:

① Choose a neutral flame, as shown in Figure 2-8.

② Contact a short section of silver electrode or copper-phosphorus electrode with the welding part of the inserted pipe, as shown in Figure 2-11. Heat the insertion tube until the welding rod melts. After the welding rod starts to melt, the insertion tube is just at the welding temperature.

③After welding, insert the pipe, heat the sleeve to cherry red, place the welding rod on the welded part, and make the flame move back and forth continuously between points A and B. As shown in Figure 1-12. Do not press the welding rod tightly on the welded part, just lightly touch the two, so that the molten solder can completely enter the gap between the insertion tube and the casing. Do not use flame to heat the electrode directly, but melt the electrode by the conduction heat of the copper drum tube.





1- Welding rod	2- welding torch	3- steel pipe

Figure 2-11 Welding of welding rod and insertion tube   Figure 2-12 Heating sleeve

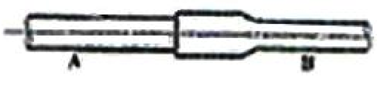
④Remove the flame. At this time, the welding rod is still in its original position. Take it away after a few seconds. The appearance of the welding part is as shown in 2-13. If it is suspected or found that there is still a gap between the inserted tube and the casing, it should be heated again for repair welding.

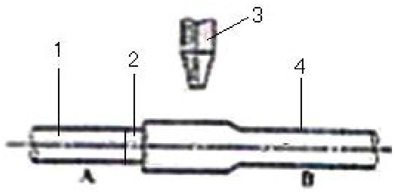
(2) Welding of copper pipe and steel pipe

The welding steps of copper pipe and steel pipe:

①Choose a low-temperature flame for increasing carbon, as shown in Figure 2-10.

②Before heating, apply flux to the parts to be welded. Heat the insertion tube and sleeve, and move the flame nozzle continuously back and forth between the bright spots of A and B, as shown in Figure 2-14. Note that the flame should not directly hit the flux. The temperature when heating steel pipes is slightly higher than when heating copper pipes.

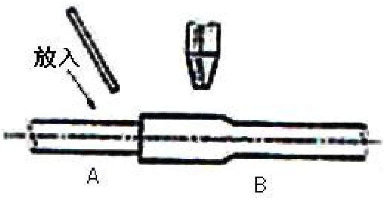




1- Steel pipe	2- melted solder	3- welding torch	4- steel pipe

Figure 2-13 Appearance of welding part   Figure 2-14 Heating

③When the pipe is heated and the flux melts into a liquid, immediately put the preheated electrode on the solder joint, as shown in Figure 2-15. When the welding rod starts to melt, the flame nozzle is moved back and forth between A and B. As shown in Figure 2-15, until the solder flows into the gap between the two tubes.



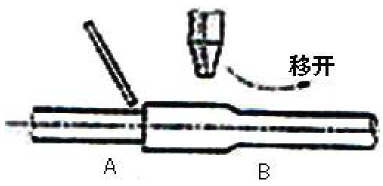


Figure 2-15 Put in welding rod　　Figure 2-16 Remove the flame

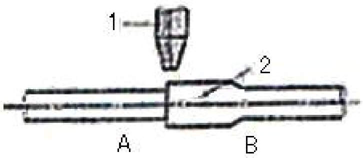
④Remove the flame and keep the electrode and the welding point in contact for a few seconds before removing it, as shown in Figure 2-16. If it is suspected and found that there is still a gap between the two tubes, heat again to make the flame nozzle move continuously between the bright spots of A and B, and add a small amount of solder if necessary.

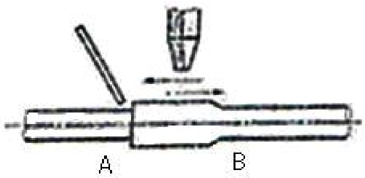
(3) Welding of aluminum tube and aluminum tube:

The welding steps of aluminum tube and aluminum tube:

①Choose a low-temperature flame for increasing carbon, as shown in Figure 2-10.

②Before heating the pipe, put the flux on the welding part, heat the insert pipe and sleeve with flame, as shown in Figure 2-17. Do not make the flame directly hit the flux, and melt the flux through the conduction heat of the tube. The insertion tube should be heated to a higher temperature.





1- welding torch	2- aluminum tube

Figure 2-17 Heating tube　　Figure 2-18 Moving flame

③When the solder just begins to melt, put the solder on the solder joint (not directly in contact with the flame), and move the flame back and forth between A and B, as shown in Figure 2-18. At the same time, lightly touch and wrap the electrode on the soldering part. Move along the tube because the fluidity of this kind of solder is not as good as that of a silver electrode.

④Remove the flame first, and then remove the welding rod. If you suspect or find a gap between the tubes, use the welding torch to heat back and forth between A and B, as shown in Figure 2-19. If necessary, add a proper amount of solder. The final operation of this welding is basically the same as the above-mentioned welding methods.

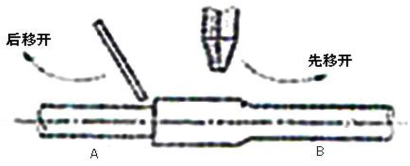


Figure 2-19 First remove the welding torch and then remove the electrode

4. Inspection of welding quality of pipeline (joint)

(1) Requirements for welding quality of pipelines (joints)

①The welded pipe is clean and bright.

②The welded pipe has no burrs.

③There is no unevenness in the welding point.

④The welding point must not be corroded.

⑤The welding place should not be contaminated with oil, paint and other residues.

If it does not meet the requirements, it will affect the quality of welding, produce pores or false welding, and cause failures such as refrigerant leakage.

(2) Inspection method of welding quality of pipeline (joint)

In order to ensure the welding quality of the pipes (joints) of the refrigeration system of refrigerators and air conditioners, quality inspections should be carried out on each welding point. Generally, visual inspection, air tightness inspection and halogen leak detector inspection can be used.

Task 2 Threaded connection of refrigeration pipeline

1. Task description

In the assembly and maintenance of the "training device", especially the connection of indoor and outdoor pipelines of split air conditioners, threaded joints are often used. The so-called threaded connection of the refrigeration pipe joint is to use the nut at the flared joint end of the copper pipe to tightly combine the thread of the pipe joint at the other end, and tighten it with a nut. It has the functions of convenient assembly and disassembly, simple adjustment and replacement, and multiple disassembly and assembly. This connection is usually referred to as "live connection", which is an extremely important connection method in pipeline connection.

Through training in this task, you should be able to achieve:

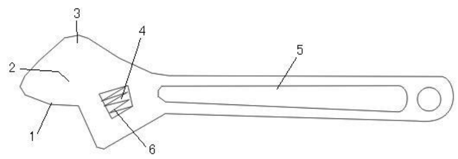
2. Related knowledge

1. Takeover tools

In the assembly and maintenance of the "training device", the frequently used takeover tools are: adjustable wrenches and open wrenches.

(1) Adjustable wrench

Adjustable wrench is a special tool for tightening or disassembling hexagon nuts and bolts. It can be adjusted by turbine to adjust the tightness of hexagon nuts or bolts within a certain range. As shown in Figure 2-27.



1- Trap arm	2- wrench	3-stubbing arm	4-turbo	5-handle	6-axis slightly

Figure 2-27 Adjustable wrench

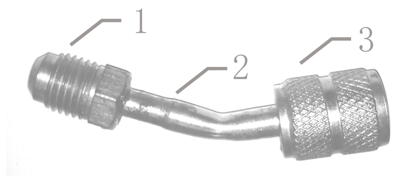
(2) Stay wrench

The open spanner is a special tool used to tighten or disassemble certain specifications of hexagonal nuts and bolts. There are two types of single head and double head. The double-ended open wrench is shown in the figure.

Figure 2-28 Open wrench

2. Pipe joint and pipe nut

In the assembly and maintenance of split-type air conditioners, pipe joints and pipe nuts are often used to take over accessories. The pipe connection methods include the connection of the bell nut and the pipe joint, the connection of the quick joint and the connection of the light pipe joint, etc., and the connection of the bell nut and the pipe joint is the most common way. As shown in Figure 2-29.



1- pipe joint	2-copper tube	3- Takeover nut

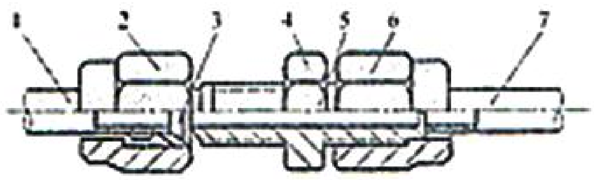
Figure 2-29 The most common threaded connection pipe joint

Third, the threaded connection of the refrigeration pipeline

There are two methods for threaded connection:

1. Full connector connection

The full connector connection is shown in Figure 2-32. Expand the connecting part of the copper pipe 1 and the copper pipe 2 into a bell mouth shape, and use the middle double-threaded joint to firmly attach the copper pipe bell mouth to the two ends of the joint, and then use two wrenches to screw the joint (nut) Just tight.

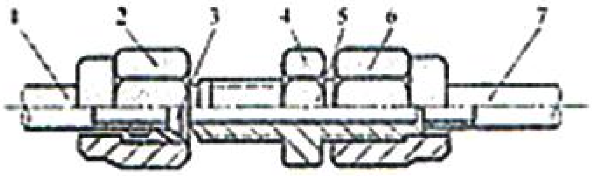


1- Copper tube 1	4-Double threaded joint	7-copper tube 2
2-nut	5- junction	
3- bell mouth	6-nut	

Figure 2-32 Full connector connection

2. Half joint connection

The board connector connection is shown in Figure 2-33. During operation, expand the connecting part of the copper pipe into a bell mouth shape, and firmly attach the bell mouth of the copper pipe to the joint, and then tighten the joint (nut) with two wrenches.



1- Copper tube 1	4-connector	7-copper tube 2
2-nut	5- junction	
3- bell mouth	6-nut	

Figure 2-33 Half joint connection

Project 4 "Modern refrigeration and air-conditioning system skills training device" assembly

This project mainly introduces the theoretical knowledge and practical operation skills of refrigeration system pipelines of refrigerators and air conditioners in the "training device", assembling, air tightness inspection, vacuuming and filling refrigerant.

Through the training of this project, you should be able to achieve:

① Familiar with the composition of the "training device" refrigeration system and the use of special tools.

②Master the basic methods and operating skills of air tightness inspection of refrigeration system.

③Master the basic methods and operating skills of vacuuming and pre-filling the refrigeration system.

The main tasks of this project:

①Assembly of refrigeration system pipes’

②The air tightness inspection of the refrigeration system.

③ Vacuum pre-filling refrigerant for refrigeration system.

Task 1 Assembly of refrigeration system pipeline

1. Task description

The refrigeration systems of refrigerators and air conditioners in the "training device" are all closed systems connected by compressors, evaporators, condensers, throttling devices, filter driers and refrigeration pipes. The piping of the refrigeration system plays the role of connecting up and down. Therefore, it is very important to master the assembly and connection technology of the refrigeration system piping.

Through training in this task, you should be able to achieve:

① Familiar with the composition of the refrigeration system.

②Familiar with the operation skills of making and connecting refrigeration pipelines of "training device".

2. Related knowledge

1. The composition of the refrigerator refrigeration system in the "training device"

Refrigerator refrigeration system is mainly composed of compressor, evaporator, condenser, throttling device and filter drier, etc. The components are connected by copper pipes. The main components are as follows:

(1) Compressor

The compressor is the power device that makes the refrigeration system of the refrigerator complete the practice refrigeration cycle. Its function is to suck in the vaporized refrigerant that has absorbed heat in the evaporator, compress it into high-pressure gas and send it to the condenser for cooling. People vividly call the compressor the heart of the refrigerator, so the quality of the compressor directly affects the refrigeration performance of the refrigerator. Most of the compressors used in refrigerators are fully enclosed. The fully enclosed type is to seal the compressor and the motor in the casing. At present, the hermetic compressors used in refrigerators mainly include three types: sliding tube compressors, connecting rod compressors, and rotary compressors. The hermetic compressor used in the refrigerator is a low back pressure compressor. The back pressure refers to the suction pressure of the compressor, that is, the outlet pressure of the evaporator, which is related to the evaporator temperature. The low back pressure evaporation temperature range is -3.5~-15℃. This device uses a 65W, 0.5A fully enclosed connecting rod piston compressor.

(2) Evaporator

The evaporator is a major component in the refrigeration system of a refrigerator. Its function is to evaporate the liquid refrigerant decompressed by the interaction between the compressor and the capillary tube, absorb the heat of the air around the evaporator, and make this part of the low-temperature air and the high-temperature air in the box form convection to achieve the temperature drop in the box the goal of. According to its structure, the evaporator can be divided into five types: plate tube type, serpentine tube type, wire tube type, fin type, and aluminum composite plate inflation type. This device uses aluminum composite board inflation evaporator.

(3) Condenser

The condenser is used to be a radiator, which is a heat exchange component that causes the gaseous refrigerant to release heat and condense into a liquid refrigerant. Its function is to dissipate the heat of the high-temperature and high-pressure gaseous refrigerant discharged from the compressor through natural convection and condense into a high-pressure liquid refrigerant. According to the different cooling medium and cooling method, the condenser can be divided into four types: shutter type, steel wire steel pipe type, flat plate type and finned tube type. This decoration uses steel wire steel tube condenser.

(4) Throttle device

Most of the throttling devices of refrigerator refrigeration systems use capillary tubes. Its function is to turn the high-pressure liquid refrigerant from the condenser into a low-pressure liquid refrigerant through throttling, and then enter the evaporator to evaporate and absorb heat. The electronic temperature control type of this device selects a capillary tube with a diameter of 1.8×0,6mm and a length of 1700mm, and the intelligent temperature control type selects a capillary tube with a diameter of 1.8×0.6mm and a length of 1800mm.

(5) Dry filter

The filter drier in the refrigeration system of the refrigerator integrates the two functions of filtration and drying. Its function is to filter out the dirt in the refrigeration system and the small amount of water remaining in the adsorption system to ensure that the capillary tube is unblocked and the refrigeration system works normally. This device uses a single-tube filter drier.

The circulation process of the refrigerator refrigeration system is: the compressor absorbs heat and then compresses the low-pressure refrigerant vapor, turns it into high-pressure refrigerant vapor, and then discharges it into the condenser. The high-pressure vapor is condensed into a normal temperature and high-pressure refrigerant liquid in the condenser. After throttling by the capillary tube, the liquid with lower pressure enters the evaporator, absorbs heat and evaporates in the evaporator to become a vapor with lower pressure, and then enters the compressor to complete a cycle of the refrigeration system. Such a reciprocating cycle achieves the refrigeration purpose of the refrigerator.

There are many types of refrigerators. According to the principle of refrigeration, they can be divided into vapor compressor refrigerators, absorption-diffusion refrigerators and semiconductor refrigerators. The vapor compression refrigerator is the refrigerator with the most production, the most common use, and the most widely used. According to its cooling method, there are three types: direct cooling, indirect cooling, and mixed cooling and indirect cooling.

2. The composition of the air conditioner refrigeration system in the "training device"

The refrigeration system of air conditioner is mainly composed of compressor, evaporator, condenser, throttling device and filter drier. When working, the compressor absorbs low-pressure refrigerant vapor and then compresses it, turns it into high-pressure refrigerant vapor and then discharges it into the condenser. The high-pressure vapor is condensed into a normal temperature and high-pressure refrigerant liquid in the condenser, which is throttled by the throttling device It becomes a liquid with a lower pressure and enters the evaporator, absorbs heat and evaporates in the evaporator to become a vapor with a lower pressure, and then enters the suction port of the compressor to complete a cycle of the refrigeration system. During this cycle, there are usually some auxiliary equipment, which are set up to improve the economy, reliability and safety of operation, such as electromagnetic four-way valve, filter, one-way valve, sight glass, etc.

The functions of the main components of the air conditioner refrigeration system are as follows.

(1) Compressor

The role of the compressor is similar to the compressor of a refrigerator, and will not be repeated. However, the air conditioner compressor generally uses a rotary compressor, and this device uses a 585W, 3/4 HP rotary compressor.

(2) Evaporator

The function of the air conditioner evaporator is similar to that of the refrigerator evaporator, but its structure is different. It consists of a copper tube and a heat sink made of aluminum foil sheathed outside the copper tube. When the refrigerant liquid throttled by the capillary tube (or expansion valve) enters the evaporator, due to the increase in volume and decrease in pressure, it rapidly expands and evaporates into refrigerant gas. Its temperature drops sharply and needs to absorb a lot of heat. The centrifugal fan (window type air conditioner) or the cross flow fan (split type air conditioner) of the machine operates, and the indoor air is transferred to the refrigerant in the evaporator through the aluminum foil heat sink. Because the refrigerant flows at a high speed in the evaporator, the fan circulates the indoor air in and out, and the heat exchange between the inside and outside of the evaporator is continuously carried out to achieve the purpose of indoor cooling. According to the different characteristics of the cooling medium, the evaporator is divided into two categories: evaporator for cooling liquid and evaporator for cooling air. This device uses a cold wind fin evaporator.

(3) Condenser

The air conditioner condenser is a heat exchanger in which the refrigerant radiates heat to the outside of the refrigeration system and liquefies. The high-temperature and high-pressure refrigerant superheated vapor from the compressor enters the condenser and transfers the heat to the surrounding medium through the passage of the condenser and the aluminum foil heat sink. After the refrigerant condenses and releases heat, it lowers the temperature and condenses into a refrigerant liquid. Part of the heat released by the condenser is the heat absorbed by the evaporator, and the other part is the heat generated by the external force converted into heat energy when the compressor compresses the refrigerant gas. It should be noted here that for the heat pump air conditioner, the evaporator and the condenser are interchangeable. When cooling, the indoor is the evaporator, and the outdoor is the condenser; while the heating is the indoor condenser, the outdoor is the evaporator. According to the different cooling media, condensers can be divided into four types: water cooling, air cooling, water-air cooling and evaporation-condensing. This device uses an air-cooled finned condenser.

(4) Throttle device

There are three commonly used throttling devices: capillary tube, thermal expansion valve (internal balance, external balance) and electronic expansion valve. The advantage of the electronic expansion valve is that it can accurately control the refrigerant flow, thereby accurately controlling the evaporation temperature. It is often used in places where the temperature control accuracy is relatively high. The electronic expansion valve can work normally at -70℃, while the thermal expansion valve can only work at -60℃. This device chooses two capillary tubes with a diameter of 3×0.6mm and a length of 450mm and 410mm.

(5) Electromagnetic four-way valve

In the refrigeration system of the heat pump split air conditioner, the electromagnetic four-way valve has the function of switching the system cooling and heating modes. This function is realized by changing the flow direction of the refrigerant. This device uses the DSF-4 electromagnetic four-way valve.

Three, refrigeration system assembly tools

Common tools are shown in Table 3-2

Table 3-2 Common tools for refrigeration system assembly

Serial number	Name	Quantity	Remarks
1	Long handle Phillips screwdriver	1	
2	Allen wrench	2	
3	250mm adjustable wrench	2	
4	3m tape measure	1 piece	
5	Expander	1 set	
6	Eccentric Flare	1 set	
7	Bender	1 set	
8	Nitrogen cylinder (including nitrogen)	1 set	Bring your own
9	Pressure reducer	1 set	Bring your own
10	Pressure-resistant rubber air hose	1 set	Bring your own
11	1/4" connection type hand valve	1 set	Bring your own

4. Manufacture of "training device" refrigeration pipeline

1. "Training Device" Manufacture of Three Refrigeration Pipes of Refrigerator

The "training device" makes three refrigeration pipes for refrigerators, denoted by A, B, and C respectively.

(1) Manufacture of refrigerator pipe armor

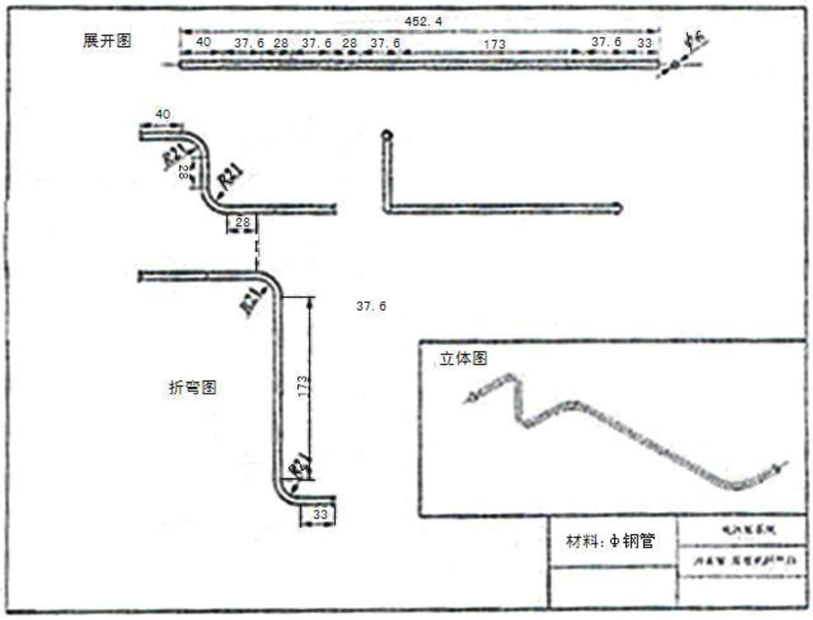


Figure 3-6 Dimension drawing of refrigerator pipe A

Place pipe benders, pipe cutters, expander flares, chamfers and other tools, tape measure and pencil on the work surface. Take a section of copper pipe with a specification of φ6, and the length can refer to the expanded view of the dimension drawing of the refrigerator pipe A in Figure 3-6.

Figure 3-7 Outline drawing of refrigerator pipe

Break the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, and then use a pipe bender to process the copper pipe into the shape shown in Figure 3-7, and install it on both ends of the processed copper pipe. Install the matching napkin, and then use the expander to expand the two ends of the copper pipe into a bell mouth, and set it aside for use when the pipeline is connected.

(2) Manufacture of refrigerator pipe B

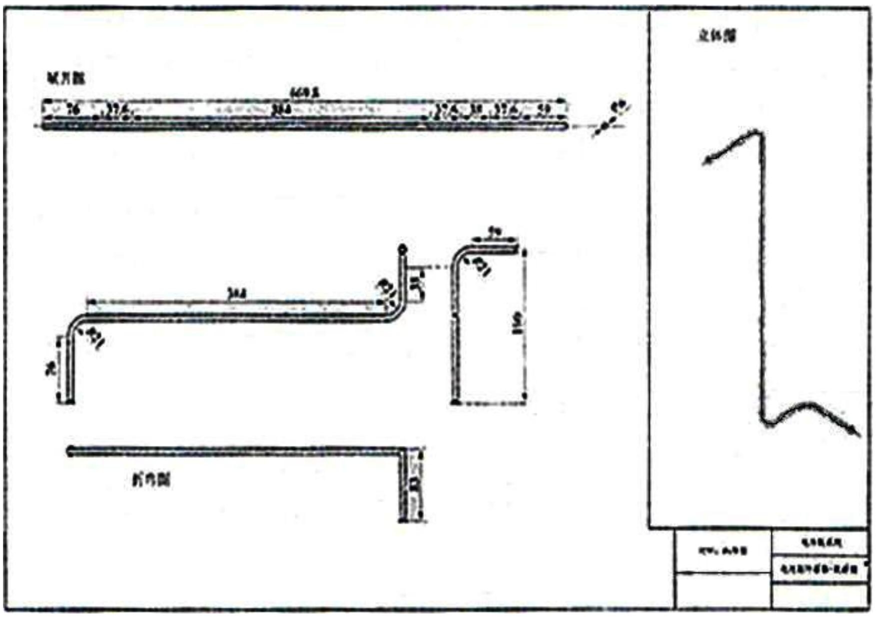


Figure 3-8 Dimension drawing of refrigerator pipe B

Take a section of copper pipe with a specification of φ6. For the length of the copper pipe, please refer to the expanded view in Figure 3-8.

Straighten the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, and then use a pipe bender to process the copper pipe into the shape shown in Figure 3-9, and install it on both ends of the processed copper pipe. Install the matching napkin, and then use an expander to expand the two ends of the copper pipe into a bell mouth, and place it aside for use when the pipeline is connected.

Figure 3-9 Outline drawing of refrigerator pipe B

(3) Manufacture of refrigerator pipe C

Take a section of φ6 copper pipe. For the length of the copper pipe, please refer to the expanded view in Figure 3-10 Dimensional Drawing of Refrigerator Pipe C.

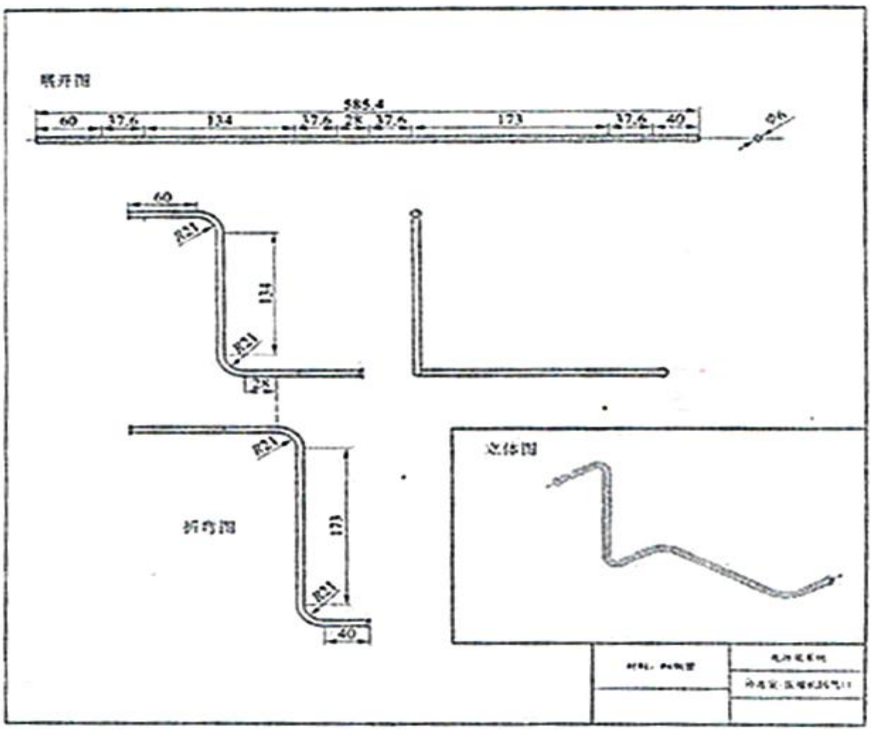


Figure 3-10 Dimension drawing of refrigerator pipe C

Straighten the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, then use a pipe bender to process the copper pipe into the shape shown in Figure 3-11, and install the processed copper pipe Then use the tube expander to expand the two ends of the copper pipe into bell mouths, and place them aside to prepare for pipe connection.

Figure 3-11 Outline drawing of refrigerator pipe C

2. "Training device" air conditioner refrigeration system pipe production

The "training device" air conditioner needs to make nine refrigeration pipes, which are represented by one, two, three, four, five, six, seven, eight, and nine.

(1) The shape of the air conditioner duct is shown in Figure 3-12. When making air conditioner pipes, cut two sections of copper pipes with specifications of 3/8in. For the length of the copper pipe, please refer to the expanded view in Figure 3-13 of the air conditioner piping dimension.

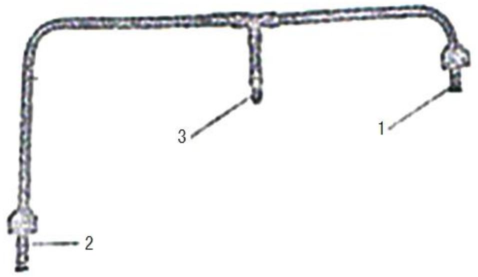


Figure 3-12 Outline drawing of air conditioner duct 1

Straighten the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, and then use a pipe bender to process the two sections of copper pipes into Figure 3-13. The shape shown in 2 is shown in the bending diagram. Install the designated ends of the two sections of copper pipes with nipples, and then use the master flares to expand the two ends of the copper pipes into bell mouths, and insert the other end of the two sections of copper pipes into the standard three-way valve. The middle end of the three-way valve is connected to a copper pipe with a length of 38mm and a diameter of 3/8in, and then the filling valve is welded, and then the four parts are welded with a welding torch and set aside for use when connecting the pipeline.

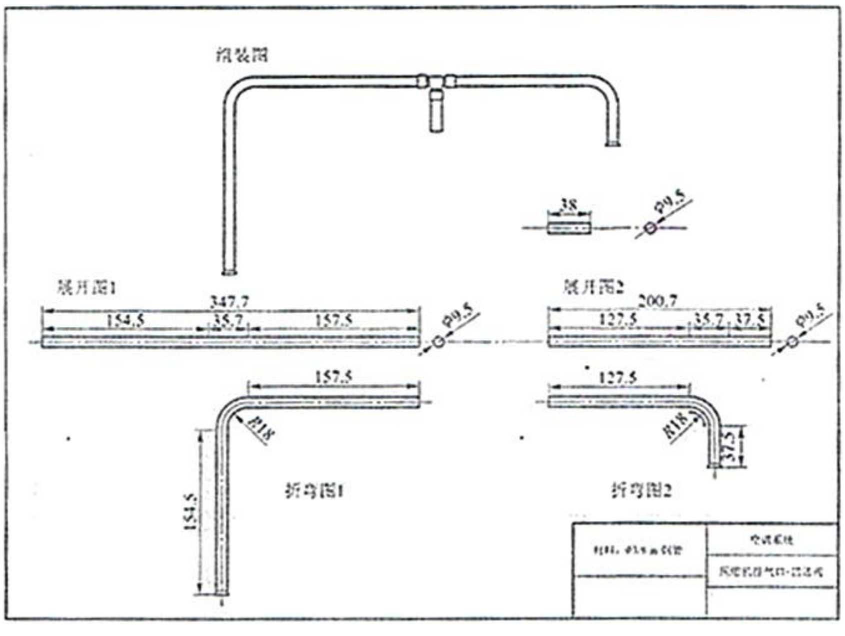


Figure 3-13 Dimension drawing of air conditioner duct 1

(2) Production of the second pipe of the air conditioner

The appearance of the second air conditioner duct is shown in Figure 3-14. When making the second air conditioner pipe, cut a piece of copper pipe with a specification of 3/8in. For the length of the copper pipe, please refer to the expanded view in Figure 3-15.

Figure 3-14 Outline drawing of air conditioner pipe 2

Straighten the copper pipe by hand, use a chamfer to remove the constrictions and burrs at both ends of the copper pipe, and then use a pipe bender to process the copper pipe into the shape shown in Figure 3-14, and install the processed copper pipe at both ends Install the matching nipples, and then use the expander to expand the two ends of the copper pipe into bell mouths, and place them aside for use when managing the connection.

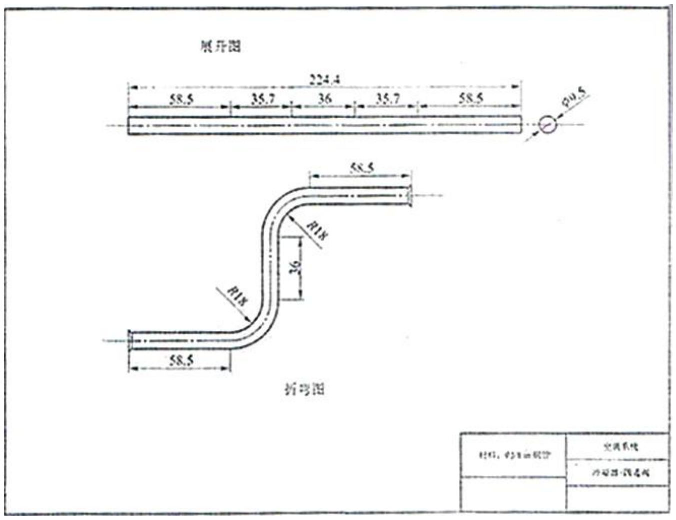


Figure 3-15 Dimension drawing of air conditioner pipe 2

(3) Production of air conditioner pipe three

The appearance of the air conditioner pipe 3 is shown in Figure 3-16. When making the air conditioner pipe 3, a section of copper pipe with a specification of φ6 is cut. For the length of the copper pipe, please refer to the expanded view in Figure 3-17.

Figure 3-16 Outline drawing of air conditioner pipe 3

Straighten the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, and then use a pipe bender to process the copper pipe into the shape shown in Figure 3-16, and install it on both ends of the processed copper pipe. Install the matching nipples, and then use the expander to expand the two ends of the copper pipe into bell mouths, and place them aside for use when the pipeline is connected.

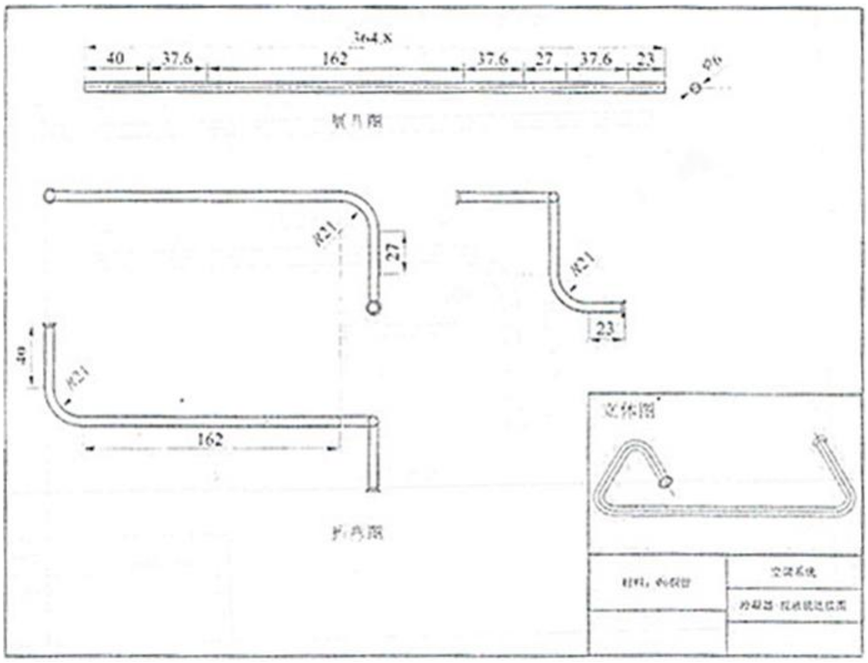


Figure 3-17 Dimensional drawing of air conditioner pipe three

(4) Manufacture of air conditioner duct four

The appearance of the air conditioner duct 4 is shown in Figure 3-18. When the air conditioner duct 4 is made, a section of copper pipe with a specification of φ6 is cut. For the length of the copper pipe, please refer to the expanded view in Figure 3-19.

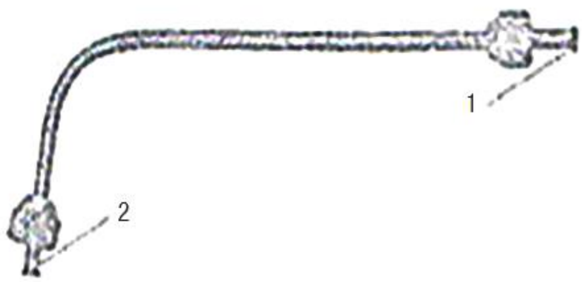


Figure 3-18 Outline drawing of air conditioner duct four

Straighten the copper pipe by hand, use a chamfer to remove the constriction and burrs at both ends of the copper pipe, and then use a pipe bender to process the copper pipe into the shape shown in Figure 3-18, and install it on both ends of the processed copper pipe. Install the matching nipples, and then use an expander to expand the two ends of the copper pipe into bell mouths, and set them aside for pipeline connection.

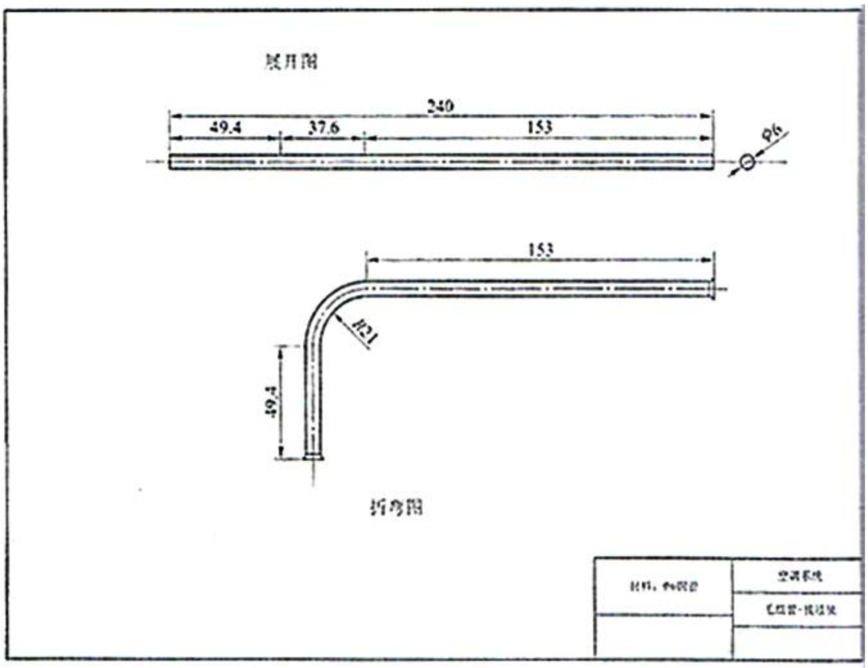


Figure 3-19 Dimensional drawing of air conditioner duct four

(5) Manufacture of air conditioner pipe five

The appearance of the air conditioner duct 5 is shown in Figure 3-20. When the air conditioner duct 5 is made, a section of φ6 copper duct is cut. For the length of the copper pipe, please refer to the expanded view in Figure 3-21.

Figure 3-20 Outline drawing of air conditioner pipe 5

Straighten the copper pipe by hand, use a chamfer to remove the constrictions and burrs at both ends of the copper pipe, install a matching nipple on one end of the copper pipe, and use the expander to expand one end of the copper pipe into a bell mouth. Connect the other end to the air-conditioning valve. Here, the same pipe diameter is used to connect the two parts. Use a welding torch to weld the two parts and place them aside for use when the pipeline is connected.

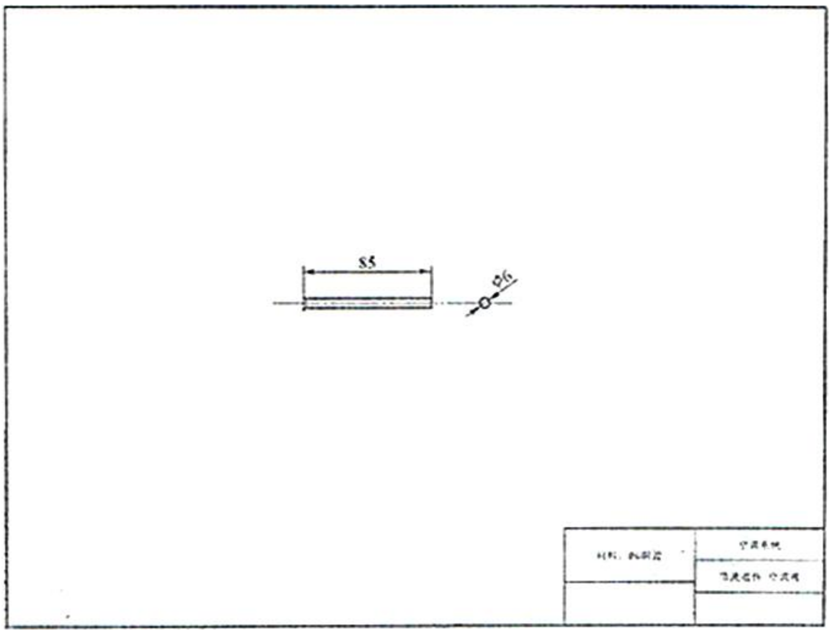


Figure 3-21 Dimensional drawing of air conditioner pipe five

(6) Production of duct six of air conditioner

The shape of the air-conditioner duct 6 is shown in Figure 3-22. When the air-conditioner duct 6 is made, a section of copper pipe with a specification of φ6 is cut. The length of the copper pipe can be referred to the expanded view in Figure 3-23.

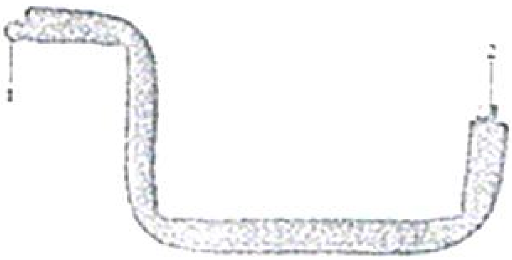


Figure 3-22 Outline drawing of air conditioning duct VI

Break the copper pipe by hand, use the chamfering device to remove the burrs and burrs at both ends of the copper pipe, and then use the pipe bender to process the copper pipe into the shape shown in Figure 3-22, and put the matching heat preservation sleeve on the copper pipe On the outside, install matching nipples on both ends of the copper pipe, and use the expander to expand the ends of the copper pipe into bell mouths, and place them aside for use when the pipeline is connected.

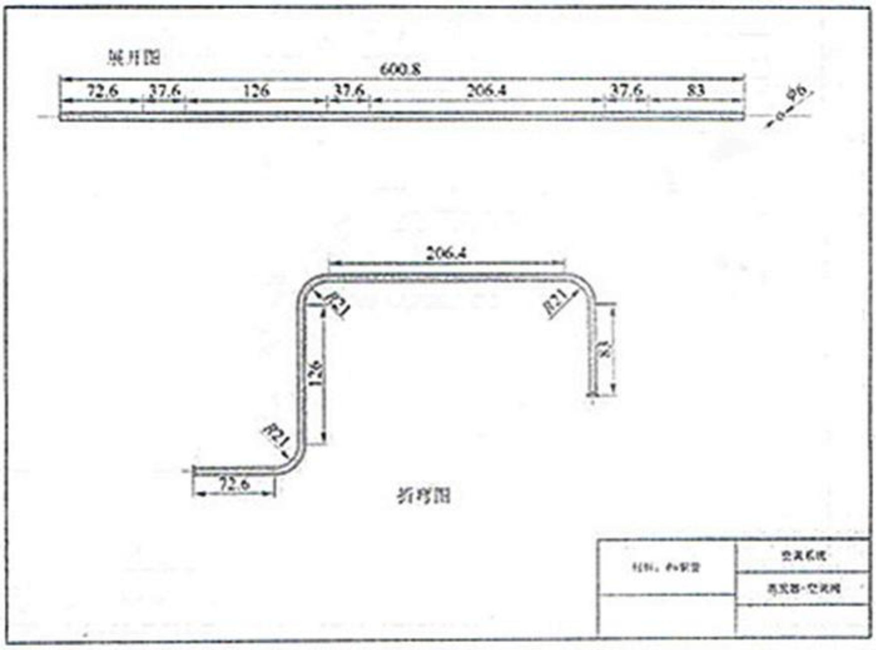


Figure 3-23 Dimensional drawing of air conditioning duct 6

(7) Manufacture of air conditioner pipe seven

Figure 3-24 shows the appearance of air conditioner duct seven. When making the air conditioner pipe seven, cut a piece of copper pipe with a specification of 3/8in. The length of the copper pipe can refer to the expanded view in Figure 3-25.

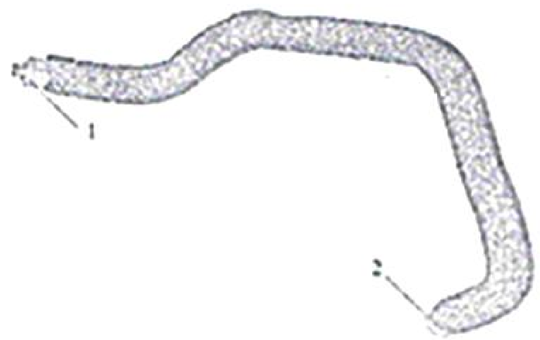


Figure 3-24 Outline drawing of air conditioner pipe 7

Straighten the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, then use a pipe bender to process the copper pipe into the shape shown in Figure 3-24, and fit the matching insulation pipe to the copper pipe Then install the matching nipples on both ends of the copper pipe, and use the expander to expand the two ends of the copper pipe into bell mouths, and place them aside for use when the pipeline is connected.

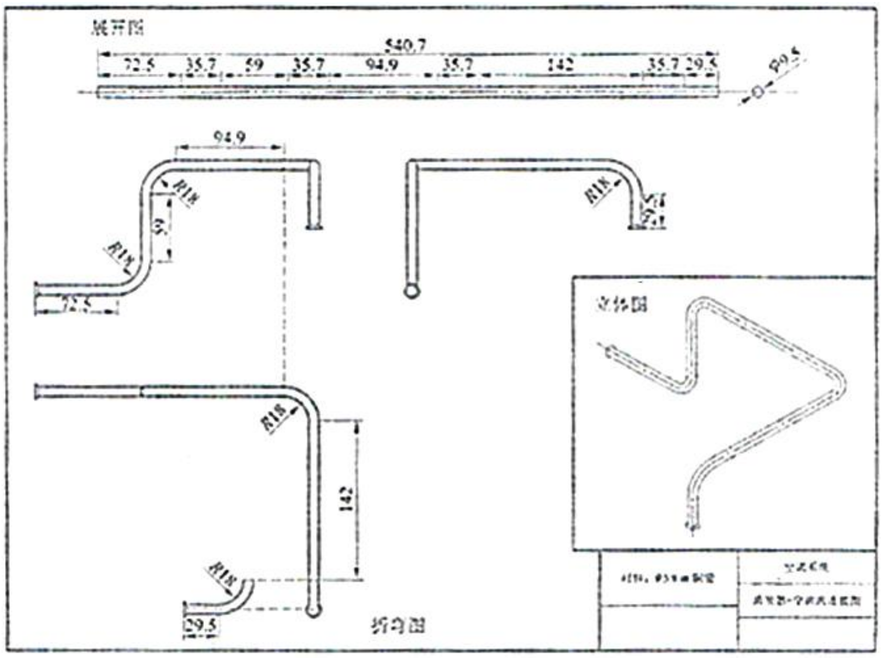


Figure 3-25 Dimensional drawing of air conditioner pipe 7

(8) Manufacture of air conditioner duct eight

The appearance of the air conditioner duct 8 is shown in Figure 3-26. When making the air conditioner duct, cut a section of copper pipe with a specification of 3/8in. For the length of the copper pipe, please refer to the expanded view in 3-27 air conditioner duct 8 dimension drawing.

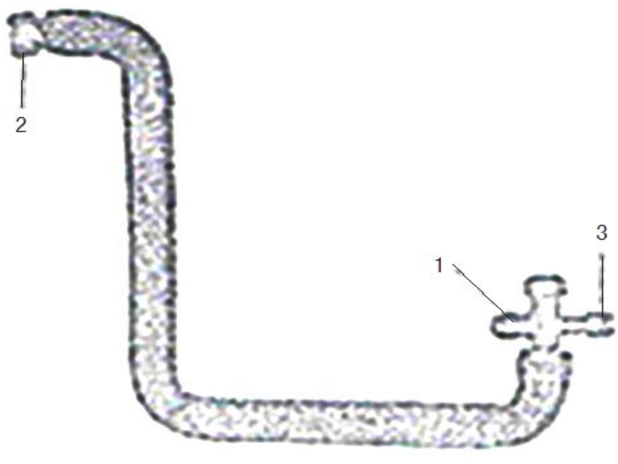


Figure 3-26 Outline drawing of air conditioner pipe 8

Straighten the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, and then use a pipe bender to process the copper pipe into the shape shown in the bending diagram in the size of Figure 3-27, according to Figure 3- As shown in 26, connect the processed copper pipe to the air-conditioning valve and weld it with a welding torch. On the premise of confirming that there is no leakage, put the matching insulation tube on the outside of the copper tube, and then install the matching nipple on the corresponding end of the copper tube, and then use an expander to expand the two ends of the copper tube into a horn Set aside to prepare for pipe connection.

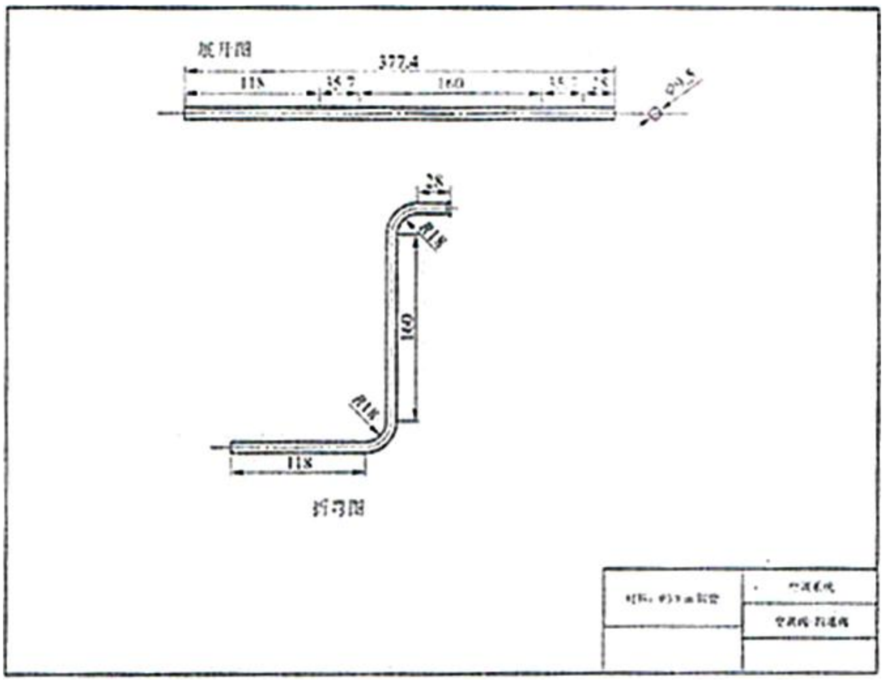


Figure 3-27 Dimensional drawing of air conditioner pipe 8

(9) Manufacture of air conditioner pipe nine

The appearance of the air conditioner duct 9 is shown in Figure 3-28. When making the air conditioner duct, cut two sections of 3/8in copper pipe. For the length of the copper pipe, please refer to the expanded view in Figure 3-29.

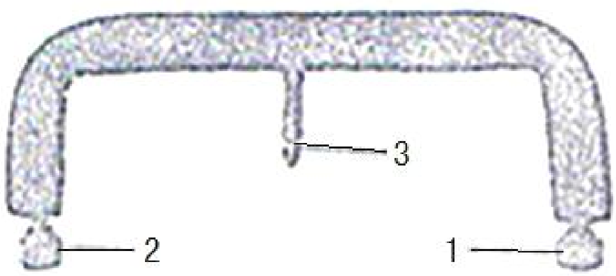


Figure 3-28 Outline drawing of air conditioner pipe 9

Straighten the copper pipe by hand, use a chamfer to remove the burrs and burrs at both ends of the copper pipe, and then use a pipe bender to process the two sections of copper pipes into Figure 3-29. And bending the shape shown in Figure 2, according to the bending diagram, insert the designated ends of the two sections of copper pipe into the standard three-way valve, and connect a 38mm long and diameter 3/ After the 8in copper pipe, weld the filling valve, and then use the welding torch to weld the four parts. After ensuring that there is no leakage, cover the copper pipe with an insulation pipe cover, and cover the other end of the two sections of copper pipe with a standard tube, and then use a flaring device to expand the two ends of the copper pipe into a bell mouth, and place it aside. It is used when the pipeline is connected.

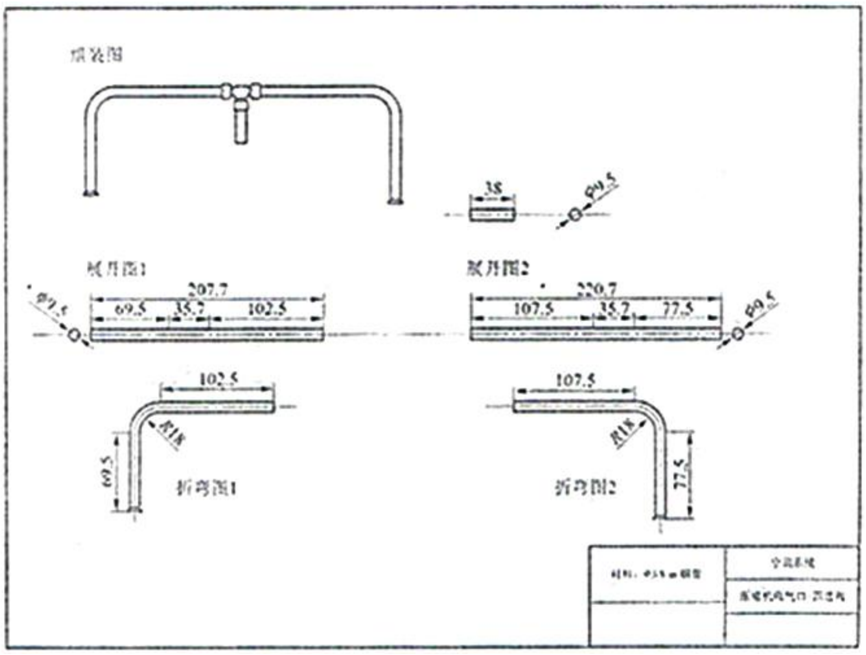


Figure 3-29 Dimensional drawing of air conditioner pipe 9

5. "Training Device" Refrigeration System Pipeline Connection

1. System blowing pollution treatment

The pipes and components must be blown before assembly.

(1) Connection method of nitrogen origin transmission system

Nitrogen cylinder, pressure reducer, and pressure-resistant rubber gas hose 1/4in connection type hand valve constitute a nitrogen gas source transmission system. Nitrogen cylinder, pressure reducer. The pressure-resistant rubber air hose and the 1/4in connection type hand valve can be connected in the order shown in Figure 3-30. Pay attention to the following points when connecting:

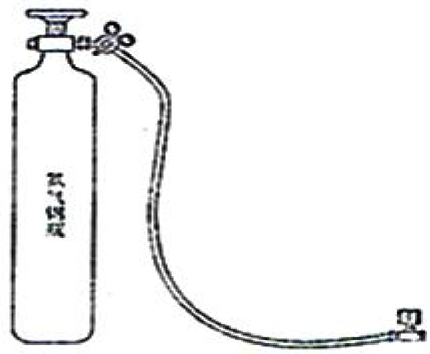


Figure 3-30 Connection sequence diagram

①Connect the output pipe structure on the pressure reducer with the pressure-resistant rubber output pipe. During the connection process, in order to reduce the resistance, the amount of refrigerating oil is appropriately added. This will make it easy to connect the pipes and then use the hug The hoop is pressed tightly.

②Remove the copper napkins at both ends of the connecting hand valve, and connect the other end of the pressure-resistant rubber air hose to the connecting hand valve. During the connection process, to reduce resistance, you can also add a small amount of refrigerating oil, and then use Hold the hoop tightly. The other end of the connected hand valve is to be connected. When connecting, pay attention to the direction of the hand valve to be consistent with the direction of nitrogen transmission, that is, the arrow points to the connected end of the hand valve.

③Use an adjustable wrench to connect the air inlet port of the pressure reducer to the port of the nitrogen cylinder and tighten, so that the connection of the entire system is completed.

(2) Filling with nitrogen to check the air tightness of the refrigeration system

Follow the steps below:

①Connect the connecting end of the connecting hand valve with a special metric and inch liquid filling pipe, and adjust the valve knob of the connecting hand valve clockwise. Close the connected hand valve, adjust the pressure regulating screw of the pressure reducer counterclockwise, and close the pressure reducer.

②Adjust the handle on the nitrogen cylinder counterclockwise (screw it to the fully open position) and open the nitrogen cylinder. At this time, the pressure gauge will cause the pressure of the nitrogen gas in the nitrogen cylinder, and then adjust the pressure adjustment screw on the pressure reducer clockwise. Adjust to the required pressure and open the connected hand valve, then the system can be pressurized or blown.

③After the operation is completed, adjust the handle on the nitrogen cylinder clockwise to turn off the nitrogen, remove the meter-made household tube, release the nitrogen in the pressure-resistant rubber gas hose, and then adjust the pressure regulator screw counterclockwise to close Pressure reducer.

2. "Training device" refrigerator refrigeration pipeline assembly

The overall layout of the "training device" refrigerator refrigeration pipeline after assembly is shown in Figure 3-31. In this system, the pipe sleeves are connected in the form of live joints, which is more convenient to connect.

The "training device" refrigerator refrigerating and freezing compartment has three interfaces, as shown in Figure 3-32.

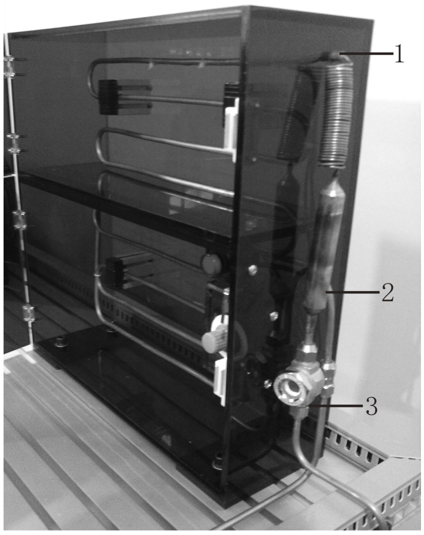


Figure 3-31 The overall layout of the refrigerator refrigeration system Figure 3-32 Three interfaces of the refrigeration pipeline of the refrigerating and freezing compartment

(1) Connection method of three unions

①Take two copper pipes with nipples and flexible joints that are matched with two threaded joints, and make their bell mouth and live joints vertical and close contact, as shown in Figure 3-33.

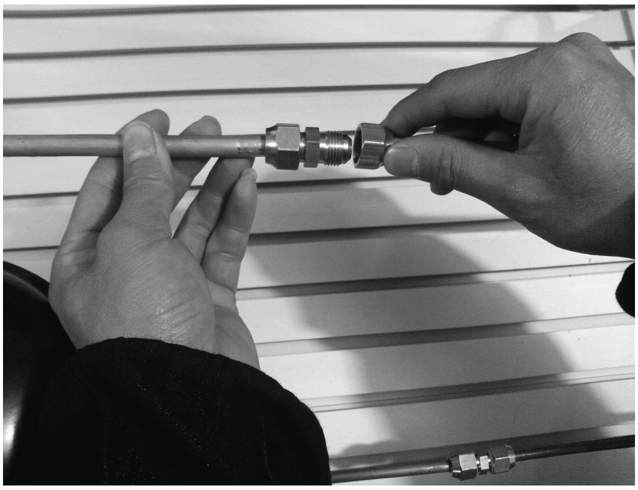


Figure 3-33 Schematic diagram of the pipeline before connection

② Use the index finger and thumb to pinch the napkin and the union, and at the same time rotate the napkin clockwise until the hands cannot be screwed, as shown in Figure 3-34.

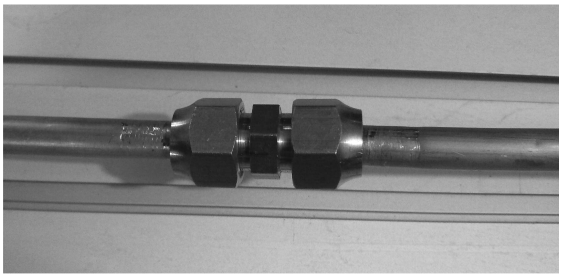


Figure 3-34 Schematic diagram after pipeline connection

③Tighten it with an adjustable wrench, as shown in Figure 3-35.

Figure 3-35 Tightening diagram after pipe connection

(2) Connection of refrigeration pipeline of "training device" electronic temperature control refrigerator

As can be seen from the overall layout of the refrigerator refrigeration system in Figure 3-31, the system is mainly composed of a compressor, a condenser, a throttling device (capillary tube), a sight glass, a filter drier, a refrigerating room, and a refrigeration pipeline. The throttling device is shown in Figure 3-36.

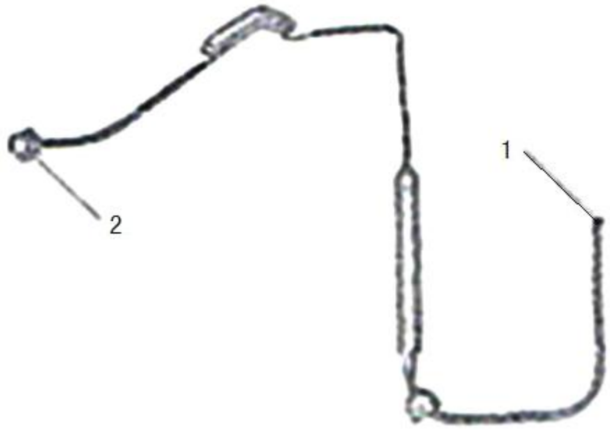


Figure 3-36 Throttle device of electronic temperature control refrigerator

The connection steps of the refrigeration pipeline of the electronic temperature control refrigerator:

①Install all the components of the refrigeration system of the electronic temperature control refrigerator according to the dimensions (unit: mm) marked on the system component positioning diagram shown in Figure 3-37, and install them to the designated position. Note that the direction label on the hand valve should be as shown in Figure 3. -31 The layout is consistent.

②Use an adjustable wrench to connect the union of the compressor exhaust port and the holder of the condenser inlet, and tighten them.

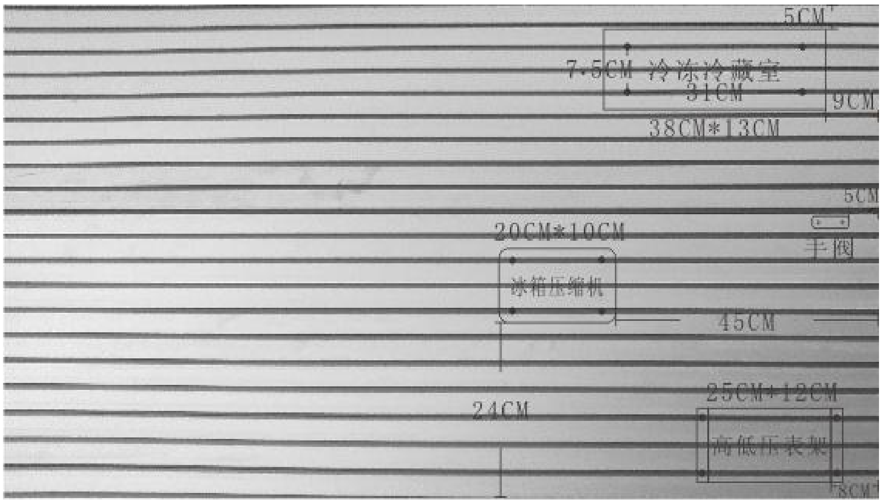


Figure 3-37 Refrigerator refrigeration system components location diagram

③Take 1 piece of refrigerator refrigeration pipe B, connect its 2 ends to the outlet of the condenser with a union, and 1 end to the sight glass, and tighten it.

④Take a throttling device for an electronic temperature control refrigerator, connect one end to the sight glass, and the second end to the pipe joint 3 of the refrigerator freezer compartment, and tighten it.

⑤Take one piece of refrigerator pipe A, connect its 1 end to the refrigerator refrigerating freezer joint 1 and the 2 end to the compressor suction port pipe joint, and tighten it.

⑥Connect the pipe joint 2 of the refrigerator freezer compartment of the refrigerator to the hand valve on the right side of the layout diagram in Figure 3-31, and close the hand valve at the same time and tighten it.

⑦Connect the pressure gauge equipped with the "training device" to the system with the matching liquid filling pipe as shown in Figure 3-38, and tighten it. One end of the red filling pipe with thimble is connected to the filling valve end of the compressor discharge port of the refrigerator, and the other end is connected to the high pressure pressure gauge; the end of the blue filling pipe with thimble is connected to the suction port of the refrigerator compressor with filling liquid The valve end is connected, and the other end is connected to a low pressure pressure gauge.

⑧The connection of the refrigeration system of the electronic temperature control refrigerator is completed.

(3) "Training device" intelligent temperature control refrigerator refrigeration system layout, as shown in Figure 3-39. The composition of the system is basically similar to that of an electronic temperature control refrigerator, and it is also composed of a compressor, a condenser, a throttling device (capillary tube), a sight glass, a filter drier, a refrigerator-freezer, and a refrigeration pipeline. But its throttling device is different from the electronic temperature control refrigerator, as shown in Figure 3-40.

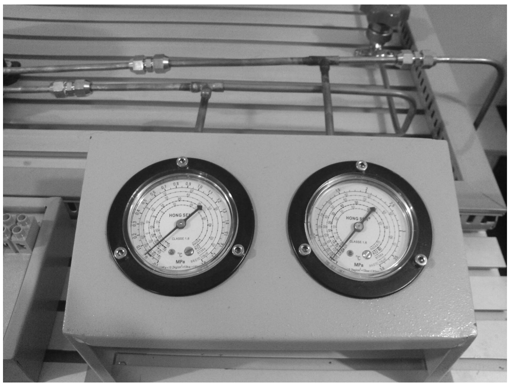


Figure 3-38 Schematic diagram of pipe connection for refrigerator pressure gauge

Figure 3-39 Layout of the intelligent temperature control refrigerator refrigeration system

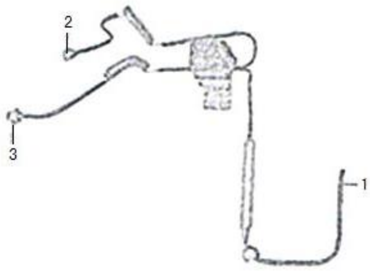


Figure 3-40 Throttle device of intelligent temperature control refrigerator

The connection steps of the refrigeration pipeline of the intelligent temperature control refrigerator:

①All components of the intelligent temperature control refrigerator refrigeration system shall be installed in the designated position according to the dimensions marked on the locating diagram of the refrigerator refrigeration system components in Figure 3-37.

②Use an adjustable wrench to connect the union of the compressor's exhaust port with the nipple at the inlet of the condenser, and tighten it.

③Take 1 piece of refrigerator pipe B, connect its 2 ends to the outlet of the condenser, and 1 end to the sight glass, and tighten it.

④Take 1 piece of intelligent temperature control refrigerator rapid flow device, connect one end to the sight glass, the second end to the pipe joint 2 of the refrigerating and freezing compartment, and the third end to the refrigerating and freezing compartment outlet joint 1, and tighten them.

⑤Connect the refrigerator pipe C1, connect its 1 end to the pipe joint 3 of the refrigerating and freezer compartment, and connect its 2 end to the union at the suction port of the compressor, and tighten it.

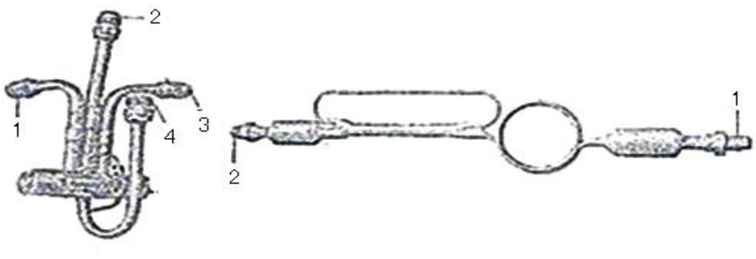
⑥ Connect the pressure gauge equipped with the "training device" to the system with the matching liquid filling pipe as shown in Figure 3-38, and tighten it. It is connected to the refrigeration system of the refrigerator with electronic temperature control.

⑦The pipe connection of the intelligent temperature control refrigerator refrigeration system is completed.

"Training device" air conditioner refrigeration pipeline connection steps:

①The layout of the regulator refrigeration system is shown in Figure 3-41. The air conditioner refrigeration system consists of a compressor, an evaporator, a condenser, an electromagnetic four-way valve, a throttling device, a sight glass, an air conditioning valve, and a refrigeration pipeline. The electromagnetic four-way valve and throttling device are shown in Figure 3-42.

Figure 3-41 Layout of air conditioner refrigeration system



(A) Electromagnetic four-way valve (B) Throttle device of air conditioner

Figure 3-42 Electromagnetic four-way valve and throttling device

② Install each part of the air conditioner refrigeration system to the designated position according to the dimensions (unit: mm) marked on the location diagram of the air conditioner refrigeration system components in Figure 3-43.

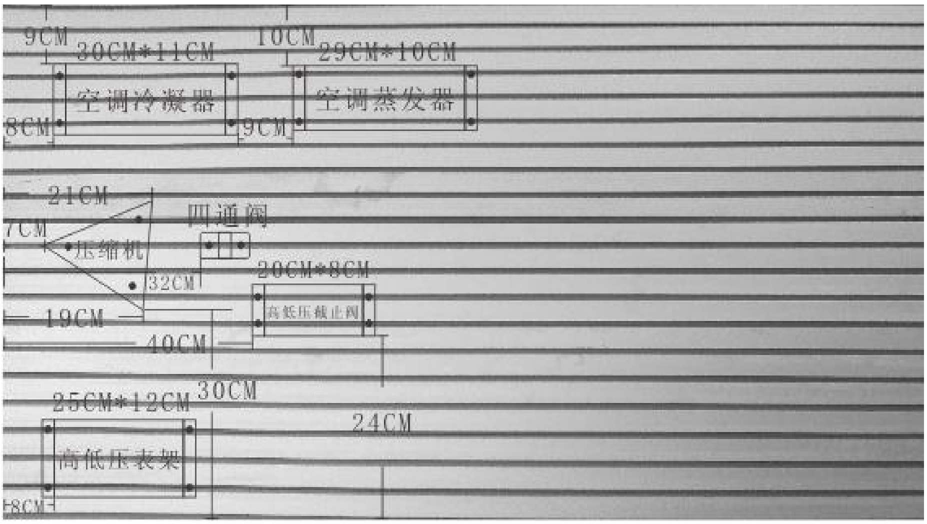


Figure 3-43 Location diagram of air conditioner refrigeration system components

③Take a piece of air conditioner pipe, connect its 1 end to the air conditioner compressor exhaust port, and connect its 2 end to the 4 end of the electromagnetic four-way valve pipe joint, and tighten it.

④Take the second pipe of the air conditioner, connect its 2 end to the 1 end of the electromagnetic four-way valve pipe joint, and connect its 1 end to the inlet end of the condenser and tighten it.

⑤Take the third pipe of the air conditioner, connect its 2 end to the outlet end of the condenser, and connect its 1 end to the sight glass, and tighten it.

⑥Take 4 of the air conditioner pipe, connect its 2 end to the other end of the sight glass, and connect its 1 end to the 2 end of the air conditioner throttling device, and tighten it.

⑦Take 5 of the air conditioner pipe, connect its 2 end to the 1 end of the air conditioner throttling device, and fix it tightly.

⑧Take 6 of the air conditioner pipe, connect its 2 end to the 1 end of the air conditioner pipe 5, and connect its 1 to the inlet end of the evaporator and tighten it.

⑨Take air conditioner pipe number seven, connect its 1 end to the outlet end of the evaporator, and connect its 2 end to the air conditioner pipe 8 end, and tighten it.

⑩Connect the 2 end of the air conditioner pipe 8 to the 3 end of the electromagnetic four-way valve connector, as shown in Figure 3-44, and tighten it firmly.

⑪Take the 9th pipe of the air conditioner, connect its 2 end to the 2 end of the electromagnetic four-way valve connector, and connect its 1 end to the suction port of the compressor, and tighten it.

⑫ Connect the pressure gauge equipped with the "training device" to the system as shown in Figure 3-45. One end of the red filling pipe with thimble is connected to the air conditioner pipe, and the other end is connected to the high pressure pressure gauge. ; One end of the blue liquid filling pipe with thimble is connected with the air conditioner pipe 9-3 end, and the other end is connected with the low pressure pressure gauge.

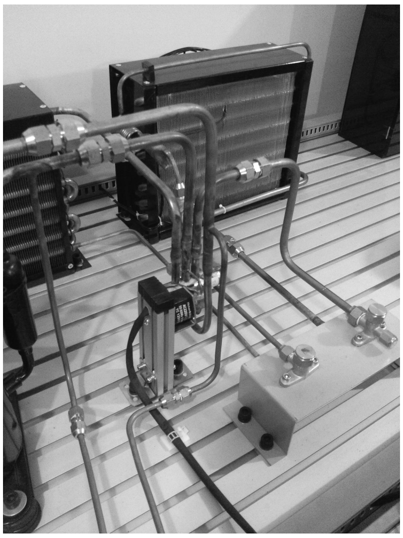


Figure 3-44(left) Schematic diagram of the eighth operation of the air conditioner pipe Figure 3-45(right) Schematic diagram of pipe connection of air conditioner pressure gauge

⑬ The "training device" air conditioner refrigeration pipeline connection is completed.

(5) "Training device" Layout of countertop components after the refrigeration pipelines of refrigerators and air conditioners are assembled

The table layout is shown in Figure 3-46.

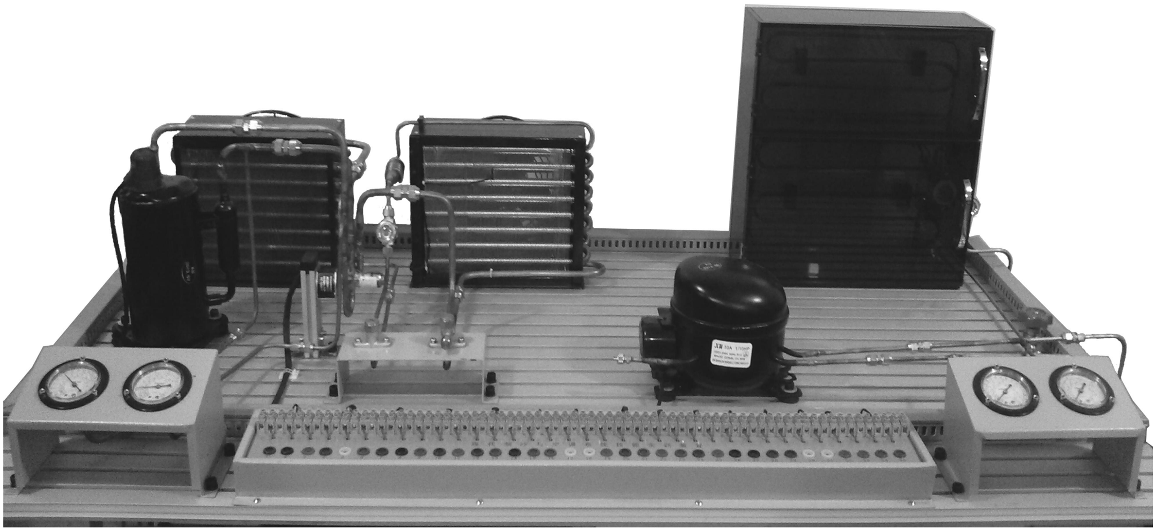


Figure 3-46 Table layout

Task 2 Air tightness inspection of refrigeration system

1. Task description

The air tightness test of the refrigeration system is commonly known as "pressure-holding leak detection". This task focuses on the main leaks in the refrigeration system: refrigeration compressors, all detachable connections, bolt ends, sight glasses, welding parts of the evaporator, pipes and filter driers, shut-off valves and stems Connections and leak detection methods: appearance leak detection, soap liquid leak detection, halogen lamp leak detection, electronic leak detector leak detection, pressure water penetration leak detection, vacuum leak detection, etc. Through training in this task, you should be able to achieve:

①Familiar with the method of air tightness inspection of refrigeration system.

②Master the use of tools and equipment required for air tightness inspection.

③Familiar with the operation technology of air tightness inspection.

2. Related knowledge

1. Method of air tightness inspection

(1) Visual leak detection

Visual leak detection is also called "visual leak detection". Because Freon refrigerants and refrigerating machine oil have a certain degree of mutual solubility, when the refrigerant leaks, the refrigerating machine oil seeps out. The refrigeration equipment that has been used for a period of time has oil leakage, dripping, oil stains, and oil in some parts of the device. In the event of loss, it can be judged that there is a Freon refrigerant leak. Visual leak detection is only used for preliminary judgment during the assembly and maintenance of refrigeration equipment, and is limited to the inspection of exposed connections.

(2) Soap liquid leak detection

Soap liquid leak detection is also called "pressure leak detection". The soapy liquid leak detection is simple and easy, and can determine the leak point. It can be used for leak detection of refrigerant-filled refrigeration devices, and can also be used as an auxiliary means of other leak detection methods. Soap liquid leak detection is a relatively simple method commonly used by refrigeration equipment assembly and maintenance personnel. The specific operation is: first use a knife to cut the soap into thin slices, soak it in hot water, and constantly stir to melt it into a silky light yellow solution for later use. Fill the system with nitrogen at a specified pressure, wipe off the oil loss on the inspected part, dip a brush or sponge in soapy liquid, apply it around the inspected part, wait for a while, and observe carefully. If bubbles are found in the detected part, it means that the part is the leak point, mark it, and continue to check other parts. Currently, detergent is often used instead of soap. Because the detergent has the advantages of convenient carrying, quick preparation, moderate viscosity, rich foam and so on.

(3) Leak detection of halogen lamps

Halogen lamp leak detection is the most commonly used leak detection instrument for refrigeration equipment. It is mainly used for leak detection of refrigeration equipment that has been filled. It can detect leaks with an annual leakage of more than 50g. The most commonly used is a halogen lamp filled with liquefied propane gas. The principle is: Freon gas is decomposed into fluorine and chlorine element gas when it comes into contact with the blowtorch. When chlorine gas contacts the hot copper in the lamp, the color of the flame will correspondingly change from light green to dark green, then to purple, from the flame color. The change can reflect whether the leakage is slight or serious. After detecting the leakage point with the halogen lamp, the halogen lamp should be moved to the freon-free gas outlet. After the flame color returns to normal light green, the leakage point shall be repeatedly verified to determine the exact location of the leakage point. Halogen lamp leak detection is not suitable for refrigeration systems with refrigerant R12, because R12 refrigerant will explode when exposed to an open flame.

(4) Leak detection with electronic leak detector

The electronic leak detector is aspirated, so move the probe of the electronic leak detector to all possible leaking parts for a few seconds or so and stop. When the leak detector sounds an alarm, it means there is a leak. Leak detection with electronic leak detectors must ensure good indoor ventilation (halogen-free gas) to avoid false judgments. In the process of using the electronic leak detector, be sure to handle it gently. When not in use, remove the battery to avoid damage to the electronic leak detector due to long-term use and battery melting. For refrigeration systems with replacement parts, the refrigeration system should be filled with a refrigerant of about 0.05MPa, and then nitrogen with a specified pressure for leak detection.

(5) Leak detection by pressurization and water immersion

Pressurized water immersion leak detection is mainly used for parts. According to the pressure resistance value of the parts, fill the spare parts with nitrogen gas lower than the pressure resistance value, and put it in the warm water of 40~50℃ and immerse it on the water surface. At a depth of less than 20cm, carefully observe whether there are bubbles on the water surface. The time should be no less than 30min. The light in the leak detection site should be sufficient.

(6) Vacuum leak detection

For a refrigeration system that really judges whether it is leaking, the refrigeration system can be evacuated to a certain degree of vacuum and left for about 1 hour to see if the pressure has risen significantly. If the rise is obvious, the refrigeration system has a leak. If there is no recovery, leave it for a longer period of time (24h) to see if the pressure has recovered significantly.

(7) Segmented leak detection

In the case where it is difficult to find the leak location, the segmented leak detection method can be used for leak detection. Segmented leak detection can be divided into high pressure section leak detection and low pressure section leak detection:

① Leak detection in high pressure section. The compressor exhaust port to the capillary inlet are all part of the high pressure section, so that this part forms a closed small system, and is equipped with a filling valve, and then filled with 1.2MPa nitrogen, and observe the pressure value of the pressure gauge on the double gauge repair valve Change, and take other leak detection measures (usually use soapy liquid for leak detection).

② Leak detection in the low pressure section. The compressor exhaust port to the capillary inlet are all part of the low pressure section, so that this part forms a closed small system, and is equipped with a filling valve, and then filled with 0.8MPa nitrogen, and observe the pressure value of the pressure gauge on the double gauge repair valve At the same time, take other leak detection measures.

2. Method of cleaning and sewage treatment of refrigeration system

After the refrigeration system is seriously polluted, if the compressor burns out, a new filter drier must be replaced before a new compressor is replaced, because the dirt in the filter drier is the most and it is difficult to eliminate. At the same time, the condenser, evaporator and capillary tube should be thoroughly cleaned. That cleaning agent R113. When cleaning, it can be divided into two types:

①For the refrigeration system where the capillary tube and the evaporator can be disassembled, use a welding torch to fuse the interface to remove the capillary tube, then fuse the interface between the filter drier, the capillary tube and the condenser, and use a copper tube to connect the outlet of the condenser with Connect the inlet of the evaporator, and then connect the inlet of the condenser and the outlet of the evaporator to the cleaning equipment to clean the condenser and evaporator. The capillary can also be cleaned in the same way. After cleaning, the cleaning agent can be tested by the method of testing the acidity of the refrigerating oil to determine whether the cleanliness of the refrigeration system is qualified, and the non-acidity reaction is qualified. Finally, blow off the cleaning agent with nitrogen. When cleaning, the cleaning agent maintains a pressure of 0.2~0.4MPa, and the nitrogen pressure of the cleaning agent is 0.8~1MPa.

②For refrigeration systems where the interface between the capillary tube and the evaporator is difficult to disassemble, the filter dryer can be removed and the condenser, capillary tube and evaporator group can be cleaned separately. When cleaning the condenser, connect the cleaning equipment to the two ends of the condenser. When cleaning the capillary tube and evaporation group, connect the cleaning equipment to the inlet of the capillary and the outlet of the evaporator. This method does not need to remove the evaporator and is relatively simple. However, due to the large flow resistance of the capillary tube and the small flow rate of the cleaning agent, it is not easy to clean the contaminants. Therefore, a gas-liquid alternating cleaning method is required.

3. Introduction of equipment and tools required for air tightness inspection

Table 3-5 Equipment and tools required for air tightness inspection of refrigeration system

Serial number	Name	Quantity	Remarks
1	Long handle Phillips screwdriver	1	
2	Allen wrench	2	
3	250mm adjustable wrench	2	
4	Double gauge repair valve	1	
5	Meter/English dosing tube (one each for red, yellow and blue)	1 set	
6	Double meter repair valve meter/inch adapter	3	

7	Single-stage oil circulation rotary vane vacuum pump	1 set	
8	Nitrogen cylinder (including nitrogen)	1 set	Bring your own
9	Pressure reducer	1 set	Bring your own
10	Pressure-resistant rubber air hose	1 set	Bring your own
11	1/4"Connected hand closing valve	1 set	Bring your own
12	Soapy water	1	Bring your own

Fourth, the operation skills of air tightness inspection

1. Air tightness inspection of refrigerator refrigeration system

Operation skills of air tightness inspection of refrigerator refrigeration system:

Before the air tightness inspection of the refrigerator refrigeration system, the refrigeration system must be blown out.

Whether it is a refrigeration system using an electronic temperature control refrigerator or a refrigeration system using a smart temperature control refrigerator, the air tightness inspection operation skills are the same. Here, the air tightness inspection of the refrigeration system of the electronic temperature control refrigerator As an example, introduce its operating skills and specific steps:

①Connect the red filling pipe (with thimble end) on the double meter repair valve to the filling valve of the process filling port of the refrigerator compressor and tighten it, and the yellow filling pipe to the pressure-resistant rubber hose Connect one end of the type hand valve and tighten it, as shown in Figure 3-51. It should be ensured that there is no leakage at the connection.

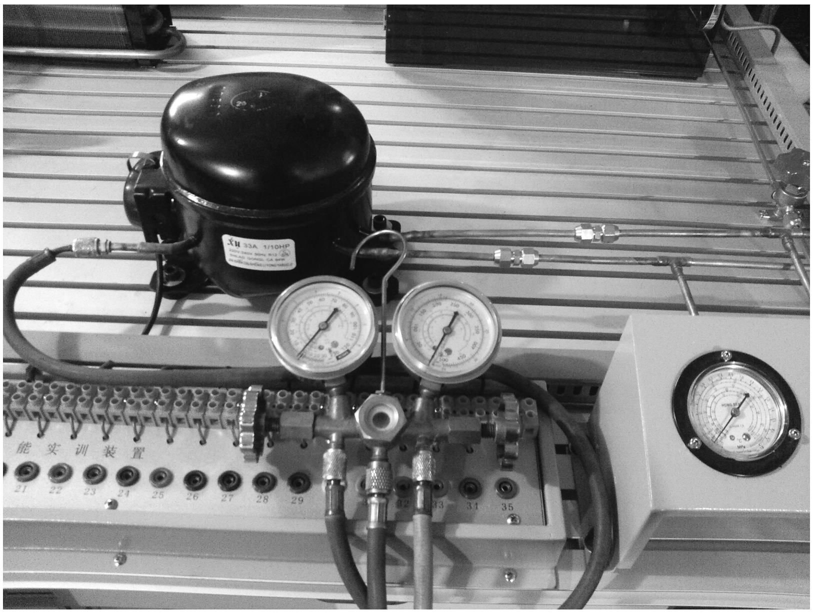


Figure 3-51 Schematic diagram of leak detection pipeline connection of refrigerator refrigeration system

②Open the valve of the nitrogen cylinder, turn the pressure adjusting screw on the pressure reducer clockwise, and observe the low pressure gauge on the pressure reducer. Make its working pressure value reach 0.8MPa.

③Open meter valve 2 on the double meter repair valve to allow nitrogen to slowly enter the refrigeration system (ensure that the valve connecting the pressure resistant rubber gas hose and the double meter repair valve in Figure 3-51 is open). Observe the pressure values of the two pressure gauges in the refrigerator refrigeration system. When the pressure is equal to the pressure value of the pressure reducer low pressure gauge, close the repair valve gauge valve 2 and the nitrogen cylinder valve valve, and loosen the pressure of the nitrogen pressure reducer. Adjust the screw and pressurization ends.

④Prepare a small piece of sponge in advance, use the sponge with the prepared soap liquid to check the welding points, nut joints and every suspicious place on the system, and carefully observe each place you apply 3~ In 5s, if there is a bubble that proves the leak, repeat the application 2~3 times to find the leakage accurately. As shown in Figure 3-52.

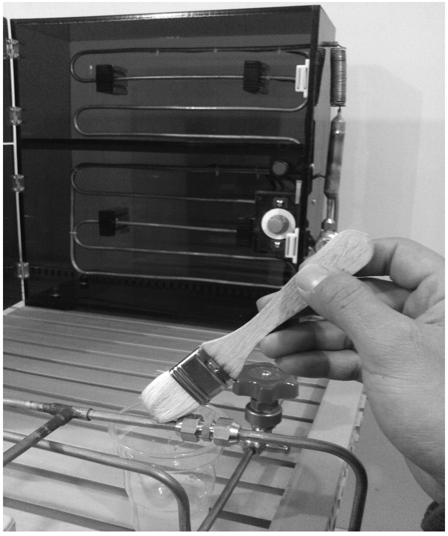


Figure 3-52 Schematic diagram of leak detection of refrigerator refrigeration system

⑤No electric leakage is found through the above leak detection operation, and the pressure of the double-meter repair valve pressure gauge drops, indicating that the system is leaking, and additional inspection is required until there is no leakage.

⑥Check all possible leaks, and after finding the leaks, wipe the surroundings with a clean towel and release the nitrogen in the refrigeration system, and then use appropriate methods for maintenance.

⑦After repairing, repeat the steps ②~④ to re-pressurize and check for leaks until there is no leakage in the system.

⑧ Then fill the system with 0.8MPa nitrogen, after the system pressure is balanced, remove the liquid filling pipe connected to the process liquid filling port, as shown in Figure 3-53, and keep the pressure for 24 hours. Within 24 hours, the pressure drop is not allowed to exceed 0.01 MPa. If the pressure drop exceeds 0.01 MPa, it means that the system is still leaking.

Figure 3-53 Schematic diagram of removing the filling pipe connected to the filling port of the refrigerator refrigeration system

2. Air tightness inspection of refrigeration system of air conditioner

Operation skills for air tightness inspection of air conditioner refrigeration system:

①Connect the red filling pipe (with thimble end) on the double meter repair valve to the filling port of the air conditioning valve in the air conditioner refrigeration system and tighten it, and connect the yellow filling pipe to the end of the connecting hand valve on the pressure-resistant rubber hose And tighten it, as shown in Figure 3-54. It should be ensured that the connection does not leak.

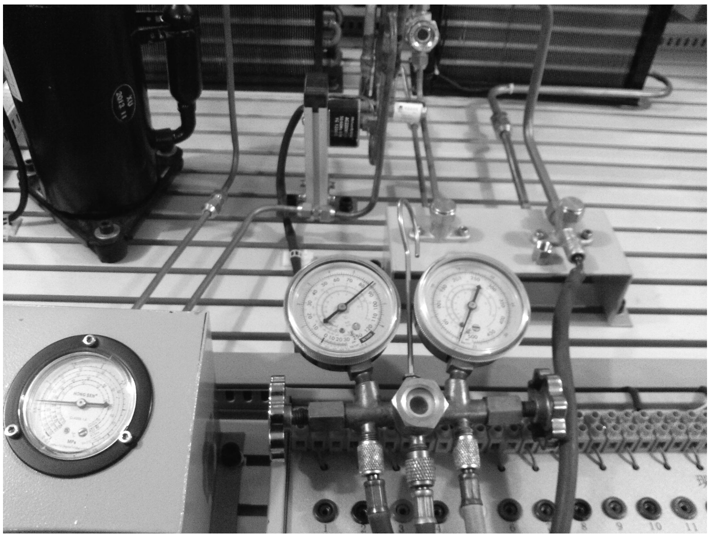


Figure 3-54 Schematic diagram of leak detection pipeline connection of air conditioner refrigeration system

②Choose a suitable Allen key and open the two air-conditioning valves in the air-conditioning refrigeration system.

③Open the valve switch of the nitrogen cylinder, turn the pressure adjusting screw on the pressure reducer clockwise, and observe the low pressure gauge on the pressure reducer. Make its working pressure value reach 1.2MPa.

④Open the meter valve 2 on the double meter repair valve to let nitrogen slowly enter the refrigeration system. Observe the pressure values of the two pressure gauges in the refrigerator refrigeration system. When the pressure is equal to the pressure value of the pressure reducer low pressure gauge, close the repair valve gauge valve 2 and the nitrogen cylinder valve valve, and loosen the pressure of the nitrogen pressure reducer. Adjust the screw and pressurization ends.

⑤Prepare a small piece of sponge in advance, use a sponge with a prepared soap solution to check the solder joints, nut joints and every suspicious spot on the system, and carefully observe each spot 3~ In 5s, if there is a vapor bubble that proves the leakage, repeat the application 2~3 times to find the leakage accurately. As shown in Figure 3-55.

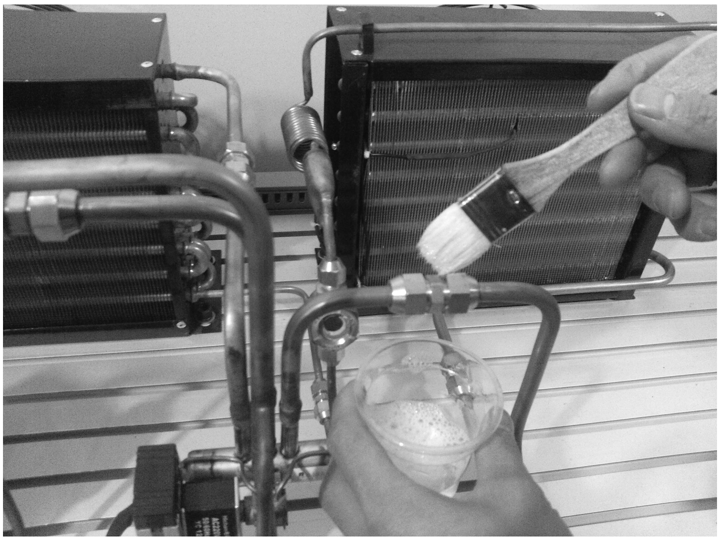


Figure 3-55 Schematic diagram of leak detection of air conditioner refrigeration system

⑥ No leakage is found through the above-mentioned leak detection operation, and the pressure of the double-meter repair valve pressure gauge drops, indicating that the system is leaking, and additional inspection is required until there is no leakage.

⑦Check all possible leaks, and after finding the leaks, wipe around the leaks with a clean towel first, and release the nitrogen in the refrigeration system, and then use appropriate methods for maintenance.

⑧After repairing, repeat the steps ②~④ and re-pressurize the leak test until there is no leakage in the system.

⑨Then fill the system with 1.2MPa nitrogen, after the system pressure is balanced, remove the filling pipe connected to the filling port, as shown in Figure 3-56, and keep the pressure for 24h. Within 24 hours, the pressure drop is not allowed to exceed 0.01 MPa. If the pressure drop exceeds 0.01 MPa, it means that the system is still leaking.

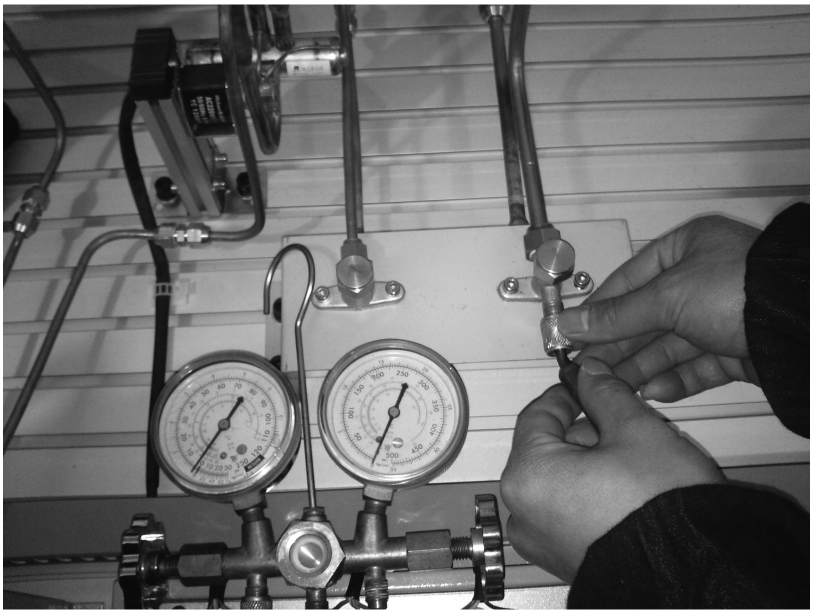


Figure 3-56 Schematic diagram of the air conditioner refrigeration system removing the liquid filling pipe connected to the liquid filling port

⑩In the case that the leak is difficult to find, it is necessary to use the method of segmented leak detection for one-step leak detection.

Task 3: Vacuum and fill refrigerant in the refrigeration system

1. Task description

The "training device" refrigerator and air conditioner refrigeration system are assembled. After the air tightness check is passed, the refrigeration system needs to be vacuumed and pre-filled with refrigerant. The operating skills that must be mastered to complete the task of "training device" when vacuuming and filling refrigerant. Training through this task should be able to achieve:

① Familiar with the method of vacuuming and filling refrigerant in refrigeration system.

②Master the operation skills of vacuuming and filling refrigerant.

2. Related knowledge

1. The method of vacuuming and filling refrigerant in refrigerator refrigeration system

After the refrigerator refrigeration system passes the air-tightness inspection, the refrigeration system should be vacuumed immediately to remove the air and moisture in the refrigeration system. If the vacuum is not completely pumped, it will cause the refrigerator to freeze. Therefore, vacuuming is an operating skill that must be mastered when assembling a "training device", which should be paid attention to in teaching and training.

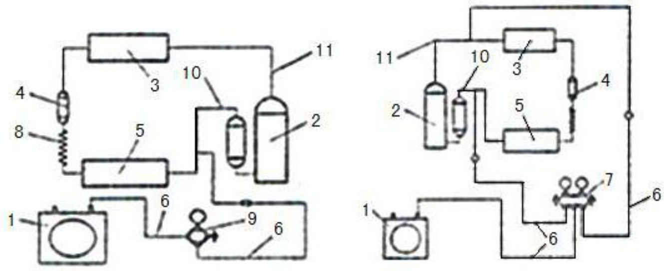
(1) The method of vacuuming the refrigeration system of the refrigerator

1) Low pressure single side vacuum

Low-pressure single-side vacuum chamber refrigerator refrigeration system is a commonly used method for vacuuming. The connection between the vacuum pump and the refrigeration system is shown in Figure 3-57 (a).

The hot spot of low-pressure single-sided vacuuming is simple process and convenient operation. However, the gas on the high pressure side is affected by the capillary flow resistance, and the vacuum degree on the high pressure side will be lower than the vacuum degree on the low pressure side. Therefore, it takes a longer time for the entire system to reach the required vacuum degree.

When low-pressure single-sided vacuuming is used, in order to ensure the quality of the vacuum, the method of secondary vacuum can also be used, that is, after the first vacuum is completed, a certain amount of refrigerant gas is injected into the system to make it and the system The remaining air is mixed, and after it is exhausted, a second vacuum is performed. In this way, after the second vacuum is completed, what remains in the system is the mixed gas of refrigerant gas and residual air, and the proportion of residual air is small, so as to achieve the purpose of reducing residual air.



1- Vacuum pump	7-Double gauge repair valve
2- Compressor	8- capillary
3- condenser	9-Single meter repair valve
4- Dry filter	10- Low pressure suction pipe
5- Evaporator	11-High pressure exhaust pipe
6-pressure hose	

Figure 3-57 Schematic diagram of vacuuming

2) Vacuum pumping on both sides of high and low pressure

The so-called high and low pressure double-sided vacuuming is to vacuum both sides of the system at the same time. The connection between the vacuum pump and the refrigeration system is shown in Figure 3-57(b). Double-sided vacuuming overcomes the influence of low-pressure single-sided vacuuming on the vacuum degree of the high-pressure side. Weld the repair valve with a vacuum pressure gauge on the process liquid adding pipe of the double-tail filter drier, let it be connected to the same vacuum pump in parallel with the process liquid adding pipe on the compressor, and perform vacuuming at the same time to achieve the true system requirements. When the height is possible, first use sealing pliers to seal the process filling pipe on the filter drier, and then close the repair valve. Then continue to vacuum, after about 30 to 60 minutes, the vacuum operation can be ended.

3) Use the refrigerator's own compressor to vacuum

When the refrigerator is repaired at home, it is inconvenient to carry the vacuum pump, so the repairers generally use the compressor of the refrigerator to vacuum. The specific operation method is as follows:

After other maintenance work is completed, remove the old filter drier and weld the capillary inlet. Start the compressor, and the air in the evaporator of the refrigerator will be discharged from the condenser port along with water vapor. For about two hours, turn off the compressor and charge the refrigerant from the process filling port. At this time, refrigerant is discharged from the condenser outlet. The purpose is to use the refrigerant to push out the air in the condenser pipe.

Reduce the amount of refrigerant added, so that the refrigerant is slowly charged to keep the pressure in the refrigerator pipeline greater than the outside atmospheric pressure, and place the air to mix in. At this time, use a pipe cutter to cut the capillary inlet, weld the new filter drier to the condenser outlet, and close the repair valve. Wait for a few seconds. When the pressure in the refrigerator pipeline is balanced with the outside atmospheric pressure, weld the capillary tube and the filter drier, and then fill the amount of refrigerant to normal, and the refrigerator can work normally.

(2) The method of adding refrigerant to the refrigerator refrigeration system

The refrigeration system can be filled with refrigerant after leak detection and vacuuming. The amount of refrigerant filling directly affects the quality of the refrigerator. Therefore, the amount of refrigerant filling must be strictly controlled when filling. In actual operation, the following methods can be used to charge refrigerant:

1) Control low pressure method

The level of low pressure is determined by the amount of refrigerant. If the refrigerant is filled more, the low-pressure pressure is high and the evaporation temperature is high; if the refrigerant is filled less, the low-pressure pressure is low, and the evaporation temperature is also low. Of course, the level of low-pressure pressure is also affected by changes in ambient temperature. When filling refrigerant in different seasons, the low-pressure pressure should be controlled at different values. When filling the refrigerant, connect the three-way valve to the refrigerant cylinder, first loosen the refrigerant cylinder valve to allow a small amount of refrigerant gas to overflow to remove the air in the refrigerant hose, and then connect the refrigerant hose Go to the low-pressure suction port of the compressor, start the compressor, and observe the value of the low-pressure pressure gauge at the same time, turn off the compressor when the requirements are met.

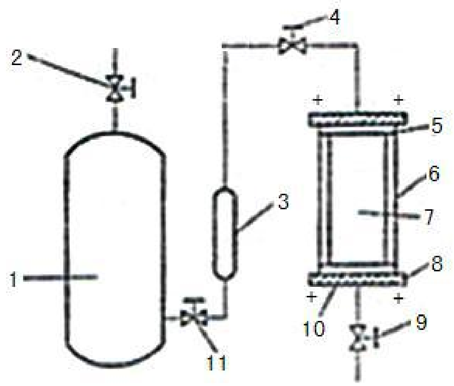
2) Weighing method

The weighing method is relatively simple. Fill the refrigeration system according to the refrigerant quality marked on the refrigerator nameplate. During the specific operation, put the small steel cylinder with refrigerant on the electronic scale, and use the repair valve assembly to connect the small steel cylinder with the refrigeration system. As with the above method, first exhaust the air in the connecting hose, weigh out the mass of the small steel cylinder, then open the repair valve, and pour refrigerant into the refrigeration system. At this time, pay close attention. When the filling volume reaches the requirement, immediately close the repair valve, turn on the power supply, and run the compressor for about 30 minutes. Check the evaporator frosting and compressor operating current. Turn off the compressor normally and wait for low pressure suction. When the port pressure gauge shows greater than zero, remove the filling pipe.

3) Quantitative injection method

This is a more scientific method with better results. It is necessary to use a refrigerant quantitative dosing device when filling, and the refrigerant quantitative dosing device can be made by hand, as shown in Figure 3-58.

Buy a glass tube with a length of 250~300mm, a diameter of 25~30mm, and a wall thickness of 5mm (or a plexiglass tube of the same specification). The volume of the glass tube is between 200~250mL. Engrave a small grid for every 1mL on the outside of the tube. Ten quarters a long grid, and write numbers. The two ends of the glass tube are equipped with round flanges. Each flange is drilled with four φ6.5mm holes. The middle is fitted with asbestos gaskets. The two flanges and asbestos are connected by four M6 bolts with threads at both ends. The gasket and the glass tube are connected together and tightened with a nut (note: do not "tighten" the glass tube). Then pressure test for leaks, after pressurizing to 1.6MPa, put it in water without leakage, and the quantitative barrel is made. Then, as shown in Figure 3-58, connect it with the filter drier, the reservoir and other devices to form a quantitative filling device, and fix it on the movable device.



1- Reservoir	7-Glass tube
2-Stop valve	8-flange
3- Dry filter	9-Stop valve
4-hand valve	10-Asbestos gasket
5-Asbestos Gasket	11-Stop valve
6-bolt and nut	

Figure 3-58 Refrigerant quantitative injector

Pour the refrigerant into the accumulator when filling, open the shut-off valves 4 and 11, store the required refrigerant in the quantitative barrel according to the scale, then close the shut-off valve 4, slowly open the shut-off valve 9 and the refrigerant is connected The hose is filled into the refrigeration system of the refrigerator. To use this method, you need to know the relationship between the volume and quality of the refrigerant, because the quantitative barrel is a mL bit unit, and the amount of refrigerant injected into the refrigerator is in g.

2. The method of vacuuming and filling refrigerant in the refrigeration system of air conditioner

(1) The method of vacuuming the refrigeration system of the air conditioner

If there is residual air in the refrigeration system of the air conditioner, it will cause the cooling efficiency of the air conditioner to decrease, the refrigeration pipeline is blocked (the air contains moisture, and the moisture freezes when it reaches a certain temperature), and the pipeline is corroded. Therefore, the air conditioning system must be vacuumed before filling the refrigerant.

The vacuuming method of the air-conditioning system is basically similar to the vacuuming method of the refrigerator system, and will not be introduced here, and you can refer to the vacuuming method of the refrigerator system.

(2) The method of filling refrigerant in the refrigeration system of the air conditioner

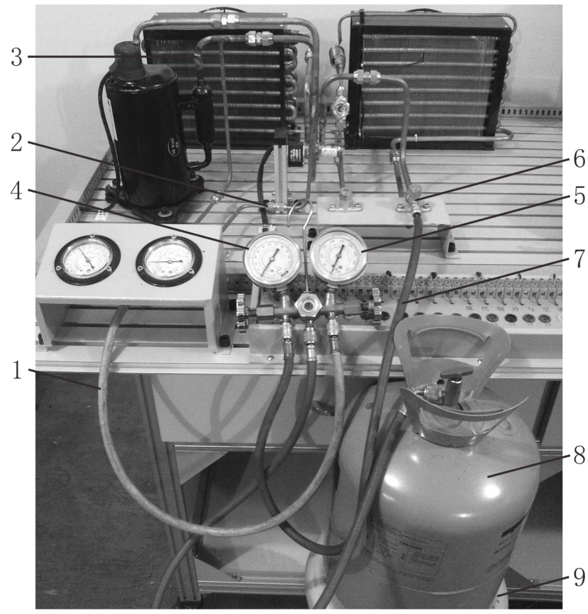
After the air-conditioning refrigeration system is vacuumed, it can be filled with refrigerant. The connection diagram of the refrigerant filling pipe is shown in Figure 3-59.

The refrigerant is sucked by the suction valve through the middle pipe of the compound pressure gauge. Therefore, after the vacuum is completed, the manual valves on the high and low pressure sides need to be closed. The flushing amount of the refrigerant can be judged by the following methods.

1) Weighing method

Place the small refrigerant cylinder on the electronic scale, as shown in Figure 3-59, and then reset the degree on the electronic scale to zero. After the refrigeration system is vacuumed, open the refrigerant cylinder valve and the refrigerant flows into the refrigeration system.

In the process of adding refrigerant, pay attention to the indication value on the electronic scale. When the amount of refrigerant reduction in the cylinder is equal to the amount of refrigerant added on the instruction manual, it can stop. Turn on the power, the compressor runs for about 30 minutes, check the evaporator condensation and compressor operating current, and everything is normal.



1-High pressure hose	4- low pressure gauge	7- low pressure hose
2-High pressure filling port	5- high pressure gauge	8- Refrigerant small cylinder
3- low pressure suction port	6-Low pressure filling port	9-electronic scale

Figure 3-59 Connection diagram of the refrigerant filling pipeline of the air conditioner refrigeration system

2) Measuring current

Set the air conditioner working mode to refrigeration, adjust the fan running state to high speed, inject refrigerant into the refrigeration system from the low-pressure process liquid filling port, and use a clamp ammeter to detect the operating current of the system when it is close to the rated operating current value calibrated on the air conditioner nameplate When, close the refrigerant cylinder valve. Let the air conditioner continue to operate for a period of time, while fine-tuning the amount of fluorine added to reach the rated operating current value.

3) Observation method

Set the working mode of the air conditioner to cooling, and adjust the fan running state to high speed. If the amount of refrigerant in the refrigeration system meets the system requirements, when cooling, all indoor exchangers will condense, the sound in the evaporator will be evenly low, the outdoor shut-off valve will condense, the summer condensate will be continuous, and the indoor heat exchanger will be connected to the capillary tube No frost or dew, etc.; when heating, the temperature of the indoor heat exchanger tube is greater than 40°C. In actual maintenance, a quantitative fluorine addition method should be used. If the piping system needs to be supplemented with fluorine, it is advisable to adopt the method of measuring current as the main, measuring low pressure as the auxiliary, and taking into account the observation.

4) Pressure measurement method

Set the working mode of the air conditioner to cooling (in winter, when heating requires fluorine, set the air conditioner in forced cooling or place the greenhouse sensor in warm water of about 27°C to simulate the temperature in summer to keep the air conditioner in cooling mode). The low-pressure process liquid inlet injects refrigerant into the refrigeration system, and at the same time observes the low-pressure pressure of the vacuum pressure gauge, and closes the fluorine cylinder valve when it reaches the range required by the system. Then consider the factors that affect the low pressure pressure, such as the outdoor air temperature and the indoor cooling load, and fine-tune the amount of freon and the gauge pressure to achieve accurate fluorine addition. The reason for fine-tuning is because the low pressure pressure is proportional to the indoor cooling load, that is, the greater the cooling load, the higher the pressure, and vice versa.

3. Tools for vacuuming and filling refrigerant in refrigeration system

Common tools for vacuuming and filling refrigerant in refrigeration systems include: vacuum pump, dual gauge repair valve (also known as manifold pressure gauge), connecting hose, electronic scale, bottle opener, vacuum pressure gauge, and metric conversion joints.

4. Operation skills of vacuuming and refrigerating refrigeration system.

1. Operational skills of refrigerator refrigeration vacuuming and filling refrigerant

The specific operation steps of vacuuming and filling refrigerant in refrigerator refrigeration system:

① Connect the refrigerant tank, vacuum pump, and compressor process liquid filling port with connecting hoses and double meter repair valves, as shown in Figure 3-69.

1- Low pressure filling port	5- corkscrew
2- Compressor	6-Refrigerant small cylinder
3-Double gauge repair valve	7-electronic scale
4- vacuum pump	8-Connecting hose

Figure 3-69 Vacuum connection diagram of refrigerator refrigeration system

Insert the vacuum pump power plug into the power socket of the ZK-01 pendant, turn on the vacuum pump power switch, and the vacuum pump starts to work.

②Rotate the manual valves at both ends of the dual-meter repair valve to make the inside of the refrigeration system communicate with the vacuum and the vacuum pump. The gas in the refrigeration system is continuously discharged from the system under the action of the vacuum pump.

③Keep vacuuming for about 50 minutes, observe the sight glass in the system, and check whether the outer ring of the sight glass turns blue. If there is a blue phenomenon, it proves that the vacuum degree of the system has reached the requirement. If there is no blue phenomenon, it proves that the vacuum of the system is not enough. Continue to pump until the outer ring of the sight glass turns blue.

④ After the vacuum is completed, first close the hand valve of the double meter repair valve on the side of the vacuum pump, and then turn off the vacuum pump power supply.

⑤Place the small refrigerant cylinder on the electronic scale and clear the reading of the electronic scale. Open the small refrigerant cylinder valve and the refrigerant flows into the refrigeration system. At this time, the display value of the electronic scale is negative.

⑥ The power of the refrigerator is turned on, the compressor of the refrigerator is started, the pointer reading of the low pressure gauge decreases rapidly, and the reading of the electronic scale appears as a negative number, and the value gradually increases.

⑦When the negative value displayed by the electronic scale reaches -45℃, the refrigeration system fills the required volume, quickly tighten the refrigerant cylinder valve, and tighten the hand valve of the double meter repair valve after 1 minute.

⑧The refrigerant filled in the refrigeration system of the "training device" refrigerator is R12. When filling R12, pay special attention to safety. The specific requirements for operation are as follows:

(A) Regardless of whether the system is leaking, the concentration of R12 in all ignition electrical areas cannot reach the explosive limit. Because R12 is heavier than air, it is required to ensure good ventilation at the operation site. When filling refrigerant, in order to avoid possible static electricity and sparks, all equipment must be reliably grounded, all wiring must be firm, and no wrong connection is allowed.

(B) Check whether there is a fire source in the surrounding environment, and maintain good ventilation, prepare the required special equipment and accessories, and check the safety of the power supply.

(C) Check whether the emptying clamp is leaking or loose, and adjust it to a suitable position.

(D) Lead the exhaust pipe to the outdoors, clamp the emptying clamp to the filter drier, start the compressor, run for 5 minutes and then stop, vibrate the compressor to discharge the part of isobutane dissolved in the lubricating oil, pause After 3 minutes, plug in and run for 5 minutes to minimize the isobutane content in the pipeline system.

(E) Turn off the power, seal the air outlet of the filter drier, place a special emptying clamp on the low-pressure pipe of the compressor, evacuate it with an R12 vacuum pump, and transport it for 10 minutes.

(F) Use a pipe cutter to remove the compressor and filter dry, blow the pipeline with nitrogen for more than 5 seconds, connect the R12 compressor and filter dryer (XH9), and weld each interface with gas welding.

(G) Blow nitrogen for leak detection. The nitrogen pressure should not exceed 0.8 MPa. Use soapy water to detect leaks.

(H) After passing the leak test, let off the nitrogen gas and perform vacuuming until the vacuum degree reaches the specified value.

(I) In order to ensure the accuracy of the filling volume, electronic scales should be used during filling, and the refrigerator should be plugged in to run. If there is no abnormality, use a lock ring to seal, and use soapy water for leak detection.

Precautions for refrigerator vacuum and refrigerant filling

1. When the refrigerator is vacuumed, check the air tightness of the connection. If the air tightness is not good, it is difficult to make the system meet the vacuum requirements.

2. At the beginning and end of vacuuming, pay attention to the sequence of closing the hand valve and power supply.

3. When the concentration of R12 in the air reaches 1.9%~8.4% (volume ratio), it will explode when encountering an open flame, so this refrigerant cannot be used in a closed room. Be sure to pay attention when filling refrigerant, and there should be no fire source in the workplace.

4. Be sure to pay attention when filling, and it is not allowed to discharge the refrigeration into the atmosphere to avoid dangerous accidents.

5. Because R12 has higher perfusion accuracy requirements (maintenance perfusion accuracy is ±2g). Therefore, when refilling refrigerant by weighing, an electronic scale with an accuracy of 1g should be used for filling the scale, and the electronic scale should be calibrated regularly. During the filling process, always pay attention to the value of the electronic scale, not to make it

excessive, generally around 45g.

6. Do not turn the small steel cylinder upside down when refilling and refrigerating, and the small refrigerant cylinder cannot be impacted.

7. After the filling is completed, the filling pipe on the compressor cannot be removed when the compressor is turned on. The filling pipe must be removed after the low pressure inlet pressure gauge shows a value greater than zero.

8. All live equipment must be grounded reliably to avoid sparks.

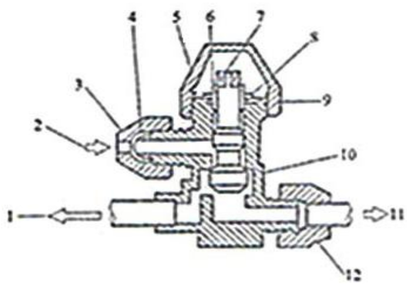
9. R12 refrigerant is a highly volatile item. If it touches the skin, it is easy to freeze. The container should not be close to the face during operation, and protective gloves must be worn. In case the refrigerant comes into contact with the eyes and skin, rinse with plenty of water, apply clean petroleum jelly to the skin, and then seek medical treatment immediately.

2. Operational skills of vacuuming and filling refrigerant in air conditioner refrigeration system

The specific steps of vacuuming and filling refrigerant in air conditioning refrigeration system:

① Connect the left low pressure side hose of the double meter repair valve to the process liquid filling port of the air conditioning system, and the right high pressure side hose to the process liquid filling port of the compressor exhaust pipe.

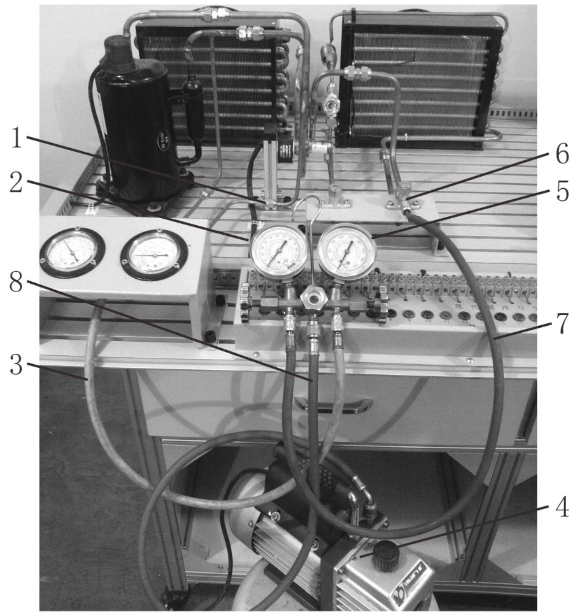
②Turn the central axis of the air-conditioning valve clockwise with an Allen key to open the air-conditioning valve at the position shown in 7 in Figure 3-70, and then turn the valve for double-meter repair to open the double-meter repair valve.



1- Outdoor unit	5-cap nut	9-O-ring
2- Refrigerant main inlet	6-seal bushing	10-Body (spare valve)
3-cone nut	7-central axis	11-Indoor unit
4- Sealing cap (copper cover)	8-Sealing gasket (copper gasket)	12-cone nut

Figure 3-70 Internal structure diagram of air conditioning valve

③Connect the middle hose of the double meter repair valve to the vacuum pump, as shown in Figure 3-71.



1-High pressure filling port	5- high pressure meter
2- low pressure meter	6-Low pressure filling port
3- high pressure hose	7- low pressure hose
4- vacuum pump	8-Intermediate hose

Figure 3-71 Air-conditioning system high and low pressure vacuum pumping on both sides

④Start the vacuum pump, and when the system vacuum reaches the requirement, first close the high and low manual valves of the double meter repair valve, and then cut off the vacuum pump power.

⑤Remove the middle hose and connect it to the nut of the vacuum pump, and then connect the nut to the small R22 refrigerant cylinder, as shown in Figure 3-72 after the connection is completed.

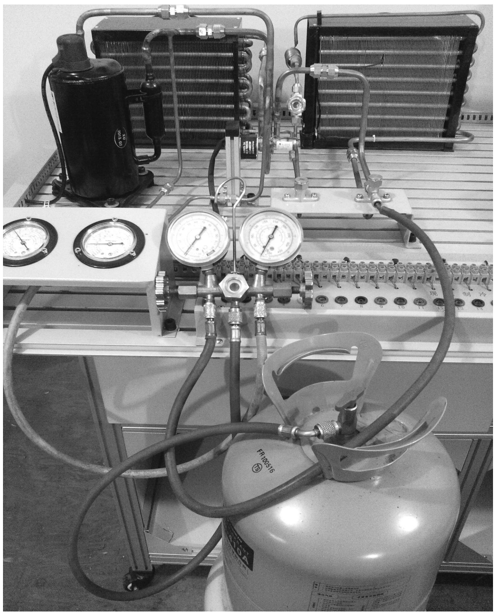


Figure 3-72 Connect the nut to the small refrigerant cylinder

⑥Open the valve on the small refrigerant cylinder, loosen the nut connecting the middle hose and the double-meter repair valve, discharge the air in the hose, and tighten the nut after a few seconds.

⑦Open the high and low pressure manual valves on both sides of the double meter repair valve to let the refrigerant enter the refrigeration system from the high pressure pipeline and the low pressure filling port (the amount of refrigerant must be controlled).

⑧ Close the high and low pressure manual valves on both sides of the dual meter repair, start the compressor, and observe its operation. If the amount of refrigerant is not enough, you can open the low pressure manual valve and add some refrigerant. Note: It is forbidden to open the high-pressure side valve of the double-meter repair valve when the compressor is running.

Project 5 The electrical wiring connection of modern refrigeration and air-conditioning system skill training device

With the development of my country's electronics industry and the upgrading of refrigerators and air conditioners, electronically controlled refrigerators and air conditioners have become very popular, and their electrical control systems have become more and more complex, and their control functions have become more and more advanced. This project mainly introduces the electric circuit connection of refrigerator and air conditioner in "training device".

Through the training of this project, you should be able to achieve:

①Familiar with the electrical control systems of electronic temperature-controlled refrigerators, intelligent temperature-controlled refrigerators, and air conditioners in the "training device".

②Master the use of measuring instruments.

③Familiar with the operation skills of electrical connection (soft soldering) and electrical wiring of electronic temperature control refrigerators, intelligent temperature control refrigerators, and air conditioners.

The main tasks of this project:

① The electrical circuit connection of the electronic temperature control refrigerator.

②The electrical circuit connection of the intelligent temperature control refrigerator.

③The electrical wiring of the air conditioner is connected.

Task 1 Electrical wiring connection of electronic temperature control refrigerator

1. Task description

The control circuit of an electronic temperature control refrigerator is composed of many electronic components, and the temperature sensor used in temperature control is to use the characteristic that the resistance of the temperature coefficient thermistor (NTC) decreases with the increase of temperature, and the thermistor It is placed directly in the adaptive position in the refrigerator, and the resistance value of the thermistor changes due to the temperature change in the refrigerator to control the on and off of the compressor to control the temperature in the refrigerator. The connection of the electrical circuit of an electronic temperature control refrigerator is to use wires to connect the refrigerator refrigeration system and the electronic temperature control to form a complete set of electronic and temperature control refrigerator electrical systems. This task mainly introduces the relevant knowledge of the refrigerator electrical control system, the use of common measuring instruments, the basic operating skills of soldering and the electrical connection of electronic temperature control refrigerators.

Through training in this task, you should be able to achieve:

①Familiar with the features of starting, protection and electronic temperature control electric control of refrigerator compressor motor.

②Familiar with the use of common measuring instruments.

③Master the electrical connection and operation skills of soldering and electronic temperature control refrigerators.

2. Related knowledge

A qualified and fully functional refrigerator should have four major functions: refrigeration, temperature control, frosting, and heat preservation. The task of the electrical control system is to ensure the normal start, stop and protection of the compressor, and realize the control function of the temperature in the refrigerator and the lighting in the refrigerator for defrosting.

1. Starting and protection of compressor motor

(1) Compressor motor

At present, the compressor motors of household refrigerators all use single-phase cage asynchronous motors, with a voltage range of 220 [(1-15%) ~ (1+10%)], that is, 187-242V. The general power is 65-150W, and there are still early-produced refrigerator compressors on the market with HP (horsepower). The corresponding relationship between the two is shown in Table 4-1.

Table 4-1 Correspondence between horsepower and watts

horsepower （HP）	1/12	1/11	1/10	1/9	1/8	1/7	1/6	1/5
watts（W）	65	69	75	82	93	105	125	150

(2) Compressor motor winding

The compressor motor is structured as a whole with the compressor and sealed in a shell.

The single-phase compressor motor has two windings (at a 90° angle to each other in space, evenly embedded in the stator core slot), as shown in Figure 4-1, one of the windings is the running winding (or called the working winding) , Denoted by CM: the other winding is the start winding (or auxiliary winding), denoted by CS. C is the common terminal, M is the running terminal, and S is the starting terminal. At room temperature, the resistance range of motor windings of different capacities is approximately: Rcm=8～22Ω, Rcs=24～45Ω. Generally, the resistance value Rcs of the starting winding should be the Rcm of the running winding (but there are exceptions, such as individual Imported compressor motors, whose starting winding resistance is smaller than the running winding resistance, are called special motors). During the wiring operation, the three-person terminal of the compressor motor must be judged first. For ordinary compression motors, the basis for judgment is Rcs>Rcm, and Rsm=Rcs+Rcm. In actual measurement, as long as the multimeter is adjusted to R×200 electrical barrier and the resistance of each winding is measured, the three terminals C, S and M can be identified.

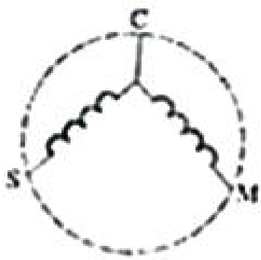


Figure 4-1 Compressor motor winding

(3) Insulation performance of compressor motor

1) Measurement of insulation resistance

Use 500 or 1000 type megohmmeter, select the test point between the lead end of the winding (the conductive part) and the shell (the insulating part), shake the handle at a constant speed of 120r/m, and read the pointer According to regulations, it must be greater than 20MΩ (cold state). The larger the value, the better the insulation performance.

2) Measurement of leakage current

Use an AC milliamp meter to measure the power supply between the insulating parts of the conductive part and it should be less than 1.5mA. Specific test methods.

3) Measurement of electrical strength

It is carried out on a high-voltage test bench, and a 1500V AC voltage is applied between the outlet end of the motor and the housing for 1 min. There should be no breakdown or flicker.

4) Measurement of ground resistance

Use a grounding resistance meter to measure the resistance between the refrigerator grounding pole and the refrigerator casing, and the index should be less than 0.1Ω. Specific test methods.

(4) Starting method of compressor electric

1) Resistance split-phase starter (RSIR method)

At present, most household refrigerators are started in this way. When starting, the starting switch S is required to be automatically turned on. When the motor speed reaches 0.8nN, the switch S should be automatically turned off to cut off the starting winding.

The starting winding of the compressor motor has a small diameter and a large number of turns, that is, a large resistance and a small inductance; while the running winding has a large diameter and a large number of turns, that is, a small resistance and a large inductance. From this, the phasor diagram shown in Figure 4-2 can be obtained. Under the action of single-phase AC voltage, the current 1cm in the operating winding with a larger inductance lags behind the voltage U by a larger phase difference. The current 1cs flowing through the windings lags behind the voltage U by a small phase difference. The two currents respectively flow into two windings that are 90° in space, forming an elliptical rotating magnetic field, thus forming an electromagnetic rotation. Torque to start the motor. The starting current IQ of the motor is larger, which is 6-8 times the rated value; while the starting torque is small, generally 1.4-2.0 times the rated torque

MN. Because this starting method has the advantages of simplicity, low cost, reliable operation, etc., household refrigerators under 200L adopt this starting method. This starting method is generally only used for hermetic compressor motors whose output power is below 130W.

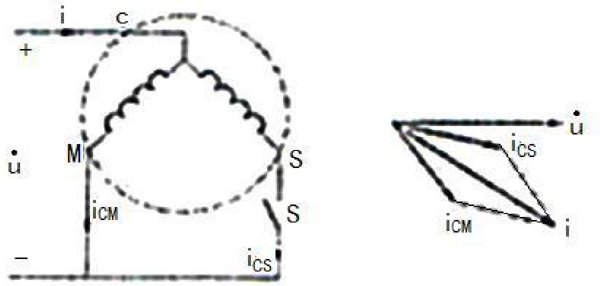


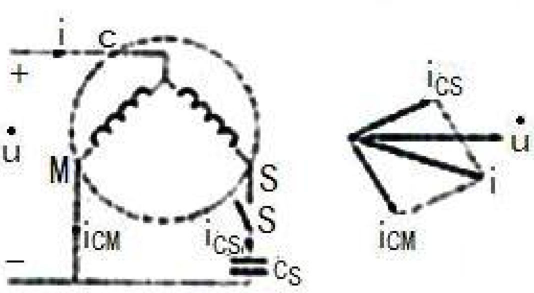
Figure 4-2 Resistance split-phase start

2) Capacitor split-phase starting method (CSIR method)

Capacitor split-phase starting method, as shown in Figure 4-3, in the starting winding branch, a large-capacity starting capacitor CS is connected in series, as long as the appropriate capacitance is selected, the starting branch can appear as a capacitive branch. And make the current flowing through the two windings have a phase difference of 90°. This will form a circular rotating magnetic field in the air gap of the stator and the rotor, which will produce a larger starting torque on the rotor to start the motor. When the motor is started, CS is cut off from the circuit together with the start winding. The purpose of adding CS is to increase the starting torque of the compressor motor and reduce the starting current. According to different requirements. The configured capacitor capacity is 30-100uF, non-polar oil-immersed capacitor with pressure resistance above DC450V, such as CBB61. When starting with the CSIR method, IQ=(5～6)IN, MQ=(2～3.5)MN, so this starting method is often used for refrigerators, cold water tanks, commercial refrigeration and freezer boxes that require large starting torque When the compressor motor starts, the output power is about 100~300W.

3) Capacitor start capacitor operation mode (CSR)

Capacitor start capacitor operation mode, as shown in Figure 4-4. In this way, in addition to serially connecting a starting capacitor CS controlled by the starting switch S in the starting winding, a non-capacity running capacitor CR (CR=2～3uF/450V) is also fixed. The purpose of adding CR is to improve the power factor of the circuit, reduce the line current, reduce the loss of electric energy, and improve the running capacity and overload capacity of the motor, as shown in Figure 4-4. This starting method is often used to start compressor motors such as 180-1500W large commercial refrigerators, water chillers, and refrigerators.



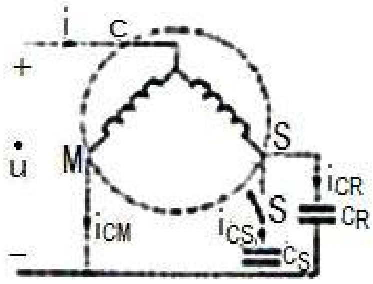


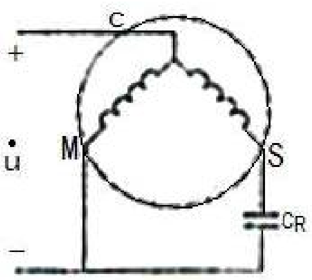
Figure 4-3 Capacitor split-phase start Figure 4-4 Capacitor start capacitor operation

4) Capacitor operation mode (PSC mode)

Capacitor operation mode is shown in Figure 4-5. This kind of starting method is often used to start the compressor motor and fan motor of household appliances air conditioner. There is a fixed capacitor CR in series in the starting branch, no starting switch is needed. When starting, both the starting and running windings work to make the motor Have better running performance.

5) Manual start mode

Manual start mode, as shown in Figure 4-6. Turn off the power switch S first, and draw a sheathed wire from the S end of the compressor. When the power switch S is closed, hold the other end of the wire and touch the M end of the compressor to start the compressor motor. . Manual start mode is mainly used to check whether the compressor has mechanical failures such as cylinder jam or shaft reporting.



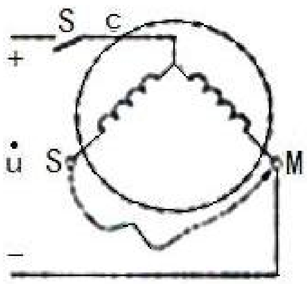


Figure 4-5 Capacitor operation Figure 4-6 Manual start

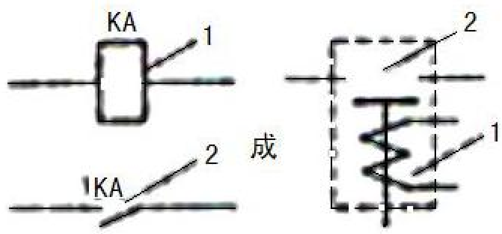
(5) Starter

In the aforementioned three starting methods of RSIR, CSIR and CSR, a starting switch S must be connected to the starting winding branch. When the motor starts, it will be closed in the future, and it should be opened in time after starting to cut off the motor. Start winding or start capacitor. Obviously, this day pass cannot be operated manually, but must be realized with an automatic switch called a starter. The original refrigerator used a reed snap-on starter, which has now been eliminated. There are two types of starters commonly used today: one is a heavy hammer current starter relay, and the other is a PTC starter.

1) Heavy hammer current starting relay

①The symbol of the heavy hammer current starting relay in the circuit is shown in Figure 4-7.

②The heavy hammer current starter relay is composed of a current excitation coil 1 and a pair of moving and closing (contacts) 2. The current coil is connected in series with the operating winding CM of the compressor motor, and the moving contact is connected with the starting winding CS of the compressor motor. Lu connected, the starter has two indicators, namely the minimum pull-in current IA and the maximum release current IB, and IA>IB.

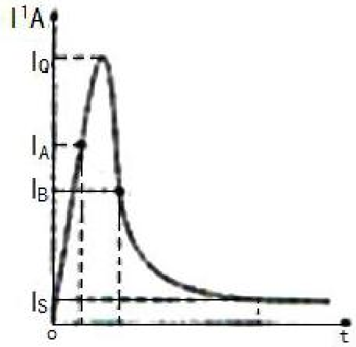


1- Relay coil 2-relay contact

Figure 4-7 The symbol of the heavy hammer current start relay

For the RSIR starting mode, the starting process is: once the 220V AC power supply is turned on, a large starting current IQ (=6～8IN) will flow through the running winding of the compressor motor and the current coil of the starter. When the current rises to When the minimum pull-in current IA of the current starter relay, the contact pulls in, turns on the starting winding, forms a rotating magnetic field between the stator and rotor of the motor, and generates a starting torque to start the motor. With the increase of the motor speed, the current of the running winding drops quickly. When the speed reaches about 80% of the rated value, when the current flowing through the running winding drops to the maximum release current IB of the relay, the suction force of the relay is not enough to overcome the weight itself. The weight of the heavy hammer allows the heavy hammer to fall freely and disconnect the contact, thereby cutting off the starting winding, so that the compressor motor runs in the normal rated working current IN state, and the starting is completed. The whole starting process time is about 1~3S. This kind of starter is actually an electromagnetic switch, and its biggest disadvantage is that it has contacts. Noise will be generated when the contact is closed; when the contact is disconnected, sparks must be generated at the point where the contact is disconnected. Only after a while will the contact burn, resulting in poor contact or contact loss; at the same time, the moment the contact is disconnected It can also cause interference to radio communication equipment. The starting curve of the heavy hammer current starting relay is shown in Figure 4-8.

③The wiring diagram of the heavy hammer current starting relay is shown in Figure 4-9.



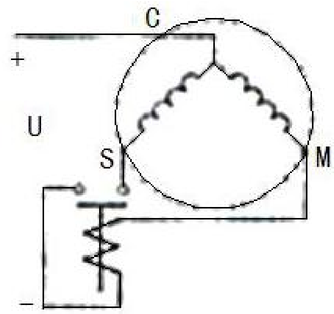
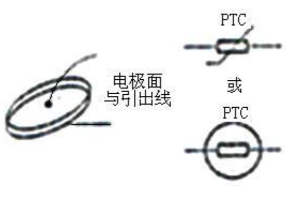


Figure 4-8(left) Curve of heavy hammer current start relay

Figure 4-9 (right)Wiring diagram of heavy hammer current start relay

2) PTC starter

PTC is a combination of the first letter of the three words Positive Temperature Coefficient in English. It is made of barium titanate as the main raw material and doped with trace rare earth elements. It adopts ceramic technology and is sintered at high temperature. For semiconductor devices (thermistors) with temperature coefficient resistance characteristics, the outline structure and circuit diagram symbols are shown in Figure 4-10.



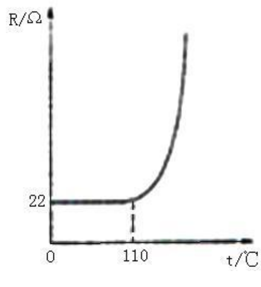


Figure 4-10(left) PTC starter outline structure and circuit diagram symbols

Figure 4-11(right) Resistance temperature characteristic curve of PTC starter

① Characteristics. PTC has the characteristic of positive temperature coefficient resistance, and the resistance increases with the increase of temperature. When the temperature rises to the Curie point temperature of 110°C, its resistance will increase thousands of times, that is, at normal temperature (110° Below C), it presents a low-resistance conduction (usually tens of ohms) state, and at high temperatures (above the Curie point temperature), it presents a high-resistance (passage of tens of kiloohms) "off" state, which shows that PTC The element has a "temperature switch" characteristic, which is just in line with the requirements of the compressor for split-phase starting. The characteristic curve of its resistance temperature is shown in Figure 4-11.

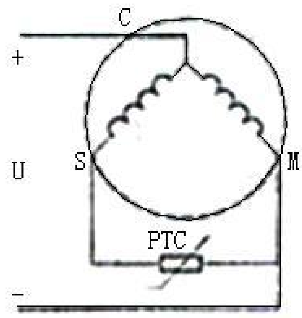


Figure 4-12 PTC wiring diagram

② Wiring method and start-up overweight. The wiring method of PTC is shown in Figure 4-12. In the circuit, the PTC element is connected in series with the starting winding CS of the compressor motor. The prerequisite for starting with the PTC element is that the PTC must be in a low resistance state at room temperature. . At the moment of energization and starting, a large starting current flows through the motor’s starting and running windings at the same time, generating a rotating magnetic field between the air gap of the stator and rotor to start the motor. Because the large current flows through the PTC element, it takes a few tenths of a second. Inside, the temperature of the PTC element can be quickly increased by about 150°C, making the PTC in a high resistance state. This greatly reduces the current flowing through the starter winding, causing the starter winding to be equivalent to a short-circuit state. At this time, the current flowing through the PTC element is 10-15mA, and the PTC element is maintained at a high temperature and high resistance state. The start is completed. .

③Using characteristics. Refrigerators using PTC starter should be kept frequently started. At this time, because the PTC element is always in a high temperature and high resistance state during the cooling operation of the compressor, if the power is turned on immediately after the power is cut off, the PTC element cannot be reduced to the residential area due to the existence of thermal inertia after the power is cut off. It is below the midpoint temperature (110°C), but still remains in the high resistance state, compressing the starting branch of the motor, unable to flow enough starting current, unable to form a rotating magnetic field to start the motor, but a large starting current has been Flow through the running winding, which may burn the running winding. Therefore, the refrigerator with PTC starter must be kept at least 3 minutes apart after the power is cut off, and the 3PTC element should be cooled below the Curie point temperature to restore it to a low resistance state before the second start.

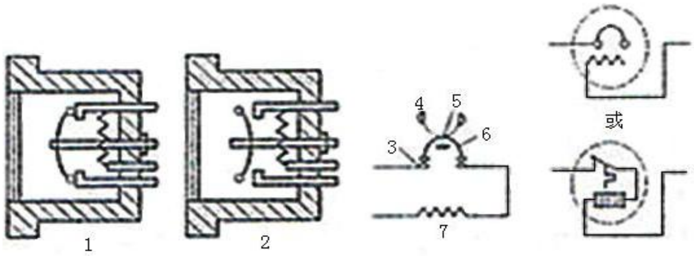
The biggest advantage of using PTC components to start is that it is a non-contact sky switch, which uses the temperature switch characteristics of PTC. No noise, no wear, no sparks, high reliability, long life during starting operation, and a wide matching range with the compressor motor. Generally, the pressure selection matches the compressor motor road, so it is often matched with the compressor Power (such as 1/8HP) as its specification, marked on the shell.

At present, the main technical indicators of domestic PTC components are that the resistance value at 25°C room temperature is generally 15~47 (1±30%) Ω, and the commonly used 22 Ω and 33 Ω in refrigerators; porcelain withstand voltage ≥ 300V, maximum withstand current It is 7A, the maximum working circuit is less than 20mA, and the starting time is 0.1~1.5s.

(6) Protection of compressor

Refrigerator compressor motor needs over temperature rise and over current protection.

When the compressor is running continuously, the temperature of the electronic winding and iron core of the motor can reach 100-110°C, and the compression heat generated by the compressor piston to the compressor can also reach 100°C. This heat will pass through the compressor shell to Dispersed in the surrounding air, the temperature of its shell can reach over 100°C in summer. This will accelerate the aging of the winding insulation and shorten the service life of the compressor. However, the refrigerator compressor works intermittently, and it is controlled by the thermostat. Therefore, during the normal cooling operation, the temperature rise will not exceed or exceed the maximum temperature allowed by the insulating material. The shell temperature is Around 95°C. However, if the thermostat malfunctions or is improperly installed, or other reasons such as improper use, it may cause the compressor to operate continuously for a long time, causing its temperature rise to exceed the specified allowable range. Some over-temperature rise protection devices are required. Is one of them. Second, when due to some reasons, such as an open circuit in the starting branch or mechanical failure of the compressor such as cylinder jamming or shaft holding, the compressor cannot be started after the power is turned on. At this time, a large starting current flows through the compressor. The running winding makes the winding heat up quickly until the smoke burns out the running winding. In this case, an overcurrent protection device is required. The butterfly overcurrent and overtemperature protection relay can play this protective role. Its structure is shown in Figure 4-13.



1- turn on	5- fixed point
2- disconnect	6-Bimetallic sheet
3-stationary contact	7- Resistance heater
4-moving contact	

Figure 4-13 Structure diagram of butterfly overcurrent and overtemperature protection relay

It combines a butterfly-shaped bimetallic strip, a pair of movable (normally closed) contacts and a 0.6-1.2Ω nickel-chromium resistance wire together in a small round shell made of high-temperature resistant phenolic plastic. Lead out two terminals and connect them in series in the compressor circuit. When installing, press its open end tightly on the surface of the compressor shell to feel the temperature rise of the compressor. Its connection in the electric circuit of the refrigerator is shown in Figure 4-14. It is a compressor connected in series to connect the power supply.

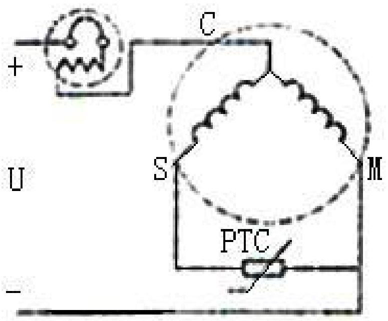


Figure 4-14 Connection of protection circuit

After the power is turned on, if a large starting current flows through the compressor motor, the starting can be completed within 1 to 3S, and the current quickly drops to the rated current. Although the current is large during starting, the time is very short, which is not enough The bimetallic sheet is warped and bent up due to thermal deformation. However, if the compressor cannot start normally after the power is turned on, and the excessive current flows through the resistance wire for a long time, the resistance wire of 0.6～1.2Ω can be heated to a fiery red high temperature within a few seconds and directly The butterfly-shaped bimetallic sheet strongly dissipates heat. When heated to a certain temperature, the bimetallic sheet is deformed and quickly bends upwards and flips to separate the moving contact and the static contact (as shown by the dotted line in Figure 4-13) and cut off the circuit . It is usually required to operate within 6-15s. This means that the working current of the overcurrent is normal. The temperature of the bimetallic strip will also increase as the case temperature rises, which will eventually lead to the separation of the moving and static contacts. After the disconnected contacts are separated Generally, it takes about 3 minutes to reset. The delay disconnection and reset time are adjusted by the manufacturer before the product leaves the factory, and no user adjustment is required. This butterfly overcurrent and overtemperature protection relay is often used in conjunction with a heavy hammer starter relay. The starter and the protector are assembled in a plastic case in structure, and they are directly inserted into the three leads of the compressor. This assembled starting protection relay has the advantages of simple structure, convenient installation, reliable performance, small size, etc., and is widely used.

2. Electrical control characteristics of electronic temperature control refrigerators

The electrical control system of an electronic temperature control refrigerator is composed of a power supply circuit, a starting circuit, a temperature control circuit of the refrigerating room, a compressor on/off control circuit, a defrosting circuit, and a working status indicating circuit.

(1) Power supply circuit

The power supply circuit is shown in Figure 4-15. It provides DC +12V and +6.8V power for the control circuit, intervenes in the mains AC 220V voltage, and uses the transformer T to convert the current 220V voltage into the current 13.5 voltage, which is formed by a bridge composed of diodes. After the rectifier circuit is rectified, it is filtered by the capacitor C1 to obtain a voltage +VCC, which is supplied to the two relays RY01 and RY02 in the control circuit. The +VCC voltage obtains a +12V power supply by inheriting the voltage stabilizer 7812, and a voltage of +6.8V is obtained under the action of the voltage stabilizing circuit formed by the Zener diode VZ1 and the capacitor C3 of the resistor R1. The voltage is supplied to other components in the control loop except for relays and integrated blocks.

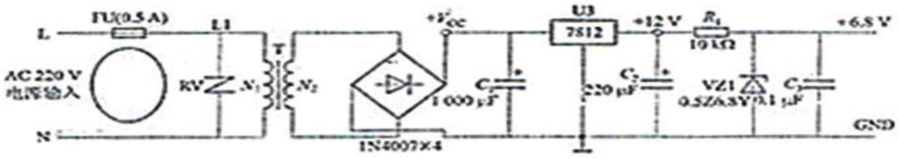


Figure 4-15 Power supply circuit

(2) Starting circuit

The principle of the starting circuit is shown in Figure 4-16. Because the starting relay and light-emitting diode require a relatively large current, they cannot be directly driven by a control signal. Therefore, the control signal is used to control the saturation and load stop of the transistor (equivalent to the connection of the switch). On and off), and operate the action of the starter relay and light-emitting diode, the control signal comes from the 11th pin of the NAND gate TA4572BP.

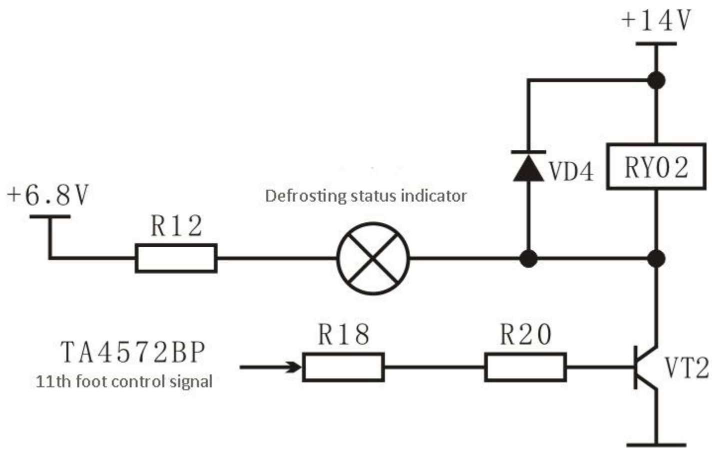


Figure 4-16 Principle of starting circuit

(3) The temperature control circuit of the refrigerator compartment

Two different NTC thermistor type sensors are used in the Toshiba GR-204E refrigerator electronic temperature controller, namely, the refrigerated one is the temperature sensor and the evaporator temperature sensor. The temperature of the refrigerating chamber is known through the refrigerating chamber temperature sensor to control the start and stop of the compressor. The control circuit of the refrigerator compartment is composed of a temperature detection circuit and a temperature adjustment circuit.

1) Temperature detection circuit

The temperature detection circuit is shown in Figure 4-17. It is composed of a cold storage greenhouse sensor and a circuit in series, using the temperature characteristics of the thermistor, the lower the temperature, the greater its resistance, so the compressor UR7 obtained from the resistor R7 is smaller.

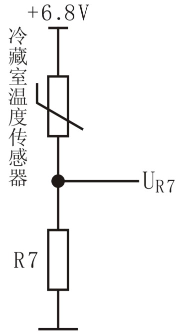


Figure 4-17 Temperature detection circuit

2) Temperature adjustment circuit

The temperature adjustment circuit is shown in Figure 4-18. The circuit consists of resistors R1, R2, R3 and sliding resistor Rw. The reference voltage UR11 can be changed by the sliding resistance, which is the output signal of the temperature regulation circuit, and can also be said to be the stop action voltage of the compressor.

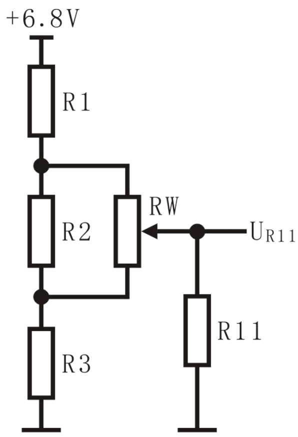


Figure 4-18 Temperature adjustment circuit

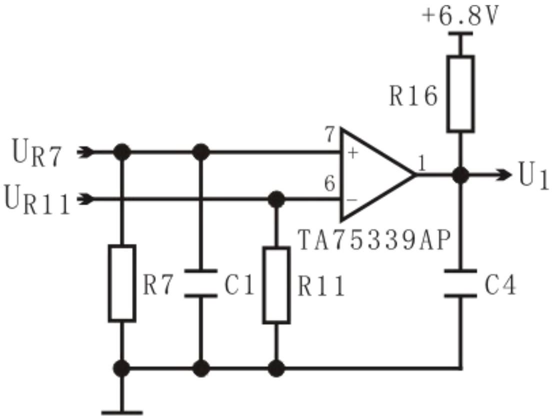
(4) Compressor on/off control circuit

The compressor on/off control circuit includes a compressor shutdown detection circuit and a startup temperature detection circuit.

1) Compressor shutdown detection circuit

The compressor stop detection circuit is shown in Figure 4-19. In the GR-204E refrigerator control circuit, a voltage comparator composed of TA75339AP operational amplifier combines the first two circuits (temperature detection circuit output voltage UR7, temperature adjustment circuit The output voltage UR11) is compared with the output voltage UR7 and UR11 to determine the working status of the control refrigeration compressor relay RY01. When UR7>UR11, the comparator output U1 is high, and the set 1 relay RY01 keeps the original state; when UR7<UR11

When the comparator output U1 is low, the RS flip-flop is set to 0, and the relay RY01 is powered off. Resistor R16 is an up resistor, which will raise the potential of U1 when U1 output is high. U1 outputs the reset terminal of the RS trigger composed of TA4572BP (NAND gate), and controls the compressor relay RY01.



输入	输出U_1/V
$U_{R7} > U_{R11}$	约6V
$U_{R7} < U_{R11}$	0V

Figure 4-19 Compressor shutdown detection circuit

2) Compressor startup temperature detection circuit

The compressor start-up temperature detection circuit is shown in Figure 4-20. The voltage comparator composed of TA75339AP operational amplifier compares the voltage UR7 output by the previous temperature detection circuit with the fixed voltage obtained by the partial pressure of resistors R8 and R9 to determine Control the working status of compressor relay RY01. When UR7>UR9, the comparator output U2 is low, U1 is set to 0, and the relay RY01 is energized; when UR11<UR7<UR9, the comparator output U1 is high, and the comparator output U2 is high , U1 is set to 1, the RS flip-flop composed of TA4572BP (NAND gate) remains, and the working state of relay RY01 remains unchanged. Resistor R15 is a pull-up resistor, when U2 output is high level, it plays the role of raising the potential of U2 point. U2 is output to the position end of the R2 trigger to control the compressor relay RY01.

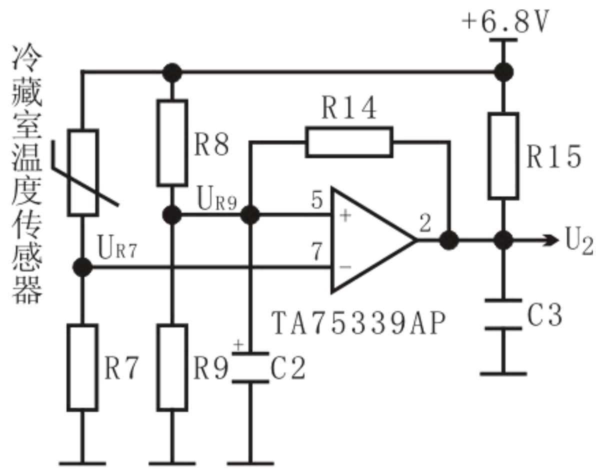


Figure 4-20 Compressor startup temperature detection circuit

(5) Defrost circuit

In the GR-204E refrigerator control circuit, the defrosting adopts a semi-automatic electric heating defrosting method, as shown in Figure 4-21. Press the "Start defrosting" button manually to automatically end the defrosting. When it is necessary to manually stop the defrosting during the defrosting period, you can also manually press the "defrost stop" button to stop the defrosting.

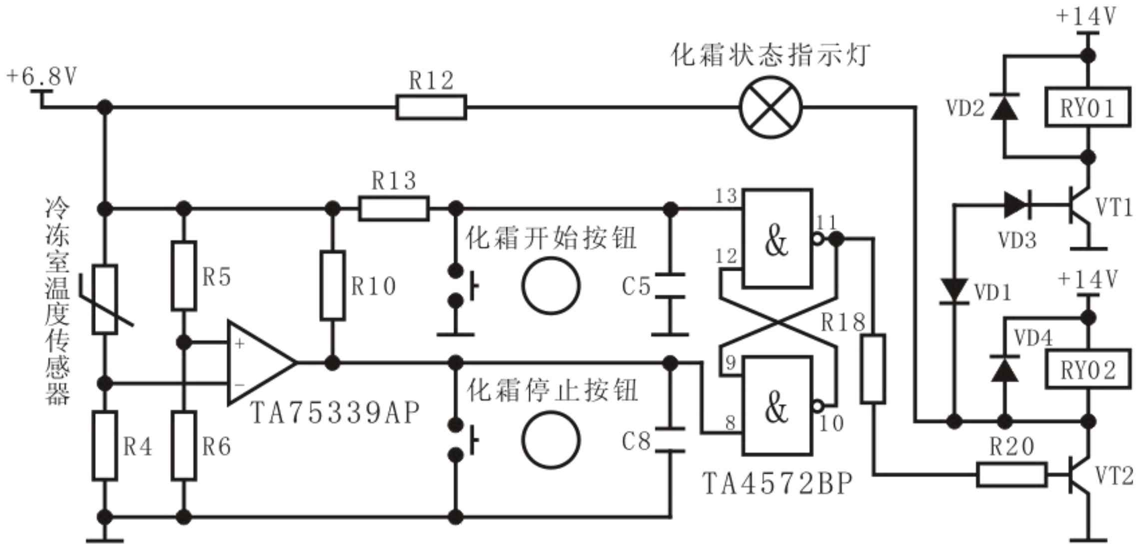


Figure 4-21 Defrost circuit

When the frost layer is thick and needs to be defrosted, press the "Start defrosting" button to make U13 (pin 13 of the NAND gate) low. At this time, due to the low temperature in the freezer, the two input terminals U8 of a set of voltage comparators as a circuit for detecting the end of the defrost are smaller than U9, and the output of U14 is high, that is, the reset terminal of the trigger is 1 (the NAND gate Pin 8 is high), so the input terminal of the trigger is 1 (the pin 11 of the NAND gate is high). This level makes the transistor VT2 in a saturated conduction state, the relay RY02 acts, and the defrost heater is energized Work, the defrosting state starts. At the same time, due to the function of the diode VD1, the triode VT1 is cut off to ensure that the refrigeration compressor is in a stopped state during the defrosting period. After a period of defrosting, the temperature of the freezer compartment rises, that is, the resistance value of the evaporator temperature sensor becomes smaller as the temperature rises. When U8>U9, the output terminal U14 is low level, which makes the trigger flip. The output terminal is 0, so that the transistor VT2 is cut off, and the defrosting work is automatic system. During the defrosting period, when the terminal defrosting is required, just press the "defrost stop" button to force U14 to low level, which can also make the trigger flip and stop the defrosting. During defrosting, the defrosting status indicator on the operation panel is on. When the defrosting is over, the defrosting status indicator will also go out.

Task 2 The electrical circuit connection of the intelligent temperature control refrigerator

1. Task description

Intelligent temperature control refrigerator, also known as microcomputer controlled refrigerator. Because of its precise temperature and air, many additional functions, humanized operation interface, and the development of microcomputer (single-chip microcomputer) technology and the reduction of cost, it is more and more widely used in refrigerators. The connection of the electrical circuit of the intelligent temperature control refrigerator is to connect the refrigeration system of the refrigerator with the intelligent thermostat by using the wire to form a complete set of intelligent temperature control refrigerator electrical control system.

2. Related knowledge

1. Main functions of refrigerator intelligent control system

(1) Cooling temperature control function

Through the temperature sensor and microcomputer control, the automatic control of the temperature in each compartment of the refrigerator is realized, so that the temperature in the refrigerator reaches the user's temperature setting range.

(2) Power supply overvoltage protection function

When the mains power supply voltage is too high, the control board and other electrical components will not be damaged by means of fuse fusing.

(3) Compressor 3min delay start protection function

Each time the compressor stops, the pressure in the refrigeration system pipeline needs to be balanced for a period of time. If it is started immediately after the stop, the load will be large and the compressor will be easily damaged. The single-chip microcomputer system detects each time it is powered on. If the shutdown time is less than 3 minutes, it will automatically delay 3 minutes before starting to protect the compressor.

(4) System protection and power-off memory function

In order to prevent the user from temporarily poor contact when plugging in the power supply, the compressor is allowed to be turned on only 3s after the MCU is powered on. When the system crashes due to strong interference and other reasons, it can automatically reset and keep the display before resetting and running in the mode before resetting. Recall the system after the power failure, and it will automatically run according to the model and settings before the power failure.

(5) Automatic temperature compensation function in low temperature environment

Due to the single-cycle refrigeration system of the refrigerator, the freezer compartment is cooled at the same time, and the mechanical temperature control refrigerator will cause the refrigerating room temperature to be too low and not work under the low temperature environment, and then the freezing room temperature is too high. The automatic temperature compensation function realizes the temperature control of the refrigerator and freezer compartments under various environmental conditions by automatically controlling the compensating heater of the refrigerator compartment.

(6) Automatic frost control function of refrigerated evaporator

The surface of the evaporator will be frosted after a period of cooling. If the frost layer is too thick, it will directly affect the cooling effect of the refrigerator. The automatic frost control will melt the frost on the surface of the evaporator in the refrigerator compartment into water and remove it according to the cooling operation time of the refrigerator. Outside the box, automatic frost control also ensures that refrigeration is performed after the frosting process is over (the temperature of the evaporator in the refrigerating room is higher than 5°C) to prevent the defrosting water from freezing and blocking the drain hole and affecting the refrigeration capacity.

(7) Automatic defrost control function

Frost-free refrigerators are not non-frosting, but the refrigerator has an automatic defrost control function, which does not require the user to manually defrost. The automatic defrosting control room defrosts according to the cooling operation time of the refrigerator and the temperature in the refrigerator to control the defrosting and heating work. During the defrosting process, the defrosting heater melts the frost on the freezer compartment evaporator into water and discharges it In addition to the refrigerator, the automatic frost control also ensures that the frost is removed (the temperature of the freezer evaporator is higher than 6°C), and the refrigeration is performed after a few minutes delay. During the automatic defrosting process, the freezer compartment stops cooling and the fan motor stops running to prevent the temperature of the freezer compartment from rising.

(8) Turn off the prompt function

According to the detected door switch signal, if the door opening time exceeds the set time, the buzzer will sound to remind the user to close the door; if the door has not been closed for a long time, the switch will be faulty or the user forgets to close the door, and the lights will be turned off automatically. .

(9) Quick freezing and quick cooling function

Quick cooling and quick freezing electric energy are pre-stored expert modes set by the refrigerator according to user needs. After entering the quick-freezing mode, the refrigerator will quickly cool down; after entering the quick-freezing mode, the freezer will be quickly cooled to achieve the cold preservation effect. The quick-cooling and quick-freezing modes are entered by the user through the security check setting. After meeting the conditions, it will automatically exit and run according to the original settings. In quick cooling and quick freezing mode, the compressor runs continuously.

(10) Status display function

This function displays the set temperature, actual temperature, current operating mode, compartment closed state, fault code, etc. of the refrigerator through the display operation panel. Common display methods include: LED light-emitting diode display, LCD liquid crystal display, LED display, etc.

(11) Self-diagnosis, fault prompt and processing function

Through the software setting, the single-chip microcomputer judges the common faults of the refrigerator and displays it on the display operation panel in the form of the fault code. At the same time, the program runs in the fault processing mode to keep the refrigerator basic functions.

(12) System self-check function

In order to facilitate production inspection and after-sales maintenance, through a specific combination of cases, you can enter the control system self-inspection program. After entering the self-inspection, the refrigerator will operate and display according to a specific process, for the inspection and maintenance personnel as the basis for judgment and reference. The self-check procedure is not open to users. You can refer to the maintenance manual to understand the entry method and the operation process after entry.

2. Circuit control principle of refrigerator intelligent control system unit

The refrigerator intelligent control system is composed of a power failure 3Min detection circuit, a sensor input circuit, a relay drive circuit, a backlight circuit, and a buzzer circuit.

(1) Power-off 3Min detection circuit

The 3min power-off detection circuit is used to delay the start of the compressor when the power is off for less than 3min, so as to avoid excessive compressor starting load and achieve the purpose of protecting the compressor.

The circuit realizes this function by charging and discharging the capacitor, as shown in Figure 4-56. When energized, 5V charges the capacitor C1 through the resistor R1 and the resistor R2 at the same time; after the power is off, the capacitor discharges through the resistor R1, because the charging resistance is much smaller than the discharge resistance. So charging is fast and discharging is slow.

Each time the power is turned on, the single-chip computer detects the voltage on the capacitor. If the power-off time is too short, the single-chip detects the high level, and adds the compressor delay start condition in the control program. Conversely, when the single-chip microcomputer detects a low level, the program will start immediately as long as the compressor start-up conditions are met (the 3min delay time is not very accurate, and it is acceptable within the range of 2~5min).

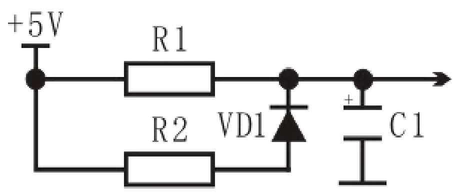


Figure 4-56 Detection circuit of 3min power failure

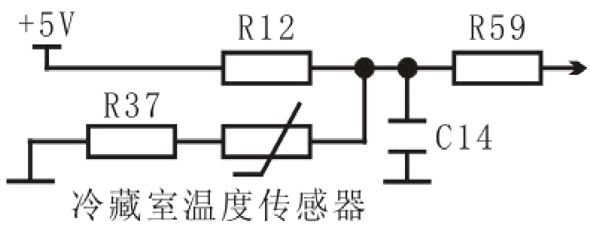


Figure 4-57 Sensor input circuit of refrigerator compartment

(2) Sensor input circuit

The function of the sensor input circuit is to convert the change in the resistance of the sensor into a voltage signal. Take the sensor input circuit of the refrigerator compartment as an example, as shown in Figure 4-57. Resistor R12 and the temperature sensor of the refrigerating room form a voltage divider circuit. Resistor R59 is an input resistor to protect the input circuit of the microcontroller chip. The capacitor is used to filter out some spike interference signals and avoid sampling errors.

(3) Relay drive circuit

The relay drive circuit is shown in Figure 4-58. Now take the compressor relay as an example. When the compressor needs to run, the pin of the single-chip microcomputer outputs a high level, and the transistor is turned on through the current-limiting resistor R43, the coil of the relay RY01 is energized, the contact of the relay is closed, the compressor is powered on, and the compressor starts to run. The resistors R43 and R41 form a voltage divider protection circuit to prevent the triode from being broken down. The diode VD11 plays a freewheeling function in the circuit to prevent the relay coil from generating high voltage and damaging the components in the circuit when the power is off.

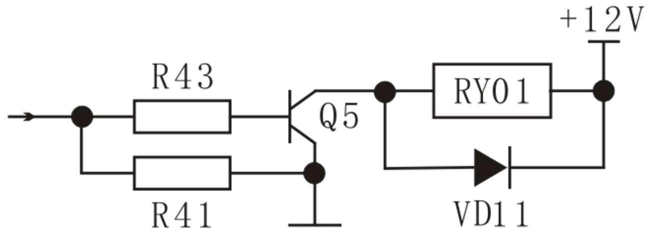


Figure 4-58 Relay drive circuit

(4) Backlight driving circuit

The backlight drive circuit is shown in Figure 4-59. When the display screen needs to be bright, the single-chip microcomputer pin outputs high level, the transistor is turned on, and the backlight source is lit. The backlight is composed of LED light-emitting diodes in series.

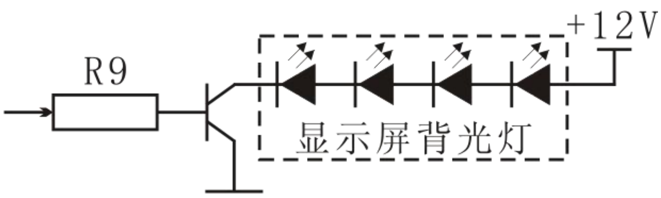


Figure 4-59 Backlight source drive circuit

(5) Buzzer drive circuit

The buzzer drive circuit, as shown in Figure 4-60, has the same control principle as that of the backlight drive circuit.

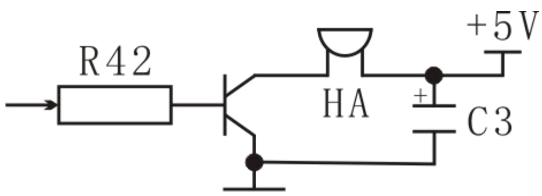


Figure 4-60 Buzzer drive circuit

Function description of discrete circuit of intelligent temperature control refrigerator circuit board

1. Power supply overvoltage protection circuit. When the power supply voltage is too high, the fuse on the circuit board is activated to avoid damage to other important components on the circuit board.

2. Power conversion circuit. Provide 5V and 12V DC power supply for the control system.

3. Crystal oscillator circuit. Generate high frequency oscillation to provide standard clock for single chip microcomputer.

4. Reset circuit. The control system is cleared when the power is on to improve the stability and reliability of the control system.

5. Power-off memory storage circuit. The memory with power-off memory function can memorize the user's set value and some operating process parameters, and realize the operation of automatically returning to the original set function after power-on.

6. Power phase detection circuit. Provide power phase reference signal for bistable drive.

7. Display circuit. Display the operating status of the refrigerator.

8. Buzzer circuit. Buzzer sounds when carrying out case operations or prompts or alarms.

9. Button circuit. The user performs setting adjustment operations.

10. Backlight circuit. LCD backlighting.

11. Refrigerator door switch detection circuit. The light is on when the refrigerator door is opened, and the door is not closed for a long time to give a sound reminder.

12. Freezer door switch detection circuit. The fan motor is stopped when the freezer is opened and closed to prevent the cold air from escaping.

13. Compartment temperature detection circuit. Detect the temperature in the refrigerator compartment and the freezer compartment, and control the operation of the compressor and fan motor.

14. Refrigerator evaporator temperature detection circuit. By detecting the temperature of the refrigerator compartment evaporator, it is judged whether the defrosting of the refrigerator compartment has been completed.

15. Freezer compartment evaporator temperature detection circuit. By detecting the temperature of the freezer compartment evaporator, it is judged whether the freezer compartment

defrosting has been completed.

16. Compressor and its drive circuit. The weak current output of the single-chip microcomputer drives the relay through signal amplification, and then realizes the control of the compressor on and off, achieving the purpose of temperature control.

17. Defrost heating and its drive circuit. The on-off of the defrost heater is controlled by a relay to realize the function of automatic defrost.

18. Connect the water tank heater and its driving circuit. The on-off of the water tank heater is controlled by a relay, and the power is cut off later than the defrosting heater during the defrosting process to ensure the outflow of frost water.

19. Lighting lamp and its driving circuit. The lighting is controlled by the relay to realize the lighting when the refrigerator door is opened.

20. Fan motor and its drive circuit. The operation of the fan motor is controlled by the relay, and the cold air on the freezer compartment evaporator is distributed to the compartment by the air duct to realize the control function.

21. Drive circuit. The strong and weak isolation is realized through the photoelectric coupler, and the thyristor is driven to control the bistable conversion, that is, the conversion between the refrigeration refrigeration cycle and the refrigeration refrigeration cycle.

Task 3 Air conditioner electrical wiring connection

一. Task description

The connection of the electrical circuit of the air conditioner is to use wires to connect the air conditioning refrigeration system and the air conditioning controller to form a complete heat pump air conditioning electrical system. This task mainly introduces the main functions of the air conditioner electrical control system, the circuit control principle of the air conditioner electrical control system unit, and the electrical connection operation of the air conditioner.

二. Related knowledge

1. The composition of the air conditioner control section

The application of microcomputer in the air conditioner makes the air conditioner more automatic control and develops towards the direction of intelligent control. Microcomputer for air conditioner is mainly composed of the following parts:

(1) Input part

This part accepts external signals or instructions. There are two main types: one is an operation instruction signal, which is input by a human operating panel control switch or a remote control button; the other is an instruction conversion signal, which is provided by an input detection device. These detection devices are various switches, thermistors, and thermal relays in the air conditioner. Command conversion signal, commonly used photoelectric coupler, A/D converter is input to the microcomputer chip (ie single chip).

(2) Output part

This part sends out the results of the microcomputer processing. The output end of the microcomputer chip is often a Darlington tube or an in-phase or inverted integrated circuit driver. The microcomputer chip is powered by a DC stabilized power supply, and its clock circuit is generally a crystal oscillator or an RC oscillator.

(3) Memory part

There are two parts: internal memory and external memory. The internal memory is the body of the integrated circuit (IC), and the external memory is equivalent to a memo notebook, which can record and store the numerical value of the calculation object, the result of the calculation, and the calculation program.

(4) Calculation part

This part is the central structure of the microcomputer, which can perform comparison, calculation and processing, and pass the memory part to the control part.

(5) Control part

This part transmits commands and action instructions to output signals after input, output, memory, and calculation. This part is a central processing unit.

The above five parts constitute a microcomputer, and their mutual relations are shown in Figure 4-66.

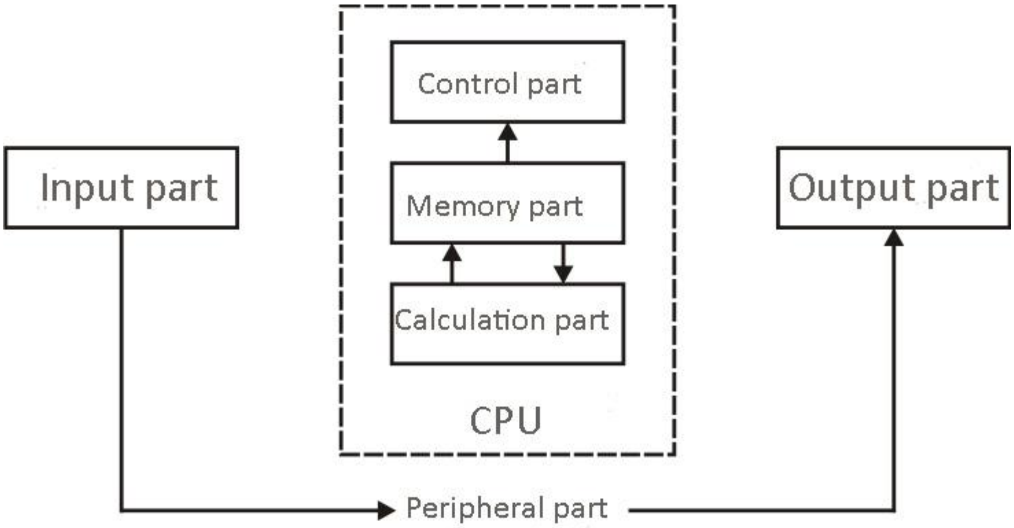


Figure 4-66 The relationship between the various parts of the microcomputer

2. The main control functions of the controller

(1) Automatic control function of cooling and heating constant temperature

This function realizes the automatic control of the indoor temperature through the corresponding cooperation of the temperature sensor and the microcomputer single chip microcomputer, and can also realize cooling or heating at the same time.

(2) Power supply overvoltage, undervoltage and overcurrent protection functions

The normal working voltage of the air conditioner compressor is between 180-245V. If the voltage exceeds the outer range, the microcontroller can take protective measures to stop the compressor and fan motors. The compressor overcurrent protection is detected by a current transformer, and the compressor is automatically shut down through the internal control of the microcontroller.

(3) Compressor 3min delay start protection function

When the compressor stops, the microcontroller will delay the restart of the compressor for 3 minutes to prevent the sudden power failure and the sudden power on again to make the compressor Su Nuai (because the pressure in the system will not be quickly balanced after the compressor is stopped, such as It is easy to damage the compressor if it is turned on immediately after it is stopped).

(4) The refrigeration system pressure is too high or too low protection function

There are system high pressure and low pressure detection switches on the outdoor host pipeline. When the system pipeline pressure is higher or lower than its set pressure, the pressure control switch contacts will be disconnected or connected, and the single-chip control system can make it quickly Disconnect the power supply to protect the compressor.

(5) Fan speed control and automatic control function

During heating or cooling, this function is realized by the indoor pipe temperature sensor detecting the temperature and controlling the speed of the indoor or outdoor fan through the single-chip microcomputer to automatically adjust the speed of the indoor and outdoor fan motor to provide the most suitable operating state.

(6) Auxiliary electric heating function

When the heat pump heating mode is adopted, when the outdoor temperature is lower than -5℃, the heating capacity of the heat pump air conditioner will decrease significantly. Therefore, an auxiliary electric heater must be installed on the indoor unit. When the indoor temperature is 15℃, the single-chip microcomputer will automatically connect Connect the auxiliary electric heater. When the difference between the indoor temperature and the set temperature is more than 8°C, the single-chip microcomputer will automatically turn on the electric heater, so that the indoor temperature can rise as soon as possible. When the difference between the indoor temperature and the set temperature is 4°C and the air outlet of the air conditioner reaches 50°C, the single-chip microcomputer will automatically disconnect the heater power.

(7) Drying and dehumidifying function

Dehumidification can be performed when the room is at high temperature and high humidity (that is, the room temperature is higher than 5°C). When the air conditioner compressor is on and off, the indoor fan motor and low-speed operation make the humidity of the room drop.

(8) Heat discharge function when heating stops

When heating, due to the auxiliary electric heater, the heat of the indoor unit cannot be discharged after the air conditioner is shut down, which easily causes the plastic parts of the air conditioner to be heated and deformed. Therefore, when the air conditioner is required to stop, the indoor fan can automatically delay more than 2 minutes to discharge the heat. This function is automatically controlled by the microcontroller.

(9) Automatic debugging function

This function is used when the air conditioner is installed or repaired, that is, the automatic control of the microcomputer is changed to manual control through the debugging switch, and the air conditioner is working in the cooling state. This function is determined by the inside of the microcomputer.

(10) Over-temperature rise prevention function

In heating operation, when the indoor pipe temperature is above 60℃, this signal is sent to the microcomputer through the indoor pipe temperature resistance, and then the air conditioner compressor is stopped.

(11) The indoor anti-cold wind function during heating

In the heating operation in winter, the cold wind will be blown out in the room for the first time or during defrosting, which makes people feel uncomfortable. Therefore, the anti-cold wind function can be easily achieved by using the software design features of the microcomputer. The fan does not rotate. When the indoor unit pipe temperature rises to a certain value, the indoor fan starts to run.

(12) Automatic defrost function

During hot running, the automatic defrosting function can be realized through microcomputer control. During defrosting, the solenoid four-way valve coil is cut off, the indoor and outdoor fan motors stop running, but the compressor continues to run. When the frost on the outdoor unit radiator goes out, the solenoid four-way valve coil is energized, and the air conditioner continues to heat up. In software design, defrost when the outdoor unit pipe temperature is lower than -4°C and the compressor runs continuously for more than 50 minutes Start; when the outdoor pipe temperature rises to 12℃ or defrosts for more than 10 minutes, the air conditioner defrosting ends.

(13) Automatically run in sleep function

Automatic operation refers to the function of the single-chip microcomputer to automatically determine the operating state of the air conditioner according to the indoor temperature. Such as automatic cooling in summer, automatic heating in winter, control the temperature between 15~30℃. Since the body's metabolism is different during the day and night, the comfortable temperature is also different. The air conditioner automatically adjusts the set temperature after the person falls asleep. During cooling operation, the room temperature is increased by 3°C from the set temperature, and heating in winter can reduce the temperature by 5°C from the set temperature, which can prevent the feeling of overheating or overcooling after falling asleep.

(14) Timing operation function

According to the needs of people's life and work, the single-chip microcomputer can control the air conditioner to start and stop regularly, the control time is 1~1h, and the control function is to start or shut down.

(15) Indoor wind speed automatic control function

According to the difference between the indoor temperature and the set temperature, the indoor fan speed can be changed automatically. When the room temperature differs greatly from the set temperature, the fan speed becomes faster, and when the temperature difference is small, the fan speed becomes lower. The indoor fan speed can also be controlled by the remote control.

(16) LCD display function

This function can display air conditioning customs, operating mode, time, temperature, wind fault code, etc. through light-emitting diodes or liquid crystal displays.

(17) Multi-machine control function

This function uses a computer motherboard to simultaneously control the operation of multiple air conditioners.

The above functions are totally different due to different manufacturers' operating parameters. With the continuous development of science and technology, the application of single-chip microcomputers in air conditioners will be more complete and more reliable.

3. Circuit control principle of air conditioner control system unit

The system uses a dual-sensor microcomputer remote control system. The entire electrical system is composed of a power supply circuit, a single-chip main controller circuit, an infrared receiving circuit, a forced operation circuit, an indicating circuit, a temperature detection circuit, and a driving circuit.

(1) Power supply circuit

The power circuit is composed of AC and DC power supplies. AC power is mainly used for transformers and compressors. Indoor/outdoor air blowers and other executive components provide power; DC power is mainly +5V, +12V, +5V is mainly divided into infrared receiving circuit, single-chip main control circuit and temperature detection circuit to provide power; +12V is mainly driving circuit, step Enter the motor and relay to provide power.

(2) MCU main control circuit

The single-chip microcomputer model used in the main control circuit of the single-chip microcomputer is QDMCU07, and the chip manufacturer is QUNDA.

(3) Infrared receiving circuit

In the infrared receiving circuit, the information sent from the user's remote control is transmitted to the main controller of the single-chip microcomputer through an infrared tube, and the processing and analysis are performed, and corresponding actions are performed.

(4) Forced operation circuit

The forced operation circuit is mainly composed of a button switch and a current-limiting resistor. When the button switch is pressed, the single-chip microcomputer obtains a +5V trigger signal; however, the main controller of the single-chip microcomputer automatically selects the working mode through the corresponding signal obtained by detecting the ambient temperature. The button switch "SB" here is also called "emergency switch", that is, when there is no damage to the remote control, the air conditioning system can be started through its button switch.

(5) Indication circuit

The indicating circuit respectively shows the indicated state of timing, power supply and fault.

(6) Temperature detection circuit

In the temperature detection circuit, the resistance of the thermistor in the system changes linearly with the temperature.

(7) Drive circuit

The driving circuit is mainly based on the Darlington tube ULN2003AG, which reversely drives the control signal output by the single-chip microcomputer to ensure that the weak signal output by the main controller of the single-chip microcomputer can drive its execution period.

4. Solenoid four-way valve

The working principle of the heat pump type air conditioner is basically the same as that of the cold air type air conditioner. The difference is that the heat pump type air conditioner adds an electromagnetic four-way valve (also called a reversing valve), and its appearance structure is shown in Figure 4-70.

Figure 4-70 Outline structure drawing of solenoid four-way valve

When the direction of the electromagnetic four-way valve is changed, the flow direction of the refrigerant in the refrigeration system can be reversed, and the functions of the indoor unit and the outdoor unit can be interchanged. Therefore, when cooling, the working principle of the heat pump type air conditioner is basically the same as that of the cold wind type air conditioner; when heating, the refrigerant flow is reversed, the functions of the indoor unit and the outdoor unit are interchanged, and the refrigerant releases heat in the outdoor unit and is The fan is brought into the room to achieve the purpose of heating.

The fault detection methods of electromagnetic four-way valve include:

① Use a multimeter to measure the resistance value of the solenoid four-way valve coil, which means the coil is short-circuited; if the resistance value is infinite, it means the coil is open.

②The voltage at both ends of the solenoid four-way valve coil of the multimeter is turned on under heating conditions. If the voltage is normal and the solenoid four-way valve does not change direction, it means that the reversing valve is mechanically stuck or the left and right capillaries are blocked; if there is no voltage at both ends , It means that the solenoid control loop of the four-way valve is faulty (main board can be repaired).