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(72) Inventor; and
(71) Applicant : **TURNER, David** [GB/GB]; 27 Greenacres, Read, Burnley Lancashire BB12 7PT (GB).

(74) Agent: **WILSON GUNN (BIRMINGHAM)**; Charles House, 148/9 Great Charles Street, Birmingham West Midlands B3 3HT (GB).

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(54) **Title**: AN IMPROVED TEMPERATURE CONTROL SYSTEM

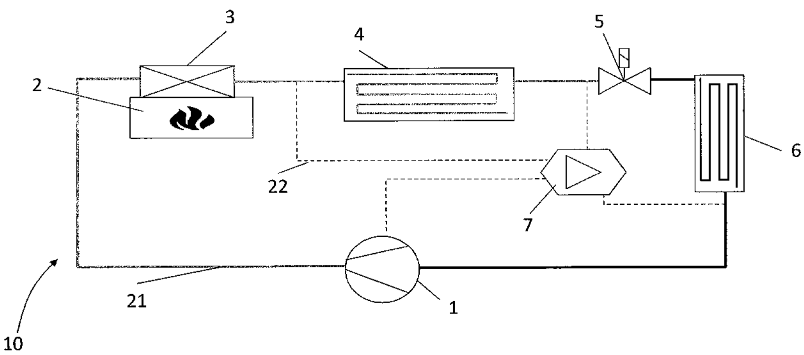

Figure 1

(57) **Abstract**: Temperature control system and method A temperature control system (10) includes a compressor (1), a condenser (4), an expansion valve (5), and an evaporator (60 all connected in series. At least one heat exchanger (3) is located between the compressor and the condenser and operable to transfer heat energy from an external heat source to the refrigerant. In one variant, an array of heat exchangers is located between the compressor and the condenser. In a further variant (210, Fig. 3), there are one or more heat exchangers located between the compressor and the condenser and flow control means to direct the flow of refrigerant either through at least one heat exchanger or directly from the compressor to the condenser bypassing at least one of the heat exchangers. Methods of heating and cooling an environment using the system are also disclosed.

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An Improved Temperature Control System

Technical Field of the Invention

The present invention relates to cooling and heating systems such as air-conditioning units and refrigerators, and in particular, to improvements in cooling and heating systems which operate using a compression cycle.

Background to the Invention

Temperature control systems, such as air-conditioning, cooling and refrigeration systems commonly use a compression cycle to either heat or cool their surroundings through respective cooling or heating of a fluid refrigerant. Generally, the refrigerant fluid is initially a gas which is compressed by a compressor, subsequently liquefied in a condenser and then injected through an expansion valve. The injection of the highly pressurised, liquid refrigerant through the expansion valve allows the refrigerant to expand rapidly. The refrigerant is then passed through an evaporator in which the refrigerant absorbs heat energy from surrounding air or other fluids which are passed about the evaporator thereby cooling them. This process may run in reverse in order to heat surroundings, whereby hot pressurised refrigerant is passed through the evaporator and the surrounding air or fluids passing over the evaporator absorb this heat.

As the refrigerant is preferably a gaseous fluid, its physical state may be approximated using the ideal gas law which states:

$$pV = nRT \qquad [Equation\ 1]$$

where p is the pressure of the gas in Pascals, V is the volume of the gas in m^3, n is the number of molecules of the gas present within the volume V, R is the molar gas constant (approximately equal to 8.31 $m^2\ kg\ s^{-2}\ K^{-1}\ mol^{-1}$) and T is the temperature of the gas in Kelvin.

Essentially, Equation 1 tells us that the product of the pressure of the gas and the volume within which the gas is contained is proportional to the product of the number of molecules of gas present and the temperature of the gas. In effect, in environments wherein the volume remains constant, such as in the refrigerant pipes of a temperature control system, an increase in temperature may have two effects depending on the opening of the subsequent expansion valve. When the valve is closed, no molecules of the gas may leave and both the volume and the pressure of the refrigerant increases. When the expansion valve is opened, the molecules of the gas pass rapidly through the opening of the valve leaving the pressure of the gas virtually unchanged. As the pressure behind the expansion valve is much lower than prior, the gas will have a higher tendency to leave through the opening of the valves instead of building up a pressure ahead of the expansion valve. The effect of heating the gas enhances the number of molecules being pushed through the valve thus creating a higher mass flow at the evaporator, therefore increasing the cooling capacity in the evaporator. The controls of the system react to the increase by reducing the mass flow of the compressor to re-achieve the original targeted cooling capacity. Both effects, the pressure increase and mass flow increase, reduce the electrical consumption of the compressor. The rate of which depends on the very specific situation; if and how much the expansion valve is opened at the operation.

Temperature control units of this type generally require a vast amount of energy to operate and it is therefore desirable to be able to reduce the energy consumption of such systems. The compressor is generally the component which consumes the most energy during operation of a temperature control system. In some cases, the energy consumed by the compressor may account for up to 80% of the total energy used by the system. For this reason, it is highly desirable for the energy consumption of a compressor in these systems to be reduced.

There are a number of known systems targeted at reducing energy consumption and include systems whereby waste heat energy from the system itself is recovered (see in particular DE000019925477A1). The system described in this document involves recovering heat energy from the motor or control unit which is used to heat up the refrigerant at a desired point in the cycle, in particular, before it enters the compressor. Similarly, WO0155647 describes a system whereby a heat exchanger is placed after the compressor to recover heat escaping from the refrigerant pipes, however, the energy recovered from this results in a loss of temperature in the refrigerant itself.

WO2014146498 and DE102007011014A1 both describe systems wherein the refrigerant is heated by an electrical means before it is passed through the compressor. This reduces the work required to be performed by the compressor to compress the refrigerant by a sufficient amount to increase the pressure as desired. However, the reduction in energy consumption of the compressor is not significant in these systems, and they are primarily employed in environments which have a very low ambient temperature where the refrigerant is generally significantly cooler and could thereby damage the compressor in combination with insufficient oil supply.

WO2011048594 A2 describes an air conditioning system having a compressor unit which incorporates a mechanical compressor and a single thermal collector in the form of a solar panel located downstream of the mechanical compressor to increase the temperature of the refrigerant. Incorporation of the thermal collector as part of a compressor unit together with the mechanical compressor limits the size of the thermal collector and is suitable only for smaller air conditioning systems. The arrangement also requires that the thermal collector is located proximal to the compressor and so has limited flexibility. The system has only very limited control over the amount of heat transferred to the refrigerant through the thermal collector. Furthermore, the system works only with a variable speed DC Inverter mechanical compressor and so is unsuitable for use in temperature control systems with fixed speed compressors.

It is therefore an aim of an embodiment or embodiments of the invention to overcome or at least partially mitigate the drawbacks of the prior art by providing a temperature control system which has a significantly reduced electrical consumption, in use.

Summary of the Invention

According to a first aspect of the present invention there is provided a temperature control system comprising: a compressor, a condenser, an expansion valve and an evaporator all connected in series by a plurality of refrigerant pipes; wherein the system further comprises an array of heat exchangers located between the compressor and the condenser operable in use to transfer heat energy from one or more external heat sources to the refrigerant leaving the compressor and before it enters the condenser.

Using heat exchangers to transfer heat energy to the refrigerant after leaving the compressor acts to heat up the refrigerant and in doing so increase the pressure of the refrigerant or increasing the mass flow into the evaporator and by so doing increasing the cooling capacity at the evaporator. As described above, both effects, increasing the pressure of the refrigerant and increasing the mass flow into the evaporator reduce the compression requirement of the compressor and hence reduces the energy consumption of the system as a whole. Providing an array of heat exchangers allows greater control over the extent of heat energy transferred to the refrigerant. This is particularly beneficial where the heat energy supplied by the external heat source cannot be controlled easily, for example where naturally occurring energy sources are used such as solar energy. The array of heat exchangers can be located at point between the compressor and the condenser which allows a greater flexibility in configuring the system. Furthermore, the size of the heat exchangers is not limited, allowing the system to be adapted for use with larger temperature control systems. The system is not limited to use with DC Inverter compressors of the type used in small air conditioner systems but can be adapted for use with fixed or variable speed compressors. This makes the system suitable for use in a wide range of temperature control applications including, but not limited to: air conditioning, chilling and refrigeration.

In some embodiments the temperature control system may additionally comprise one or more flow control members operable in use to direct the flow of the refrigerant such that it is either passed through at least one of the heat exchangers within the array or is passed directly from the compressor to the condenser, bypassing at least one of heat exchangers within the array. In further embodiments, the one or more flow control members are operable in use to direct the flow of refrigerant such that it is either passed through each heat exchanger or is passed directly from the compressor to the condenser, bypassing each heat exchanger. In further embodiments, the flow control members comprise a variable opening, which may or may not fully close, and which vary the flow-rate of the refrigerant. Each flow control member may comprise a valve.

Each heat exchanger may comprise a series of pipes containing a heated fluid (which may be a liquid or gas, and "fluid" hereinafter comprises either or both of a liquid or gas) over which the refrigerant is passed, in use. In this way, as the refrigerant passes over the pipes, heat energy is transferred from the fluid within the pipes of the heat exchanger to the refrigerant causing the refrigerant to heat up. The increase in temperature of the refrigerant causes the pressure to rise or the numbers of molecules to decrease (hence effecting an increase in mass flow means) as per Equation 1, above.

Alternatively, each heat exchanger may comprise a tank containing a heated fluid. In such embodiments, the refrigerant pipes of the system may be configured such that at least a portion of the pipes at the heat exchanger are submerged within that tank. Such embodiments work in a similar manner to that described above, wherein heat energy from the heated fluid within the tank is transferred to the refrigerant flowing through the pipes which are submerged within the tank.

At least two heat exchangers within the array may be located in series. Alternatively, at least two heat exchangers within the array may be located in parallel.

In some embodiments there is provided at least two heat exchangers in parallel and at least one further heat exchanger located in series with at least one of the heat exchangers which are in parallel to form the array of heat exchangers. In this way, by controlling the operation of each of the heat exchangers independently, the rate at which the refrigerant is heated by the heat exchangers in use may be varied.

In some embodiments each of the heat exchangers may be operable to transfer heat energy from a single heat source to the refrigerant. Alternatively, there may be provided a plurality of heat sources. In such embodiments, there may be provided a heat exchanger for each individual heat source. Alternatively, each heat source may act upon more than one heat exchanger.

The heat exchangers within the array may comprise one or more solar panels operable in use to use heat energy from sunlight to increase the temperature of a fluid within the panel, this heated fluid then acting as the heat exchanger to subsequently heat refrigerant passing through each exchanger. The solar panel may comprise a flat plate collector, for example, having a series of flow tubes through which the fluid flows or is located in a tank located underneath a collector plate which absorbs the heat energy from the sunlight.

Alternatively, the heat source may be any other external source able to heat up a fluid within each heat exchanger. In some embodiments, the heat source may provide heat energy through a combustion process. In such embodiments, the combustion process may give off hot gases which may be used to either directly or indirectly heat the refrigerant within the refrigerant pipes. In further embodiments the heat source may provide heat energy through a chemical process, such as an exothermic chemical reaction. Again, the chemical process may give off hot gases used to heat the refrigerant within the refrigerant pipes. In some embodiments the heat source may comprise a series of fuel cells and may heat the refrigerant through electrical heating. Alternatively, the heat source may be waste heat from one or more of the components of the system, which may be initially stored by the heat source, or may be used directly as it is produced by the system, in use. A further heat source may be water or other liquids heated up by solar thermal panels in a separate circuit, which may pass through the heat exchangers to heat up the refrigerant. This circuit may also contain a hot water storage tank which would allow the use of solar heat also in the absence of sunlight.

In some embodiments the compressor may comprise a first compressor and the system may additionally comprise one or more further compressors. Any further compressor may be located in series with the first compressor. Alternatively, each further compressor may be located in parallel with the first compressor. In some embodiments there is provided at least one further compressor in parallel with the first compressor and at least one further compressor located in series with the first compressor such that there is provided an array of compressors. In this way, by controlling the operation of each of the first compressor and the one or more further compressors, the rate at which the refrigerant is compressed in use may be varied.

In other embodiments, the rate at which the first compressor runs may be variable, removing the requirement to have one or more further compressors to vary the rate of compression of the refrigerant in use. However, in some embodiments it may still be desirable to have one or more further compressors in addition to the variable rate first compressor.

In some embodiments the system may comprise a plurality of evaporators. In use, the evaporators may be physically spaced apart so as to act to either cool or heat various different areas within an environment to be cooled/heated. In such embodiments, the system may additionally comprise a distributor operable to separate the refrigerant flow into a plurality of separate flows, at least one to each of the plurality of evaporators. The distributor may be placed directly after the condenser. In such embodiments, there may be provided an expansion valve for each of the evaporators. The system may additionally comprise a collector, operable in use to combine the plurality of separate flows from each of the evaporators back into a single main refrigerant flow.

In some embodiments the system may comprise a number of refrigerant pipes through which the refrigerant may flow, in use. At least two of the plurality of refrigerant pipes may be placed in parallel with each other in the system. In this way, the overall resistance within the system, or the resistance to the flow of the refrigerant around the system, or at least through the portion of the system comprising the parallel refrigerant pipes, is reduced as the effective heat transfer surface of the system is increased.

In some embodiments the system may comprise one or more valves. The one or more valves may be operable to control the flow of the refrigerant through the system, in use. In some embodiments at least one of the one or more valves may comprise a one-way valve. The/each one way valve may be operable in use to prevent refrigerant from flowing in an undesired direction. In some embodiments at least one of the one or more valves may comprise a stop valve. The/each stop valve may be operable in use to control the flow of refrigerant through the system in the desired direction. Such control may comprise controlling which components the refrigerant flows through and the flow rate at any given time. This may be desirable in embodiments wherein there is provided an array of compressors and it is required to control the compression rate of the refrigerant. Similarly, this may be desirable to control which of the heat exchangers the refrigerant is passed to control the extent to which the compressed refrigerant is heated.

In some embodiments at least one of the one or more valves comprises a security valve. The/each security valve may be operable in use to direct refrigerant within a given refrigerant pipe away from said pipe. In use, this may be desirable to ensure that there are no unwanted build-ups of pressure within a refrigerant pipe which may lead to the pipes becoming damaged or, in the worst case, rupturing. The/each security valve may be located after the heat exchanger array to prevent over pressurised refrigerant from the heat exchangers passing through the condenser and/or evaporator(s) and potentially causing damage thereto.

In some embodiments the temperature control system is operable in use to act as a cooling system, cooling the environment in which it is positioned. For example, the temperature control system may form part of a refrigerator or air-conditioning unit. Alternatively, the temperature control system is operable in use to act as a heating system, heating the environment in which it is positioned. For example, the temperature control system may form part of a heater, such as a convection heater.

In some embodiments the temperature control system may act as both a cooling system and a heating system at different times. For example, the temperature control system may form part of an air-conditioning unit or climate control unit which is operable in use to either heat or cool the environment in which it is placed to a pre-determined level. To allow for this, the system may comprise a four-way-valve operable in use to direct the flow of the refrigerant around the system in either of a first direction or a second direction. The first direction may comprise a cooling direction in which the refrigerant flows from the compressor, to the heat exchanger, to the condenser, through the expansion valve, on to the evaporator and back to the compressor. The second direction may comprise a cooling direction in which the refrigerant flows from the compressor, to the heat exchanger, to the evaporator, then through the expansion valve, on to the condenser and finally back to the compressor.

The system may additionally comprise a control unit. The control unit may be operable in use to control the operation of one or more of the components of the system, including the compressor, each heat exchanger, the condenser, the expansion valve and/or the evaporator. In relevant embodiments, the control unit may additionally or alternatively be operable to control the operation of the one or more further compressors, any of the plurality of evaporators and/or the operation of any of the one or more valves. For example, the control unit may control the rate at which the compressor acts to compress the refrigerant, and/or may control the flow of the refrigerant through the valves to each component.

In some embodiments, the system additionally comprises one or more sensors located within the refrigerant flow. The one or more sensors may be operable in use to monitor one or more parameters of the refrigerant, such as its temperature and/or pressure, at a certain point within the system. In some embodiments the sensors may be connected to the control unit. In such embodiments, the control unit may be operable to control the operation of one or more of the components of the system in response to the values of the parameters measured by the one or more sensors.

In some embodiments the system may be configured to prevent desegregation of the dispensed oil at unfavourable locations, and which may therefore cause a lack of oil supply to the compressor. For example, in embodiments in which each heat exchanger comprises U-pipes or conduits, each of the refrigerant pipes may be positioned such that the U-pipes in the heat exchangers are placed in an upper region so the oil may not desegregate and as such accumulate therein, which may cause blocking the pipe against the refrigerant to flow through. Additionally the pipes to and from the U-pipes may extend downwardly, such that oil may flow down by gravity and be collected in containers, from where it may be transported to the compressor.-

The system may additionally comprise a means to segregate and/or dispense oil or other liquid components to the refrigerant. It may be necessary to make sure that enough oil is provided to the compressor and not retained in other locations in the overall pipework to ensure that each component of the system is operating correctly. For example, the oil or other fluid may be required by the compressor to lubricate the compressor, but not in the pipework and/or U-bends of the heat exchanger. The segregation process means this may comprise a separator for segregation and/or a trap for collecting the oil or fluid. In some embodiments, the separator and trap may be located ahead of the heat exchanger array or in it. In this way, the system ensures that the oil is recovered before it flows through the heat exchanger where it would not be wanted and then would be returned to the compressor.

According to a second aspect of the present invention there is provided a temperature control system comprising: a compressor, a condenser, an expansion valve and an evaporator, all connected in series by a plurality of refrigerant pipes; one or more heat exchangers located between the compressor and the condenser operable in use to transfer heat energy from one or more external heat sources to the refrigerant leaving the compressor and before it enters the condenser; and one or more flow control members operable in use to direct the flow of the refrigerant such that it is either passed through at least one of the one or more heat exchangers or is passed directly from the compressor to the condenser, bypassing at least one of the one or more heat exchangers.

In some embodiments the refrigerant may be passed at a full rate through at least one of the, or each, heat exchanger.

In some embodiments the refrigerant may be passed at a variable rate through at least one of the, or each, heat exchanger.

In some embodiments the system comprises a single heat exchanger. In such embodiments the one or more flow control members may be operable in use to direct the flow of the refrigerant such that it is either passed through the single heat exchanger or is passed directly from the compressor to the condenser, bypassing the single heat exchanger.

The second aspect of the present invention incorporates any or all of the features of the first aspect of the invention as is desired or appropriate. For example, in some embodiments, the temperature control system of the second aspect of the invention may comprise an array of heat exchangers. The array of heat exchangers may comprise any or all of the features of the array of heat exchangers of the first aspect of the invention. Similarly, in some embodiments the one or more flow control members of the system of the second aspect of the invention may comprise any or all of the features of the one or more flow control members of the first aspect of the invention.

In some embodiments the temperature control system may act as both a cooling system and a heating system at different times. To allow for this, the system may comprise a four-way-valve operable in use to direct the flow of the refrigerant around the system in either of a first direction or a second direction. The first direction may comprise a cooling direction in which the refrigerant flows from the compressor, to the heat exchanger, to the condenser, through the expansion valve, on to the evaporator and back to the compressor. The second direction may comprise a cooling direction in which the refrigerant flows from the compressor, to the heat exchanger, to the evaporator, then through the expansion valve, on to the condenser and finally back to the compressor.

In embodiments wherein the temperature control system may act as both a heating and cooling system, the one or more flow control members may be operable in use to direct the flow of the refrigerant such that it is passed through at least one of the one or more heat exchangers when the system is used as a cooling system. On the other hand, where the system is used as a heating system, the one or more flow control members may be operable in use to direct the flow of the refrigerant such that it is either passed through at least one of the one or more heat exchangers or is passed directly from the compressor to the condenser, bypassing at least one of the one or more heat exchangers.

According to a third aspect of the present invention there is provided a method of cooling an environment using a system in accordance with the first or second aspect of the present invention comprising the steps of:

(a) using the compressor to compress or heat a refrigerant;
(b) increasing the temperature of the compressed refrigerant by passing the refrigerant through one or more heat exchangers which transfer heat energy to the refrigerant from one or more external heat sources;
(c) condensing the heated refrigerant by passing the refrigerant through a condenser; and
(d) evaporating the condensed refrigerant by passing the refrigerant through an evaporator;

wherein evaporating the condensed refrigerant comprises passing air, gas or another fluid from the environment over the evaporator to transfer heat energy within the fluid to the condensed refrigerant thereby reducing the temperature of the fluid passed over the evaporator which is subsequently supplied back to the environment to be cooled.

According to a fourth aspect of the present invention there is provided a method of heating an environment using a system in accordance with the first or second aspect of the present invention comprising the steps of:

(a) using the compressor to compress or heat a refrigerant;

(b) increasing the temperature of the compressed refrigerant by passing the refrigerant through one or more heat exchangers which transfer heat energy to the refrigerant from one or more external heat sources;

(c) passing the heated refrigerant through an evaporator; and

(d) condensing the refrigerant leaving the evaporator by passing the refrigerant through a condenser;

wherein passing the heated refrigerant through the evaporator further comprises passing air or another fluid from the environment over the evaporator to transfer heat energy within the refrigerant to the fluid refrigerant thereby increasing the temperature of the fluid passed over the evaporator which is subsequently supplied back to the environment to be heated.

The method of the third or fourth aspects of the present invention may comprise passing the refrigerant over one or more heat exchangers which comprise a series of pipes having a heated fluid located therein. Alternatively, either method may comprise passing the refrigerant through one or more heat exchangers which comprise a tank containing a heated fluid. In both cases, heat energy from the heated fluid is transferred to the refrigerant.

Either method may comprise controlling the operation of the/each heat exchanger independently. In this way, the rate at which the refrigerant is heated by the heat exchanger/s may be varied.

In embodiments of either method the refrigerant may be heated using a heat source which provides heat energy through a combustion process. In such embodiments, the combustion process may give off hot gases which may be used to either directly or indirectly heat the refrigerant within the refrigerant pipes. In further embodiments the refrigerant may be heated using a heat source which provides heat energy through a chemical process, such as an exothermic chemical reaction. Again, the chemical process may give off hot gases used to heat the refrigerant within the refrigerant pipes. In some embodiments the heat source may comprise a series of fuel cells and the refrigerant may be heated through electrical heating. Alternatively, the refrigerant may be heated using a heat source which provides heat energy from waste heat from one or more of the components of the system, which may be initially stored by the heat source, or may be used directly as it is produced by the system. A further heat source may be water or other liquids which may be heated by solar thermal panels in a separate circuit, which is passed through the heat exchangers to heat up the refrigerant. This circuit may also contain a hot water storage tank which would allow the use of solar heat in the absence of sunlight.

The method of the third or fourth aspect of the invention may be performed using a system comprising a plurality of compressors, the method comprising independently controlling the operation of each of the compressors. In this way, the rate at which the refrigerant is compressed in use may be varied. In other embodiments, such as those wherein the system comprises only a single compressor, the method may comprise varying the rate at which the single compressor runs.

The method of the third or fourth aspects of the present invention may comprise controlling the temperature at more than one location within an environment. In such embodiments the method may be performed using a system comprising a plurality of evaporators.

The method of the third or fourth aspect of the invention may comprise using one or more valves to control the flow of the refrigerant through the system. In some embodiments at least one of the one or more valves may comprise a one-way valve, or may comprise a stop valve, for example. In such embodiments, the method may comprise controlling which components the refrigerant flows through at any given time. This may be desirable in embodiments wherein there is provided an array of compressors and it is required to control the compression rate of the refrigerant. Similarly, this may be desirable to control which of the one or more heat exchangers the refrigerant is passed through to control the extent to which the compressed refrigerant is heated.

In some embodiments of the third or fourth aspects of the invention, the method comprises using a security valve to direct refrigerant within a given refrigerant pipe away from said pipe. This may be desirable to ensure that there are no unwanted build-ups of pressure within a refrigerant pipe which may lead to the pipes becoming damaged or, in the worst case, rupturing. In some embodiments, the method may comprise using a security valve to prevent over pressurised refrigerant from at least one of the one or more heat exchangers passing through the condenser and/or evaporator/s and potentially causing damage thereto.

The method of either of the third or fourth aspects of the invention may comprise using a control unit to control the operation of one or more of the components of the system, including the compressor, the/each heat exchanger, the condenser, the expansion valve and/or the evaporator. In relevant embodiments, the method may also comprise using a control unit, either additionally or alternatively, to control the operation of the one or more further compressors, any of the plurality of evaporators and/or the operation of any of the one or more valves. For example, the method may comprise using the control unit to control the rate at which the compressor acts to compress the refrigerant, and/or control the flow of the refrigerant through the valves to each component.

In some embodiments of the third or fourth aspects of the invention the method may comprise monitoring one or more parameters of the refrigerant, such as its temperature and/or pressure. In such embodiments, the method may comprise using one or more sensors located within the refrigerant flow to monitor said parameters. In some embodiments, the operation of one or more of the components of the system in response to the values of the parameters measured by the one or more sensors. The method may comprise using a control system in communication with the sensor/s to monitor and subsequently control the operation of the system.

The methods of the third or fourth aspects of the invention may comprise segregating oil or other fluids from, or dispensing oil or other fluids to, the refrigerant. It may be necessary to segregate oil or other fluids from the refrigerant at specific locations to prevent them travelling to unfavourable locations within the circuit to ensure that each component of the system is operating correctly and the oil is returned to the compressor in sufficient amounts to ensure its sufficient lubrication.

According to a further aspect of the invention, there is provided a temperature control system comprising: a compressor, a condenser, an expansion valve and an evaporator all connected in series by a plurality of refrigerant pipes; wherein the system further comprises a plurality of heat exchangers operable in use to transfer heat energy from external heat sources to the refrigerant, wherein at least two of the heat exchangers are configured to transfer heat energy from different external heat sources.

In an embodiment, at least one of the heat exchangers is located between the compressor and the condenser to transfer heat from an external heat source into the refrigerant leaving the compressor and before it enters the condenser. In an embodiment, all of the heat exchangers are located between the compressor and the condenser to transfer heat from external heat sources into the refrigerant leaving the compressor and before it enters the condenser, in which case, the heat exchangers may be arranged in an array.

The external heat sources may comprise any two or more of the following: solar energy, combustion processes, chemical processes, electrical heaters, fuel cells, geothermal energy, waste heat from one or more of the components of the system.

According to a still further aspect of the invention, there is provided a temperature control system comprising: a compressor, a condenser, an expansion valve and an evaporator all connected in series by a plurality of refrigerant pipes; wherein the compressor includes a first compressor and one or more further compressors. The/each further compressor may be located in series with the first compressor, or may be located in parallel with the first compressor. In an embodiment, at least one further compressor is connected in parallel with the first compressor and at least one further compressor is connected in series with the first compressor such that there is provided an array of compressors. The rate at which each compressor runs may be variable. In an embodiment, operation of all the compressors is controlled by a single control unit.

According to a yet further aspect of the invention, there is provided a temperature control system comprising: a compressor, a condenser, an expansion valve and an evaporator all connected in series by a plurality of refrigerant pipes; wherein the system comprises a means to segregate oil or other added components from the refrigerant to collect and supply it to other desired locations at the circuit. In an embodiment, the segregation means comprises a separator and/or an oil-trap which may be located ahead of the one or more heat exchangers or after the one or more heat exchangers or within the heat exchangers. The separator and/or the oil trap may be connected to the compressor by an oil supply line. Where an oil trap is present, it may be a U-bend in the refrigerant pipeline.

Detailed Description of the Invention

In order for the invention to be more clearly understood, embodiments thereof will now be described, by way of example only, with reference to the accompanying drawings, of which:

Figure 1 is a schematic view of a temperature control system.

Figure 2 is a schematic view of an embodiment of a temperature control system of the present invention.

Figure 3 is a schematic view of a second embodiment of a temperature control system of the present invention.

Figure 4 is a schematic view of a third embodiment of a temperature control system of the present invention.

Figure 5 is a perspective view of an embodiment of a heat exchanger for use in a temperature control system in accordance with the present invention.

Figure 6A is a perspective view of a heat source for use in a temperature control system of the present invention.

Figure 6B is a further perspective view of the heat source shown in Figure 6A.

Figure 7 is a schematic view of a fourth embodiment of a temperature control system of the present invention.

Figure 8 is a schematic view of a fifth embodiment of a temperature control system of the present invention.

Figure 9 is a schematic view of a sixth embodiment of a temperature control system of the present invention.

Figure 10 is a schematic view of a seventh embodiment of a temperature control system of the present invention.

Figure 11 is a schematic view of an eighth embodiment of a temperature control system of the present invention.

Figure 1 illustrates a temperature control system 10. The system 10 includes a compressor 1, a condenser 4, an expansion valve 5 and an evaporator 6, each connected by a number of refrigerant lines 21 to form a compression circle. The system 10 additionally includes a heat exchanger 3 located within the circle between the compressor 1 and the condenser 4. The heat exchanger 3 is operable to obtain heat energy from an external heat source, references as heat source 2 on Figure 1. To control the operation of the system 10, the system also includes a control unit 7 which is electrically connected to each of the components of the compression circle via signal lines 22 to control the operation of the components in use.

In use, the compressor 1 acts to compress a refrigerant, which may be any fluid and most preferably a gas, as it passes there-through and discharges it through the refrigerant pipes to the heat exchanger 3. The heat exchanger 3 transfers heat which is obtained through interaction with the heat source 2 with the refrigerant, resulting in the refrigerant increasing in temperature. The heated refrigerant is then passed through the condenser 4 and subsequently through the expansion valve 5 and towards the evaporator 6. When passing through the expansion valve 5 the refrigerant expands and in doing so cools down rapidly. The cool refrigerant is then passed through the evaporator 6 where it is heated by absorbing heat energy from the surroundings of the evaporator 6. As the refrigerant is heated in this manner, the temperature of the surroundings reduces. The heated refrigerant is then passed back through the compressor 1 to restart the process.

As the refrigerant is preferably a gaseous fluid, its physical state may be approximated using the ideal gas law (see above for detail) which states that the product of the pressure of the gas and the volume within which the gas is contained is proportional to the product of the number of molecules of gas present and the temperature of the gas. In effect, in environments wherein the volume remains constant, such as in the refrigerant pipes of a temperature control system, an increase in temperature may have two positive effects depending on the opening of the subsequent expansion valve.

The temperature control system 10 makes use of this fact by utilising a heat exchanger 3 and an external heat source 2 to heat the refrigerant further after the refrigerant has been passed through the compressor 1. By increasing the temperature of the refrigerant in this way, and approximating both the volume and the number of molecules of gas present within the volume to be roughly constant, because the expansion valve is closed, an increase in temperature leads to an increase in pressure also. The desired pressure is usually achieved in prior art systems through the compressor 1 alone, however, by additionally heating the refrigerant as in the present invention, you can achieve the desired pressure without the need for the compressor to perform all of the work. When the expansion valve is opened, the molecules of the heated gas will have a much higher tendency to pass through the expansion valve, because there is a very large pressure difference between before and after the expansion valve, as to build up additional pressure. This increased mass flow means that more refrigerant molecules are now in the evaporator as without the heating effect and so causing a higher cooling capacity in the evaporator. The control of the overall air conditioner reacts to the increase by reducing the mass flow of the compressor to re-achieve the original targeted cooling capacity. Both effects, the pressure increase and mass flow increase, reduce the electrical consumption of the compressor. The rate of which depends on the very specific situation, if and how much the expansion valve is opened at the operation of which changes within seconds. Therefore, by employing a heat exchanger 3 in this way, the efficiency of the compression process of the compression circle is increased as the compressor now requires less energy to provide the same cooling capacity as in systems wherein there is no heat exchanger provided.

Many different types of heat sources 2 may be used. For example, the heat source 2 may comprise one or more combustion engines, chemical processes, electrical heaters, fuel cells, or solar thermal heat sources like solar thermal panels. In the embodiment illustrated in Figure 6A, the heat source 502 comprises a series of vacuum glass tubes 501, whereas in the embodiment shown in Figure 6B the heat source 502 comprises a flat glass pane 511 having an absorption layer 522 underneath and above a series of pipes. In both instances, the heat sources 502 are operable to absorb heat from solar radiation. This heat is transferred to a fluid running through or sitting in the glass tubes 502 or the pipes 522 and is used to increase the temperature of the refrigerant by passing the heat from the fluid over/around the pipes in a the heat exchanger 533 through which the refrigerant flows.

The heat exchanger 3 as shown in Figure 1 must be dimensioned large enough to be effective, but not too large to harm the performance and/or components of the control system 10. The total amount of heat transferred by a heat exchanger to the refrigerant is defined by the size of the exchanger, but also by the number of heat exchangers used. Therefore, the temperature control system in accordance with some embodiments of the present invention employs an array of heat exchangers. Increasing the number of heat exchangers increases the heating capacity of the system but also provides greater control over the extent to which the refrigerant is heated, in use. In further embodiments, the system of the present invention may employ one or more heat exchangers, or an array of heat exchangers, and a means to control through which of the one or more heat exchangers present in the system the refrigerant is passed. This again provides greater control over the heating of the compressed refrigerant in use. Such systems are described in detail below.

Such an embodiment of a temperature control system 210 of the present invention, wherein a heat exchanger array 203 comprising a series of heat exchangers 233 is used, is shown in Figure 3. The system 210 illustrated in Figure 3 comprises a series of heat exchangers 233 connected by various refrigerant lines 212, 218, defined as pipework 211 in the drawing. The pipework 211 also includes a series of one-way valves 213 located after each heat exchanger 233 within the array 203 to prevent back-flow of refrigerant through the system 210. A similar one-way-valve 213 may be located before the array 203 to perform a similar function. In addition, the system 210 further includes a series of electronically activated valves 202 located immediately before each of the heat exchangers 233 within the heat exchanger array 203. The operation of the valves 202 is controlled by a control unit 260. In this way, the heat transferred to the refrigerant may be controlled in a variable way. Additional heat exchangers 240 may also be employed, as shown in Figure 3, downstream of the one-way valves 213. The system 210 shown in Figure 3 illustrates one example of a heat exchanger array 203. However, it should be understood that many different configurations of the array are possible and it is not limited to the configuration shown in this Figure.

Figure 2 shows a variant of the preceding systems 10, 210 shown in Figure 1. In particular, the system 110 shown in Figure 2 employs a series of compressors 101, the operation of which is controlled by a single control unit 107. Employing a series of compressors 101 in this way increases the compression effect on the refrigerant further.

Figure 4 shows part of a further embodiment of a temperature control system 310 of the invention which also includes a heat exchanger array 303 having multiple heat exchangers 333. In addition, the pipework 311 pipework and heat exchangers 333 are constructed in such a way that oil and other liquid components may be segregated from the refrigerant as desired. Such components may be then transported to the desired locations to increase the durability of components and pipework 311. To enable this, the illustrated embodiment includes an oil separator 343 which is connected to both the refrigerant line 322 and also via an oil supply line 352 to the compressor 301. Similarly, the refrigerant line 312 is configured at a point downstream of the heat exchanger array 303 to include an oil trap 351. This may be formed as a U-bend in the refrigerant line 312 to segregate and accumulate oil from within the refrigerant line 322. The oil trap 351 may also be connected to the compressor 301 as shown.

Figures 3 and 4 also illustrate a further feature of the present invention. In particular, the systems 210, 310 shown in these Figures include respective refrigerant lines 218, 318 which bypass one or more heat exchangers 233, 333 within the heat exchanger array 203, 303. In use, it may be desirable for the refrigerant within the systems 210, 310 not to pass through a heat exchanger 233, 333, but rather pass directly to the condenser after compression. Such cases may be desirable where heating of the compressed refrigerant is not required or not desired. The electronically activated valves 202, 302 shown in these Figures may in some embodiments form the flow control members of an aspect of the invention. The valves 202, 302 may be switched to either allow the refrigerant to pass fully or at variable rate through at least one of the one or more heat exchangers and/or allow the refrigerant to be passed directly from the compressor to the condenser, bypassing at least one of the one or more heat exchangers.

It should be understood that, although illustrated as comprising a plurality of heat exchangers, the system of the present invention also includes embodiments wherein there is provided a single heat exchanger and a means to bypass the sole heat exchanger.

An embodiment of a heat exchanger 433 is shown in Figure 5 and may be used in a temperature control system such as that shown in Figure 4 which includes additional means to segregate oil and other liquids from within the refrigerant pipes preventing an accumulation at undesired places and supplying it to the desired locations in the pipework. The heat exchanger 433 includes manifolds 421, 423 and one or more U-bends 425 in its refrigerant pipes 422. The pipes 422 may be configured in this way to provide the maximum length of pipe 422 in the smallest space possible.

In use, the heat exchanger 433 may be positioned so that the U-bends 425 are placed higher than the manifolds 421, 423. This is particularly advantageous when the heat exchanger is used in a temperature control system such as that shown in Figure 4 which includes additional means to return oil and other liquids from within the refrigerant pipes. By positioning the pipes 422 in this manner, it allows oil and other liquids within the refrigerant to flow back from the U-bends 425 into the manifolds 421, 423 and then onward to the designated components in the cooling circle. In this way, the oil or other liquid is prevented from blocking the mass flow in the U-bends and flowing back in the above described manner to be collected and transported to the other desired locations in the pipework.

Further embodiments of the temperature control system of the present invention are shown in Figures 7 to 11. Each of the systems illustrated in these figures operate in a substantially similar way however the differences, and the operational effect of these differences, are described in detail below. The systems also contain certain components which are common to all of the systems and so like reference numerals have been used to identify like components in each system. In the Figures, the array of heat exchangers is depicted by a single component, however, it should be understood that the single component is intended to be a heat exchanger array as in the above illustrated embodiments of the present invention.

The temperature control system 610 illustrated in Figure 7 further includes a security valve 624 being connected to the manifold of a heat exchanger array 603. The valve 624 is connected to a relief pipe 625 which itself then leads into the refrigerant line 621 after the evaporator 606 and ahead of the compressor 601. The valve 624 may be mechanically and/or electronically activated and may be operable in use to release refrigerant exceeding the critical pressure in the heat exchanger array 603 into the relief pipe 625 prior to entering the compressor 601. This prevents an unwanted excess pressure within the heat exchanger array 603 itself, and also prevents over-pressurised refrigerant from exiting the heat exchanger array 603 and passing to the condenser 604.

Figure 8 demonstrates a further embodiment of a temperature control system 710 in which the expansion valve 705 and/or compressor 701 are connected to a central control unit 700 by a series of signal transmission lines 722. The control unit 700 is operable to control the operation of the valve 705 and/or the compressor 701 to override the signals and commands as given by the original central control unit 707 of the system 710. This is beneficial as it allows additional control over these components with the aim to avoid faults in the performance of these components. The system 710 may additionally include temperature and/or pressure sensors (not shown) within the refrigerant lines 721 or components of the system 710 which are connected to the logic controller 700 to provide data thereto. This data may in turn be interpreted by the controller 700 which may control the operation of the compressor 701 and or the expansion valve 705 based on the data provided by the sensors within the refrigerant lines 721.

Figure 9 shows a further embodiment of a temperature control system 810 which additionally includes a bypass branch 820 which is connected to refrigerant lines 821 and has a separate electrically activated expansion valve 811. The expansion valve 811 simply provides an additional route for the refrigerant to be passed through towards the evaporator giving increased control over the flow of the refrigerant through the system 810. The expansion valve 811 is in turn connected to a logic controller 800 (which is substantially identical to the logic controller 700 shown in Figure 8 and performs a similar function) which also controls the flow of the refrigerant parallel through the additional expansion valve 811.

Figure 10 shows a further embodiment of a temperature control system 910. The system 910 is substantially similar to other above described systems, however the refrigerant lines 921 after having left the condenser 904 are split into various sub-circles using a distributor 971, with each sub-circle having an individual expansion valve 905, an evaporator 906 and connecting refrigerant lines 921. Each of the refrigerant lines

921 may also include temperature and/or pressure sensors which are in turn connected to the control unit 907 and/or a sub-control unit 973 being itself connected to the central control unit 907 for monitoring and controlling the flow of refrigerant through the lines 921 and indeed the temperature control process as a whole and also within in the individual sub-circles. The refrigerant lines 921 of the individual sub-circles come together in a collector 972 and from then in a common refrigerant line 921 to the compressor 901. By providing multiple evaporators 906, the system 910 can provide temperature control in a number of different spatial locations. For example, in different positions within a single area, or indeed within separate areas within an environment such as different rooms within a property.

Figure 11 shows a further embodiment of a temperature control system 1010 of the present invention. The system 1010 differs from the above-described embodiments in that it further includes a means to reverse the direction of refrigerant flow through part of the system 1010 to enable the system 1010 to be used as both a cooling and heating system. To achieve this, the system 1010 includes an additional four-way-valve 1101 being connected to a series of refrigerant lines 1021 and also to a central control unit 1007 through transmission lines 1022 for control of the valve 1101. The refrigerant lines 1021 connect the four-way-valve 1101 with a heat exchanger array 1003, a condenser 1004, an evaporator 1006 and a compressor 1001. The four-way-valve 1101 is operable to configure the refrigerant to flow through the system 1010 in one of two separate directions. The first being where the refrigerant flows through the pipes 1021 from the heat exchanger 1003 to the condenser 1004, then to the expansion valve 1005, then to the evaporator 1006 and finally back to the four-way-valve 1101 then to the compressor 1001. In this setup, the system 1010 acts as a cooling system as the condensed refrigerant is passed through the evaporator leading to the refrigerant heating up by removing heat energy from its surroundings. Alternatively, the four-way-valve may direct the refrigerant through the system 1010 from the heat exchanger array 1003 to the evaporator 1006, then to the expansion valve 1005, then to the condenser 1004, then back to the 4-way valve 1101 and on to the compressor 1001. In this setup, the refrigerant is heated and pressurised as it enters the evaporator 1006, where it subsequently cools as the refrigerant transfers heat to the surrounds. In the heating configuration, the heat exchanger array 1003 acts to heat up the gas further after the compressor 1001 which is then transferred in the evaporator 1006 as described above. The more the heat exchanger array 1003 adds heat to the refrigerant after the compressor 1001, the less the compressor 1001 must heat up the refrigerant. Ideally the compressor 1001 only moves the refrigerant forward while the heat exchanger array 1003 takes over the heating requirements. The setting of the four-way-valve 1101 and so the distinction between cooling or heating operation is set by the central control unit 1007 and may be based on the user's requirements and/or measured temperatures and/or pressures at sensors located within the refrigerant lines 1021 in the cooling circle or its components.

Similarly, where the temperature control system may act as both a heating and cooling system, such as in the system 1010 shown in Figure 11, the system 1010 may additionally include one or more flow control members, which may be in the form of valves, which are operable in use to direct the flow of the refrigerant such that it is either passed through at least one of the one or more heat exchangers or is passed directly from the compressor to the condenser, bypassing at least one of the one or more heat exchangers. The bypassing of the one or more heat exchangers may be performed using an arrangement similar or equivalent to that shown in Figures 3 and 4, which comprise an additional refrigerant line which takes refrigerant directly from the compressor to the condenser without passing through a heat exchanger. In embodiments wherein the system 1010 is used as a cooling system, it may be desirable that all of the refrigerant is passed through at least one heat exchanger. Therefore, in such cases, the flow control members, or valves, may operate to direct the refrigerant in this way. Alternatively, where the system 1010 is used as a heating system, it may be desirable for at least some of the refrigerant not to pass through a heat exchanger. Therefore, in these instances, the flow control members, or valves, may operate to direct at last some of the refrigerant such that it bypasses the/each heat exchanger.

The above embodiments are described by way of example only. Many variations are possible without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A temperature control system comprising: a compressor, a condenser, an expansion valve and an evaporator all connected in series by a plurality of refrigerant pipes; wherein the system further comprises an array of heat exchangers located between the compressor and the condenser operable in use to transfer heat energy from one or more external heat sources to the refrigerant leaving the compressor and before it enters the condenser.

2. A temperature control system as claimed in claim 1 comprising one or more flow control members operable in use to direct the flow of the refrigerant such that it is either passed through at least one of the heat exchangers within the array or is passed directly from the compressor to the condenser, bypassing at least one of heat exchangers within the array.

3. A temperature control system comprising: a compressor, a condenser, an expansion valve and an evaporator, all connected in series by a plurality of refrigerant pipes; one or more heat exchangers located between the compressor and the condenser operable in use to transfer heat energy from one or more external heat sources to the refrigerant leaving the compressor and before it enters the condenser; and one or more flow control members operable in use to direct the flow of the refrigerant such that it is either passed through at least one of the one or more heat exchangers or is passed directly from the compressor to the condenser, bypassing at least one of the one or more heat exchangers.

4. A temperature control system of claim 3 comprising an array of heat exchangers.

5. A temperature control system as claimed in any preceding claim wherein the refrigerant is passed at a variable rate through at least one of the heat exchangers.

6. A temperature control system as claimed in any of claims 2 to 5 wherein the one or more flow control members are operable in use to direct the flow of refrigerant such that it is either passed through each heat exchanger or is passed directly from the compressor to the condenser, bypassing each heat exchanger.

7. A temperature control system of any of claims 2 to 6 wherein the/each flow control member comprises a valve.

8. A temperature control system of any preceding claim wherein the/ each heat exchanger comprises a series of pipes containing a heated fluid over which the refrigerant is passed, or comprises a tank containing a heated fluid and the refrigerant pipes of the system are configured such that at least a portion of the pipes at the heat exchanger are submerged within the tank containing the fluid.

9. A temperature control system of any preceding claim which comprises an array of heat exchangers, wherein at least two heat exchangers within the array are located in series.

10. A temperature control system of any preceding claim which comprises an array of heat exchangers, wherein at least two heat exchangers are located in parallel.

11. A temperature control system of any of claims 1 to 8 which comprises an array of heat exchangers wherein there is provided at least two heat exchangers in parallel and at least one further heat exchanger located in series with at least one of the heat exchangers which are in parallel to form the array of heat exchangers.

12. A temperature control system of any preceding claim wherein each heat exchanger is operable to transfer heat energy from a single heat source to the refrigerant.

13. A temperature control system of any of claims 1 to 12 wherein there is provided a plurality of heat sources.

14. A temperature control system of any preceding claim wherein the/each heat exchanger comprises one or more solar panels operable in use to use heat energy from sunlight to increase the temperature of a fluid within the panel, this heated fluid then acting as the heat exchanger to subsequently heat refrigerant passing through each exchanger.

15. A temperature control system of claim 14 wherein the/ each solar panel comprises a flat plate collector having a series of tubes or tanks with a fluid flowing through or contained therein and located underneath a collector plate which absorbs the heat energy from the sunlight.

16. A temperature control system of any of claim 1 to 13 wherein the or each heat source is operable to provide heat energy through one of a combustion process, a chemical process, such as an exothermic chemical reaction, through waste heat from one or more of the components of the system or through a separate hot water/liquid circuit, where the water/liquid is heated up by solarthermal panels.

17. A temperature control system of any preceding claim wherein the compressor comprises a first compressor and the system may additionally comprise one or more further compressors.

18. A temperature control system of claim 17 wherein the/ each further compressor is be located in series with the first compressor, or is located in parallel with the first compressor.

19. A temperature control system of claim 17 wherein there is provided at least one further compressor in parallel with the first compressor and at least one further compressor located in series with the first compressor such that there is provided an array of compressors.

20. A temperature control system as claimed in any preceding claim wherein the rate at which the/ each compressor runs is variable.

21. A temperature control system of any preceding claim comprising a plurality of evaporators.

22. A temperature control system of any preceding claim comprising one or more valves operable to control the flow of the refrigerant through the system.

23. A temperature control system of claim 22 wherein at least one of the one or more valves comprises a one-way valve, or a stop valve.

24. A temperature control system of claim 22 or claim 23 wherein at least one of the one or more valves comprises a security valve operable in use to direct refrigerant within a given refrigerant pipe away from said pipe.

25. A temperature control system of claim 24 wherein the or each security valve is located after the heat exchanger(s) to prevent over pressurised refrigerant from

the heat exchangers passing through the condenser and/or evaporator/s and potentially causing damage thereto.

26. A temperature control system of any preceding claim operable in use to act as a cooling system, cooling the environment in which it is positioned.

27. A temperature control system of any of claims 1 to 26 operable in use to act as a heating system, heating the environment in which it is positioned.

28. A temperature control system of claim 27 when dependent on claim 26 comprising a four-way-valve operable in use to direct the flow of the refrigerant around the system in either of a first direction or a second direction, the first direction comprising a cooling direction and the second direction comprising a heating direction.

29. A temperature control system of any preceding claim comprising a control unit operable in use to control the operation of one or more of the components of the system.

30. A temperature control system of any preceding claim comprising one or more sensors operable in use to monitor one or more parameters of the refrigerant at a certain point within the system.

31. A temperature control system as claimed in any preceding claim comprising a means to segregate oil or other added components from the refrigerant to collect and supply it to other desired locations at the circuit.

32. A temperature control system as claimed in claim 31 wherein the segregation comprise a separator and/or an oil-trap.

33. A temperature control system as claimed in claim 32 wherein the separator and oil-trap are located ahead of the one or more heat exchangers or after the one or more heat exchangers or within the heat exchangers.

34. A method of cooling an environment using a system as claimed in any one of claims 1 to 33 comprising the steps of:

a. using the compressor to compress or heat a refrigerant;

b. increasing the temperature of the compressed refrigerant by passing the refrigerant through one or more of the heat exchangers which transfer(s) heat energy to the refrigerant from one or more external heat sources;

c. condensing the heated refrigerant by passing the refrigerant through a condenser; and

d. evaporating the condensed refrigerant by passing the refrigerant through an evaporator;

wherein evaporating the condensed refrigerant comprises passing air or gas or another fluid from the environment over the evaporator to transfer heat energy within the fluid to the condensed refrigerant thereby reducing the temperature of the fluid passed over the evaporator which is subsequently supplied back to the environment to be cooled.

35. A method of heating an environment using a system as claimed in any one of claims 1 to 33 comprising the steps of:

a. using the compressor to compress or heat a refrigerant;

b. increasing the temperature of the compressed refrigerant by passing the refrigerant through one or more heat exchanger(s) which transfer heat energy to the refrigerant from one or more external heat sources;

c. passing the heated refrigerant through an evaporator; and

d. condensing the refrigerant leaving the evaporator by passing the refrigerant through a condenser;

wherein passing the heated refrigerant through the evaporator further comprises passing air or gas or another fluid from the environment over the evaporator to transfer heat energy within the refrigerant to the fluid refrigerant thereby increasing the temperature of the fluid passed over the evaporator which is subsequently supplied back to the environment to be heated.

36. A system or method substantially as described herein with reference to the accompanying drawings.

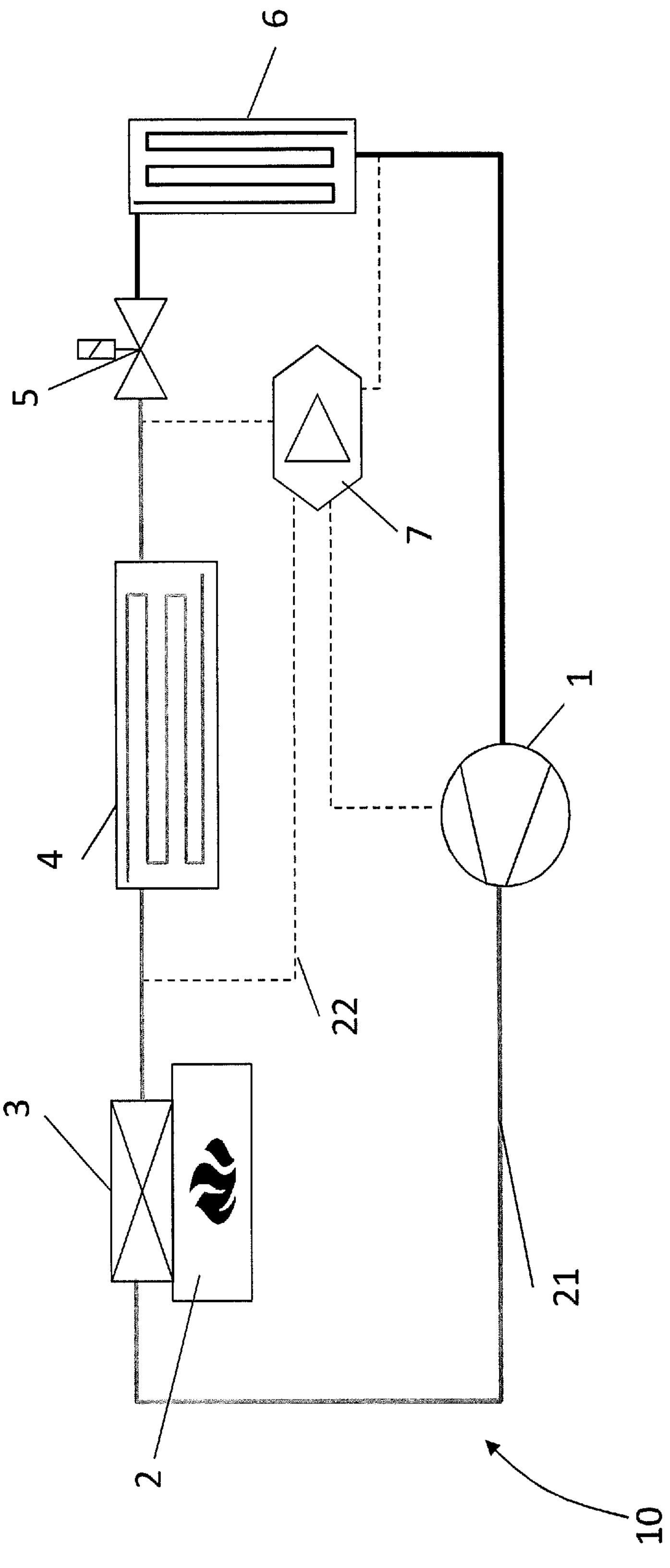
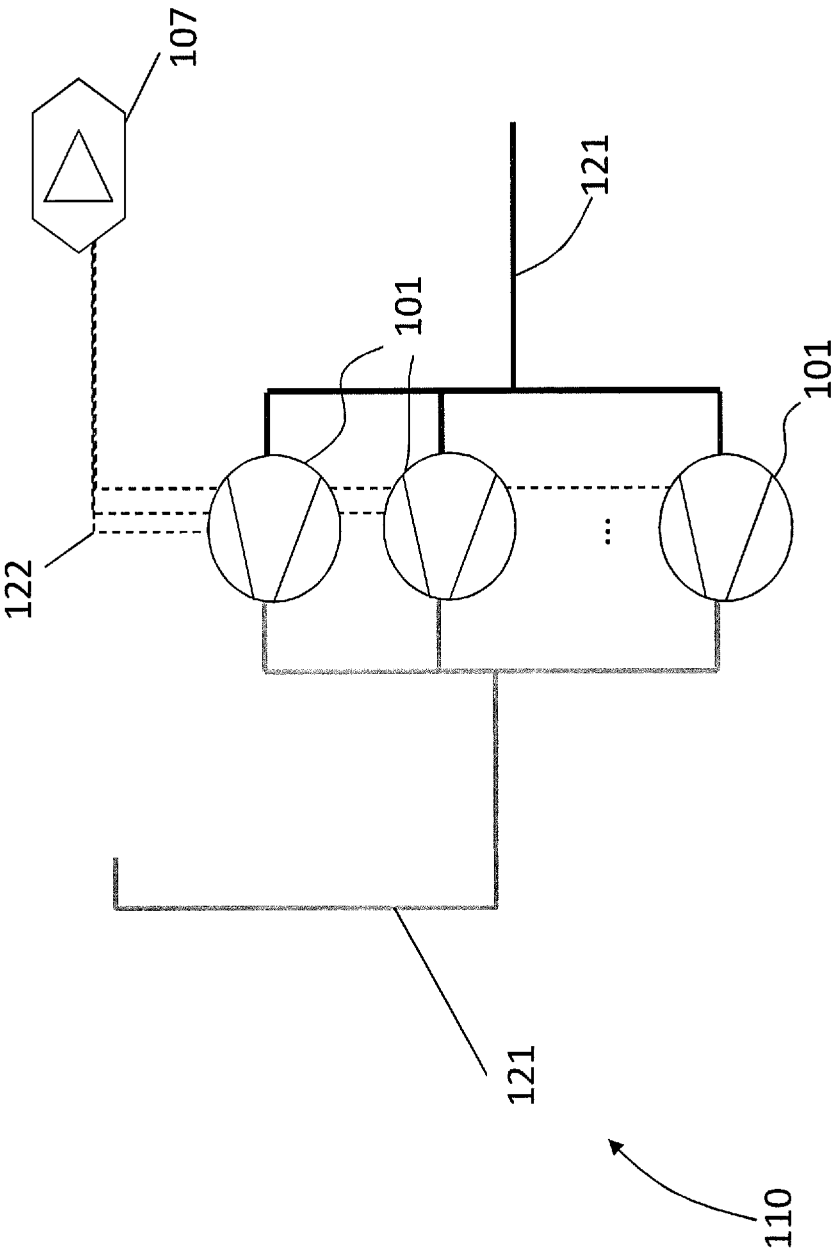


Figure 1

Figure 2



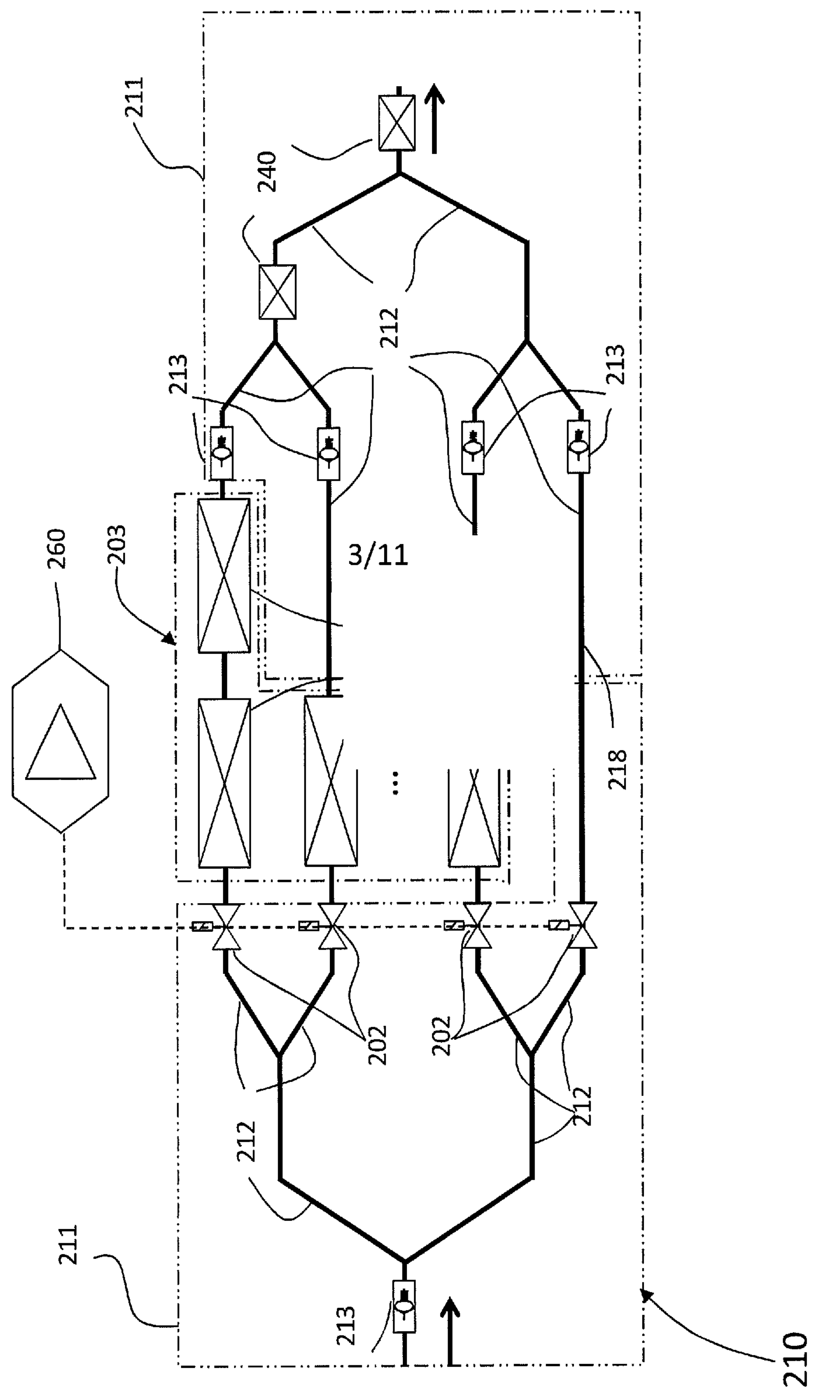


Figure 3

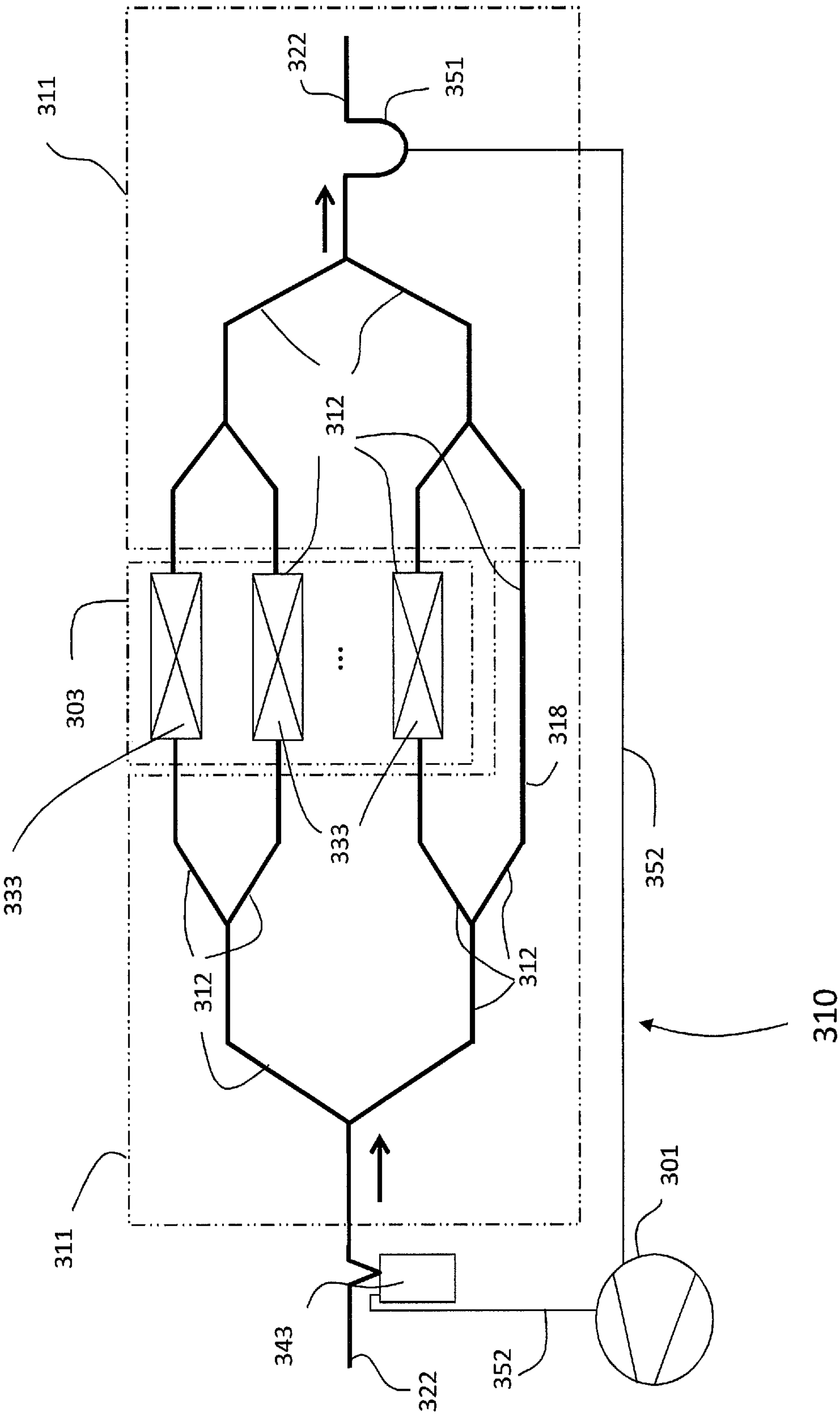
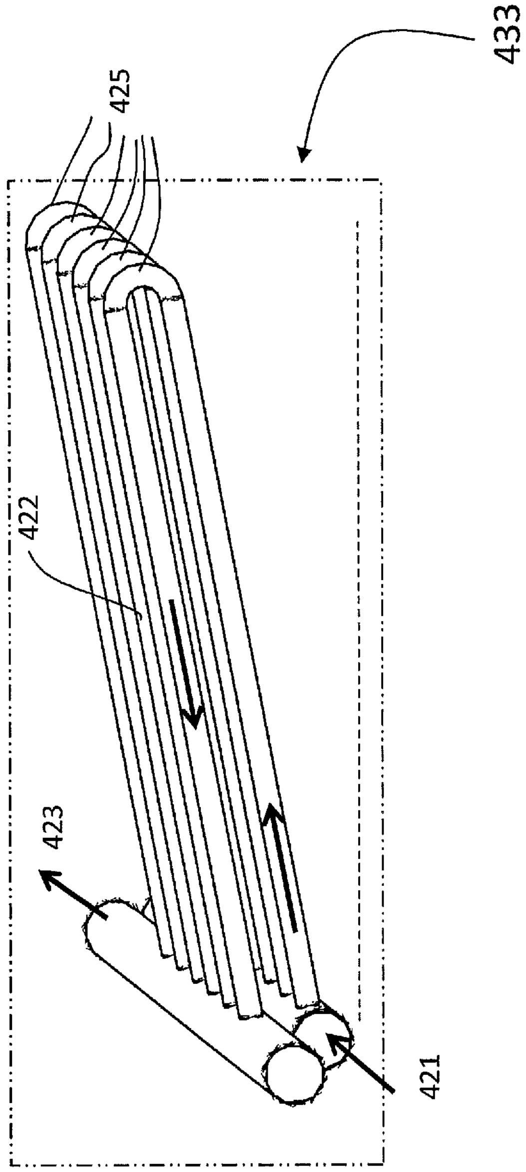


Figure 4

Figure 5



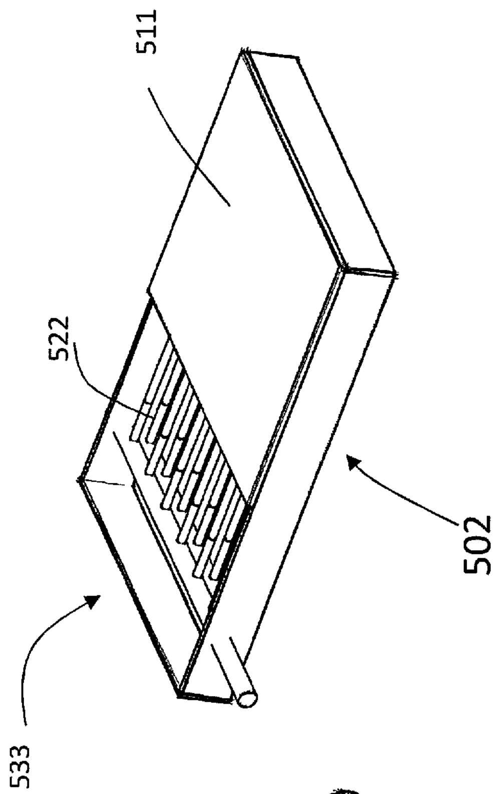


Figure 6B

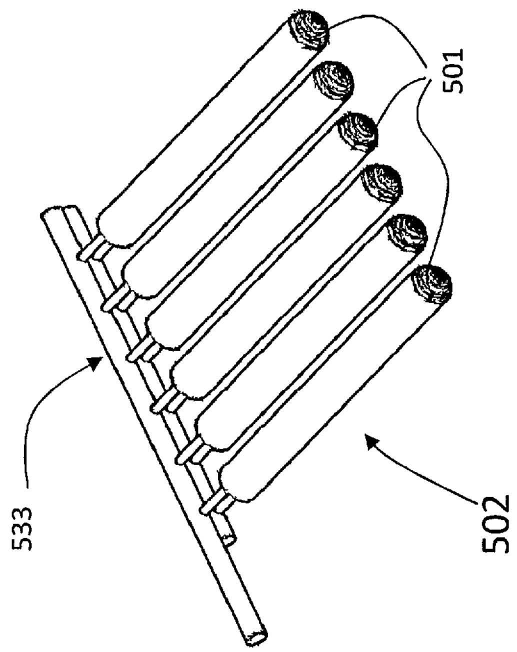


Figure 6A

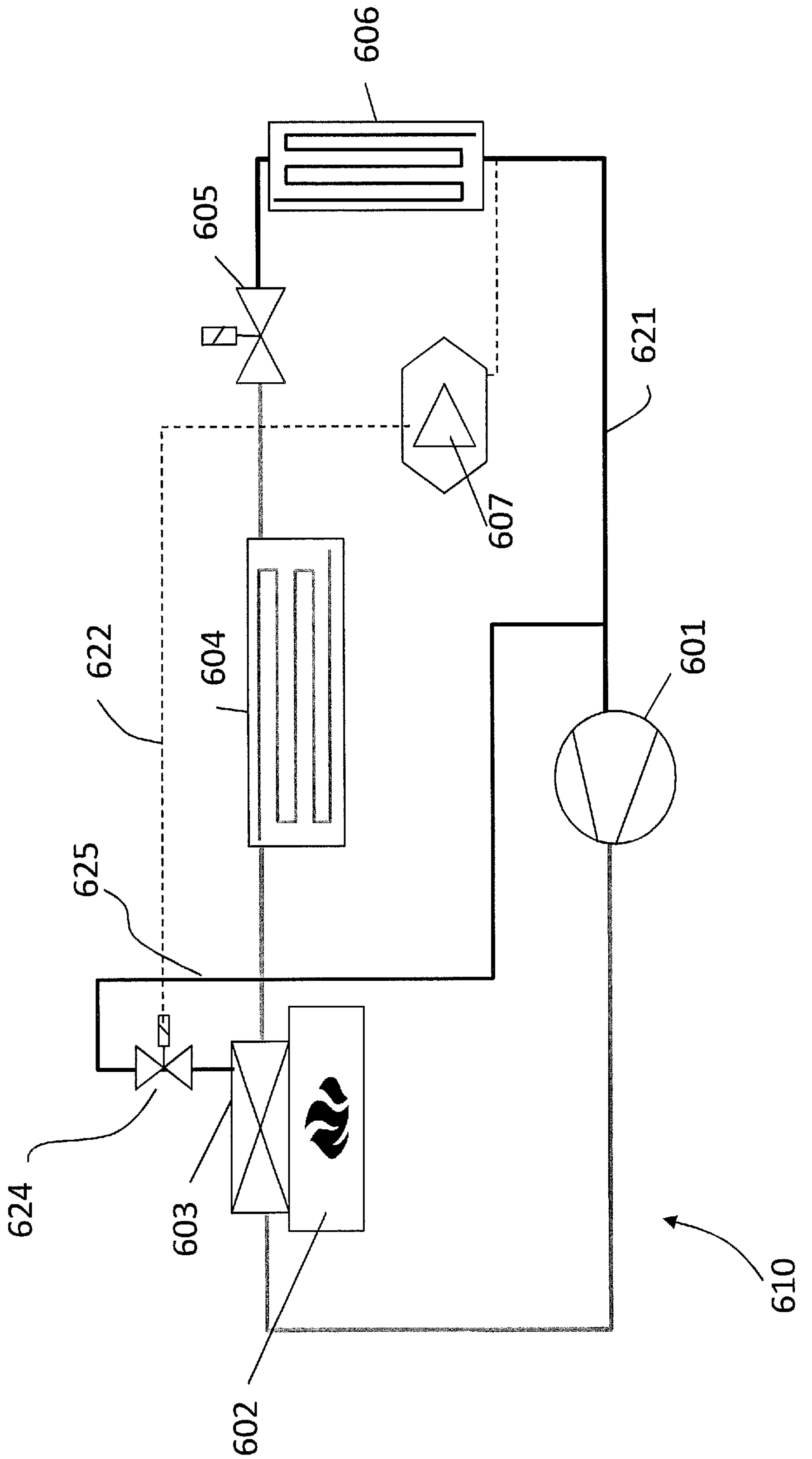


Figure 7

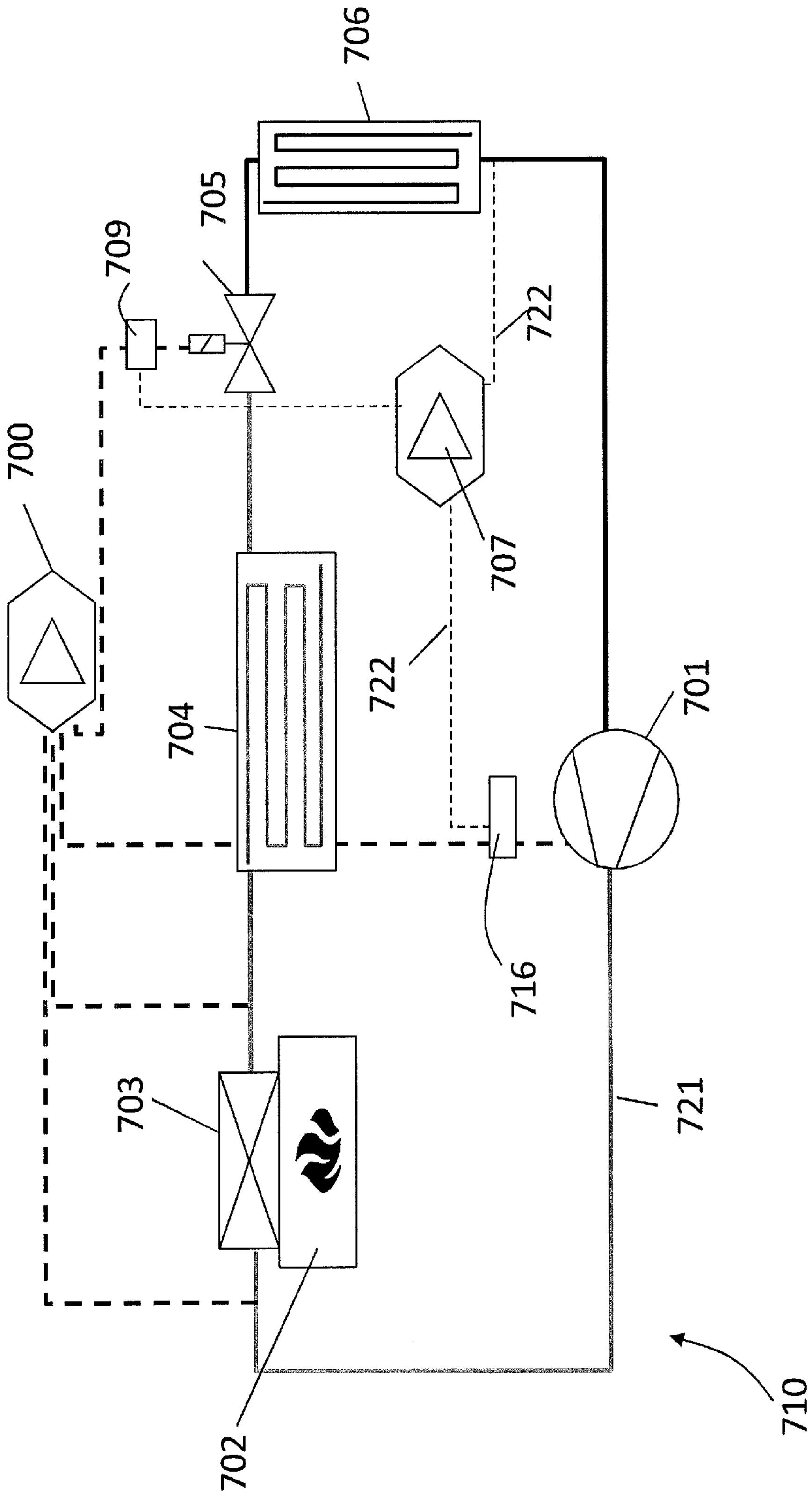


Figure 8

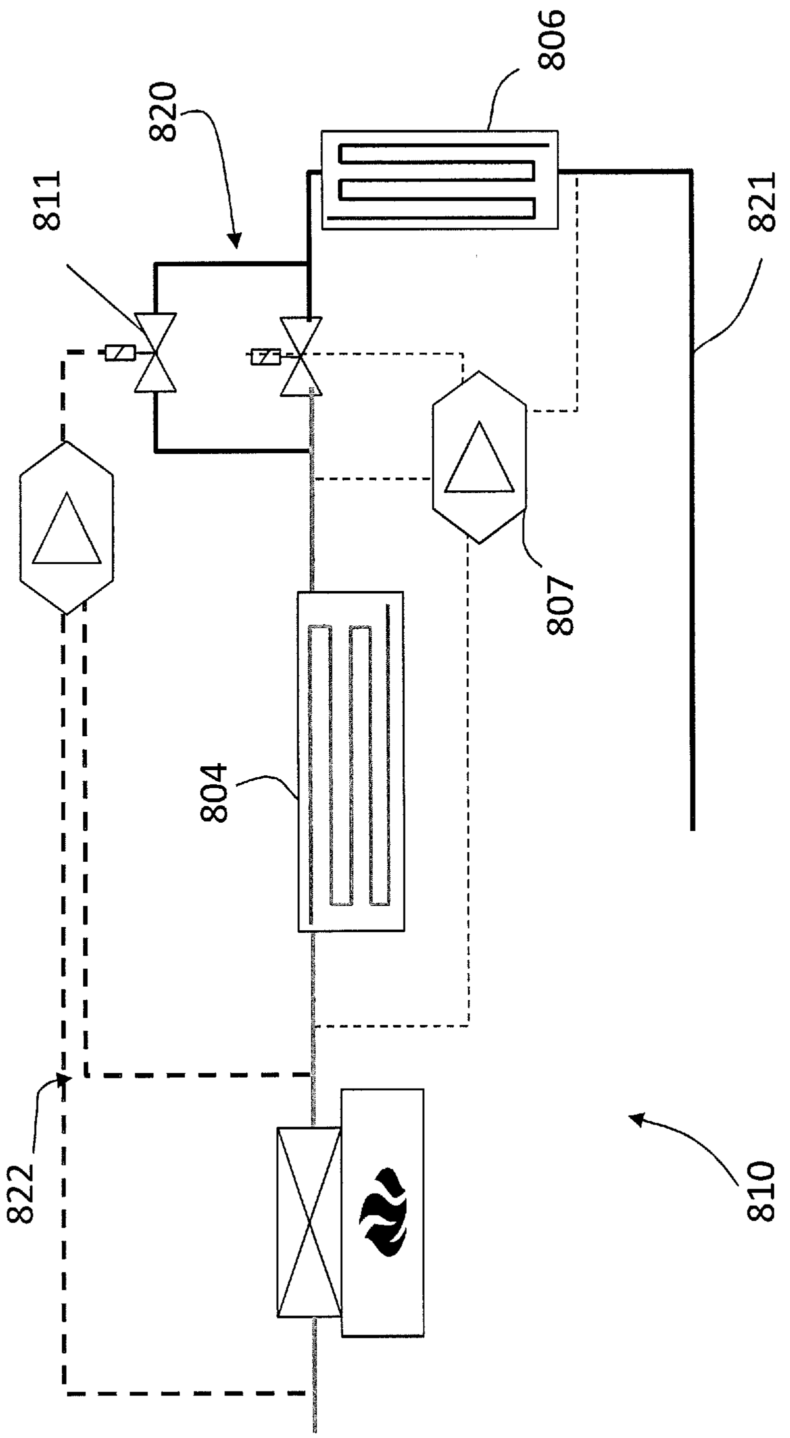


Figure 9

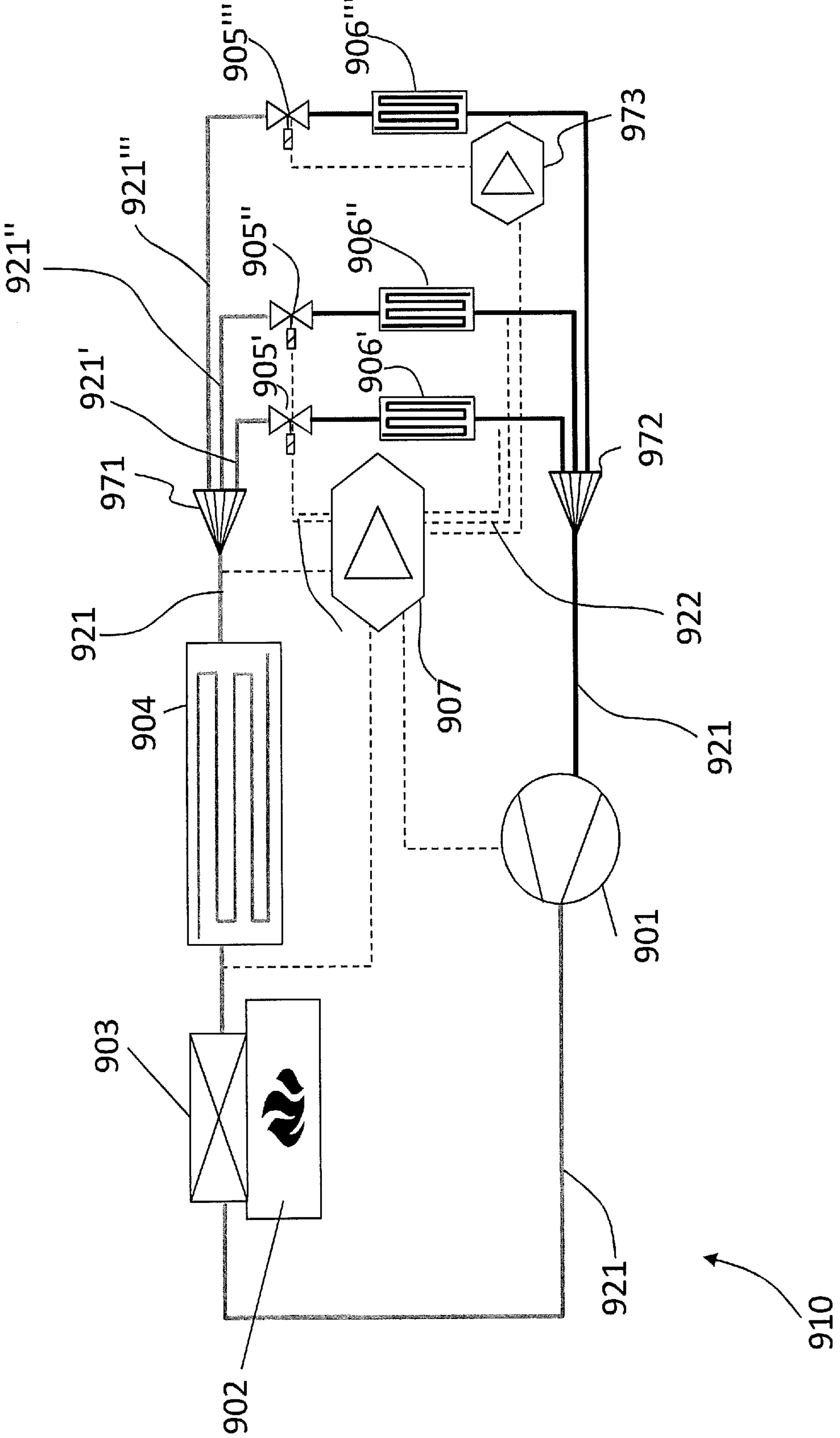

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Figure 10

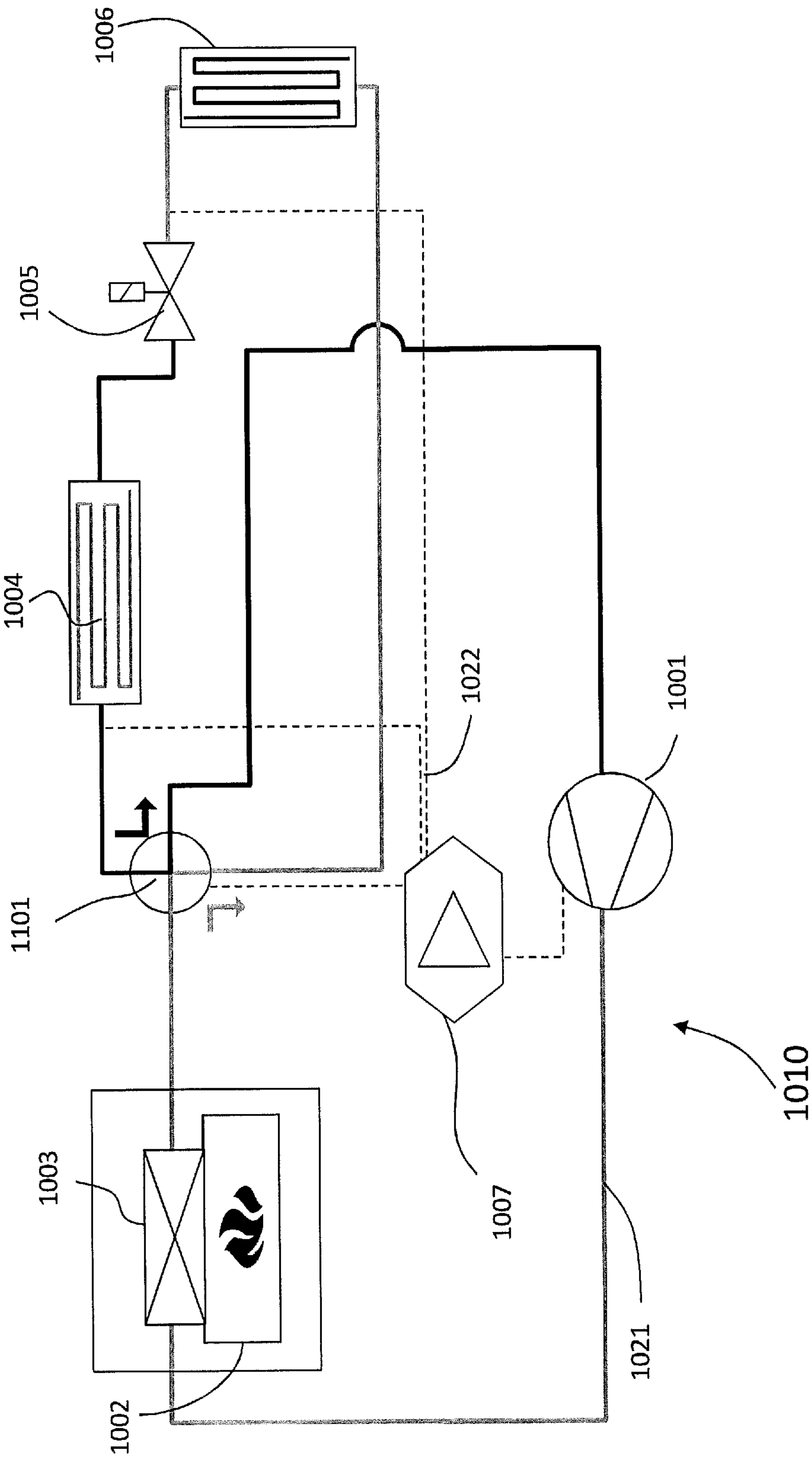

Figure 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2016/051289

A. CLASSIFICATION OF SUBJECT MATTER
INV. F25B6/02 F25B27/00 F25B27/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/048594 A2 (DZSOLAR LTD [GB]; ZAMIR OFRI [IL]) 28 April 2011 (2011-04-28) the whole document -----	1-36
X	DE 10 2013 004252 A1 (ORTHMANN KURT [DE]) 2 October 2014 (2014-10-02) the whole document -----	1-36
X	KR 2012 0110403 A (KUKJAE REFRIGERATION CO LTD [KR]) 10 October 2012 (2012-10-10) the whole document -----	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gasper, Ralf

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INTERNATIONAL SEARCH REPORT

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011048594 A2	28-04-2011	AU 2010309437 A1	03-05-2012
		EP 2491319 A2	29-08-2012
		JP 5911067 B2	27-04-2016
		JP 2013508663 A	07-03-2013
		US 2012204587 A1	16-08-2012
		WO 2011048594 A2	28-04-2011
DE 102013004252 A1	02-10-2014	NONE	
KR 20120110403 A	10-10-2012	NONE	

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(71)申请人 大卫·特纳
地址 英国兰开夏郡

(72)发明人 大卫·特纳

(74)专利代理机构 北京嘉和天工知识产权代理事务所(普通合伙) 11269
代理人 严慎 王维

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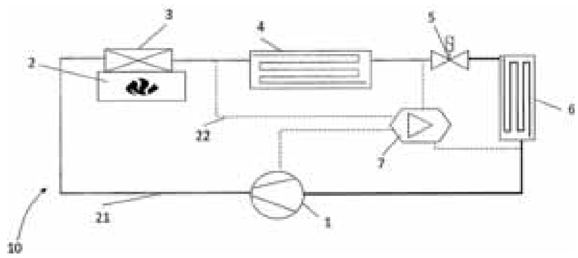
(54)发明名称

改进的温度控制系统

(57)摘要

温度控制系统(10)包括压缩机(1)、冷凝器(4)、膨胀阀(5)以及蒸发器(6),这些全都串联连接。至少一个热交换器(3)位于压缩机和冷凝器之间,并且可操作来将热能从外部热源传递到制冷剂。在一种变体中,热交换器阵列位于压缩机和冷凝器之间。在进一步的变体(210,图3)中,一个或多个热交换器位于压缩机和冷凝器之间,并且流动控制装置引导制冷剂要么流过至少一个热交换器、要么绕开热交换器中的至少一个直接从压缩机流到冷凝器。使用所述系统对环境进行加热和冷却的方法也被公开。



CN 107787434 A

1.一种温度控制系统，所述温度控制系统包括：压缩机、冷凝器、膨胀阀以及蒸发器，这些全都通过多个制冷剂管道串联连接；其中所述系统进一步包括位于所述压缩机和所述冷凝器之间的热交换器阵列，所述热交换器阵列在使用中可操作来并且在制冷剂进入所述冷凝器之前将热能从一个或更多个外部热源传递到离开所述压缩机的所述制冷剂。

2.如权利要求1所述的温度控制系统，包括一个或更多个流动控制构件，所述一个或更多个流动控制构件在使用中可操作来引导所述制冷剂的流动以使得所述制冷剂要么被传递通过所述阵列内的所述热交换器中的至少一个、要么绕开所述阵列内的所述热交换器中的至少一个直接从所述压缩机被传递到所述冷凝器。

3.一种温度控制系统，所述温度控制系统包括：压缩机、冷凝器、膨胀阀以及蒸发器，这些全都通过多个制冷剂管道串联连接；位于所述压缩机和所述冷凝器之间的一个或更多个热交换器，所述一个或更多个热交换器在使用中可操作来并且在制冷剂进入所述冷凝器之前将热能从一个或更多个外部热源传递到离开所述压缩机的所述制冷剂；以及一个或更多个流动控制构件，所述一个或更多个流动控制构件在使用中可操作来引导所述制冷剂的流动以使得所述制冷剂要么被传递通过所述一个或更多个热交换器中的至少一个、要么绕开所述一个或更多个热交换器中的至少一个直接从所述压缩机被传递到所述冷凝器。

4.如权利要求3所述的温度控制系统，包括热交换器阵列。

5.如前述任一项权利要求所述的温度控制系统，其中所述制冷剂被以可变速率传递通过所述热交换器中的至少一个。

6.如权利要求2至5中任一项所述的温度控制系统，其中所述一个或更多个流动控制构件在使用中可操作来引导所述制冷剂的流动，以使得所述制冷剂要么被传递通过每个热交换器、要么绕开每个热交换器直接从所述压缩机被传递到所述冷凝器。

7.如权利要求2至6中任一项所述的温度控制系统，包括所述/每个流动控制构件包括阀。

8.如前述任一项权利要求所述的温度控制系统，其中所述/每个热交换器包括包含所述制冷剂被传递经过的加热流体的一系列管道，或者包括包含加热流体的罐体并且所述系统的制冷剂管道被构造为使得所述热交换器处的所述管道的至少一部分被浸在所述包含所述流体的罐体内。

9.如前述任一项权利要求所述的温度控制系统，包括交换器阵列，其中所述阵列内的至少两个热交换器被串联安置。

10.如前述任一项权利要求所述的温度控制系统，包括交换器阵列，其中至少两个热交换器被并联安置。

11.如权利要求1至8中任一项所述的温度控制系统，包括热交换器阵列，其中提供有并联的至少两个热交换器以及与并联的所述热交换器中的至少一个串联安置的至少一个进一步的热交换器来形成热交换器阵列。

12.如前述任一项权利要求所述的温度控制系统，其中每个热交换器可操作来将热能从单个热源传递到所述制冷剂。

13.如权利要求1至12中任一项所述的温度控制系统，其中提供有多个热源。

14.如前述任一项权利要求所述的温度控制系统，其中所述/每个热交换器包括一个或更多个太阳能板，所述一个或更多个太阳能板在使用中可操作来使用来自太阳光的热能提

高所述板内的流体的温度，该加热流体然后充当所述热交换器来随后对通过每个热交换器的制冷剂进行加热。

15.如权利要求14所述的温度控制系统，其中所述/每个太阳能板包括平板集热器，所述平板集热器具有流体流过其中或其中包含流体的一系列管子或罐体，并且被安置在吸收来自太阳光的热能的集热器板的下面。

16.如权利要求1至13中任一项所述的温度控制系统，其中所述或每个热源可操作来通过燃烧过程、化学过程中的一个、通过来自所述系统的部件中的一个或更多个的废热、或通过在其中水/液体被太阳能热板加热的单独的热水/液体回路来提供热能，所述化学过程比如放热化学反应。

17.如前述任一项权利要求所述的温度控制系统，其中所述压缩机包括第一压缩机，并且所述系统能够附加地包括一个或更多个进一步的压缩机。

18.如权利要求17所述的温度控制系统，其中所述/每个进一步的压缩机与所述第一压缩机串联安置或与所述第一压缩机并联安置。

19.如权利要求17所述的温度控制系统，其中提供有与所述第一压缩机并联的至少一个进一步的压缩机以及与所述第一压缩机串联安置的至少一个进一步的压缩机，以使得提供压缩机阵列。

20.如前述任一项权利要求所述的温度控制系统，其中所述/每个压缩机的运行速率是可变的。

21.如前述任一项权利要求所述的温度控制系统，包括多个蒸发器。

22.如前述任一项权利要求所述的温度控制系统，包括可操作来控制所述制冷剂流过所述系统的流动的一个或更多个阀。

23.如权利要求22所述的温度控制系统，其中所述一个或更多个阀中的至少一个包括单向阀或截止阀。

24.如权利要求22或权利要求23所述的温度控制系统，其中所述一个或更多个阀中的至少一个包括安全阀，所述安全阀在使用中可操作来引导给定制冷剂管道内的制冷剂离开所述管道。

25.如权利要求24所述的温度控制系统，其中所述或每个安全阀被安置在所述一个或更多个热交换器的后面以防止来自所述热交换器的过度加压的制冷剂通过所述冷凝器和/或一个或更多个蒸发器以及可能对所述冷凝器和/或一个或更多个蒸发器引起损坏。

26.如前述任一项权利要求所述的温度控制系统，在使用中可操作来充当对其所放置的环境进行冷却的冷却系统。

27.如权利要求1至26中任一项所述的温度控制系统，在使用中可操作来充当对其所放置的环境进行加热的加热系统。

28.如权利要求27所述的温度控制系统，当从属于权利要求26时，包括四通阀，所述四通阀在使用中可操作来在第一方向或第二方向上引导所述制冷剂围绕所述系统的流动，所述第一方向包括冷却方向，所述第二方向包括加热方向。

29.如前述任一项权利要求所述的温度控制系统，包括控制单元，所述控制单元在使用中可操作来控制所述系统的部件中的一个或更多个的操作。

30.如前述任一项权利要求所述的温度控制系统，包括一个或更多个传感器，所述一个

或更多个传感器在使用中可操作来监控所述制冷剂在所述系统内的某个点处的一个或更多个参数。

31.如前述任一项权利要求所述的温度控制系统，包括使油或其他添加的成分与所述制冷剂隔离以收集所述制冷剂并且将所述制冷剂供应给所述回路处的其他期望位置的装置。

32.如权利要求31所述的温度控制系统，其中所述隔离包括分离器和/或捕油器。

33.如权利要求32所述的温度控制系统，其中所述分离器和捕油器被安置在所述一个或更多个热交换器的前面或所述一个或更多个热交换器的后面或所述热交换器内。

34.一种使用如权利要求1至33中任一项所述的系统来对环境进行冷却的方法，所述方法包括以下步骤：

a.使用所述压缩机来对制冷剂进行压缩或加热；

b.通过使所述制冷剂通过将热能从一个或更多个外部热源传递到所述制冷剂的所述热交换器中的一个或更多个来提高所述压缩的制冷剂的温度；

c.通过使所述制冷剂通过冷凝器来使所述加热的制冷剂冷凝；以及

d.通过使所述制冷剂通过蒸发器来使所述冷凝的制冷剂蒸发；

其中使所述冷凝的制冷剂蒸发包括使来自所述环境的空气或气体或另一流体经过所述蒸发器以将所述流体内的热能传递到所述冷凝的制冷剂，从而降低经过所述蒸发器的流体的温度，所述流体随后被供应回要被冷却的所述环境。

35.一种使用如权利要求1至33中任一项所述的系统来对环境进行加热的方法，所述方法包括以下步骤：

a.使用所述压缩机来对制冷剂进行压缩或加热；

b.通过使所述制冷剂通过将热能从一个或更多个外部热源传递到所述制冷剂的一个或更多个热交换器来提高所述压缩的制冷剂的温度；

c.使所述加热的制冷剂通过蒸发器；以及

d.通过使离开所述蒸发器的制冷剂通过冷凝器来使所述制冷剂冷凝；

其中使所述加热的制冷剂通过所述蒸发器进一步包括使来自所述环境的空气或气体或另一流体经过所述蒸发器以将所述制冷剂内的热能传递到所述流体制冷剂，从而提高经过所述蒸发器的流体的温度，所述流体随后被供应回要被加热的所述环境。

36.一种基本上如本文参照附图描述的系统或方法。

改进的温度控制系统

技术领域

[0001]　本发明涉及冷却和加热系统，比如空调机组和冰箱，并且具体地，涉及使用压缩循环进行操作的冷却和加热系统中的改进。

背景技术

[0002]　温度控制系统，比如空调、冷却和冰箱系统，通常使用压缩循环来通过流体制冷剂的相应冷却或加热来对它们的周围环境进行加热或冷却。一般来说，制冷剂流体最初是被压缩机压缩的气体，随后在冷凝器中被液化，并且然后通过膨胀阀被注入。高度液化的液态制冷剂通过膨胀阀的注入使得制冷剂可以快速地膨胀。制冷剂然后被传递通过蒸发器，在蒸发器中，制冷剂从周围空气或被围绕蒸发器传递、从而使它们冷却的其他流体吸收热能。该过程可以按相反次序运行来对周围环境进行加热，由此热的加压制冷剂被传递通过蒸发器，并且周围空气或经过蒸发器的流体吸收该热量。

[0003]　因为制冷剂优选为气态流体，所以其物理状态可以使用理想的气体定律来近似，理想的气体定律声明：

[0004]　$pV=nRT$　[方程1]

[0005]　其中p是以帕斯卡为单位的气体的压力，V是以m^3为单位的气体的体积，n是体积V内存在的气体的分子数量，R是摩尔气体常数(大约等于$8.31m^2kg\ s^{-2}K^{-1}mol^{-1}$)，并且T是以开氏度为单位的气体的温度。

[0006]　本质上，方程1告诉我们气体的压力和其内包含气体的体积的乘积与所存在的气体的分子数量和气体的温度的乘积是成比例的。实际上，在体积保持不变的环境中，比如在温度控制系统的制冷剂管道中，根据后面的膨胀阀的打开，温度的升高可以具有两种效果。当阀被关闭时，气体没有分子可以离开，并且制冷剂的体积和压力两者都增大。当膨胀阀被打开时，气体的分子快速地通过阀的开口，使气体的压力几乎不变。因为膨胀阀后面的压力比前面低得多，所以气体离开通过阀的开口、而不是积累膨胀阀前面的压力的趋势将更大。对气体进行加热的效果使被推送通过阀的分子的数量增加，由此在蒸发器处造成更高的质量流，因此使蒸发器中的冷却容量增大。所述系统的控制通过减小压缩机的质量流以重新实现最初的目标冷却容量来对所述增大做出反应。两种效果，压力增大和质量流增大，使压缩机的耗电降低。其速率取决于非常特定的情形；膨胀阀在操作时是否被打开以及打开程度。

[0007]　这种类型的温度控制单元的操作一般需要巨大的能量，并且因此可取的是能够降低这样的系统的能耗。压缩机一般是在温度控制系统的操作期间消耗最多能量的部件。在一些情况下，压缩机消耗的能量可能占到所述系统所用总能量的高达80％。由于这个原因，非常可取的是使这些系统中的压缩机的能耗降低。

[0008]　存在若干以降低能耗为目标的已知系统，并且包括来自其本身的废热能量被回收的系统(具体参见DE000019925477A1)。该文献所描述的系统涉及在循环中的期望点处、具体地说是在制冷剂进入压缩机之前从用于对制冷剂进行加热的电机或控制单元回收热量。

类似地，WO0155647描述了其中热交换器被放置在压缩机的后面以回收从制冷剂管道逸出的热量的系统，然而，从此回收的能量导致制冷剂本身的温度损失。

[0009] WO2014146498和DE102007011014A1两者都描述了其中制冷剂在被传递通过压缩机之前被用电装置加热的系统。这减轻了压缩机将制冷剂压缩足以根据需要增大压力的量需要执行的工作。然而，压缩机的能耗的降低在这些系统中是不显著的，并且它们主要被用在具有非常低的周围温度的环境中，在这些环境中，制冷剂一般冷得多，从而可能与供油不足结合损坏压缩机。

[0010] WO2011048594 A2描述了具有压缩机单元和太阳能板形式的单个集热器的空调系统，压缩机单元合并了机械压缩机，集热器位于机械压缩机的下游以用来提高制冷剂的温度。与机械压缩机一起作为压缩机单元的一部分的集热器的合并限制了集热器的大小，并且仅适合于较小的空调系统。所述布置还要求集热器邻近压缩机安置，并且所以具有有限的灵活性。所述系统对于通过集热器传递到制冷剂的热量的量仅具有非常有限的控制。此外，所述系统仅与可变速度直流变频机械压缩机一起工作，所以不适合用在具有固定速度压缩机的温度控制系统中。

[0011] 因此本发明的一个实施方案或多个实施方案的目的是，通过提供在使用中耗电显著降低的温度控制系统来克服或至少部分地缓解现有技术的缺点。

发明内容

[0012] 根据本发明的第一方面，提供了一种温度控制系统，所述系统包括：压缩机、冷凝器、膨胀阀以及蒸发器，这些全都通过多个制冷剂管道串联连接；其中所述系统进一步包括位于压缩机和冷凝器之间的热交换器阵列，所述热交换器阵列在使用中可操作来并且在制冷剂进入冷凝器之前将热能从一个或更多个外部热源传递到离开压缩机的制冷剂。

[0013] 使用热交换器来将热能传递到离开压缩机之后的制冷剂的作用是对制冷剂进行加热，并且在这样做时增大制冷剂的压力或增大进入蒸发器中的质量流，并且通过这样做，增大蒸发器处的冷却容量。如上所述，两种效果，增大制冷剂的压力和增大进入蒸发器中的质量流，都使压缩机的压缩要求降低，并且因此使所述系统作为整体的能耗降低。提供热交换器阵列使得对传递到制冷剂的热能的程度的控制更大。在外部热源供应的热能不能被容易控制的情况下，例如在使用天然能源(比如太阳能)的情况下，这是特别有益的。热交换器阵列可以被安置在压缩机和冷凝器之间的点处，这使得构造系统的灵活性更大。此外，热交换器的大小是没有限制的，这使得所述系统可以适于与更大的温度控制系统一起使用。所述系统不限于与小型空调系统中所用的类型的直流变频压缩机一起使用，而是可以适于与固定或可变速度压缩机一起使用。这使得所述系统适合于用在范围广泛的温度控制应用中，包括但不限于：空调、冷却和制冷。

[0014] 在一些实施方案中，温度控制系统可以附加地包括一个或更多个流动控制构件，所述一个或更多个流动控制构件在使用中可操作来引导制冷剂的流动以使得它要么被传递通过阵列内的热交换器中的至少一个、要么绕开阵列内的热交换器中的至少一个直接从压缩机被传递到冷凝器。在进一步的实施方案中，所述一个或更多个流动控制构件在使用中可操作来引导制冷剂的流动以使得它要么被传递通过每个热交换器、要么绕开每个热交换器直接从压缩机被传递到冷凝器。在进一步的实施方案中，流动控制构件包括可变开口，

该可变开口可以完全关闭或者可以不完全关闭，并且改变制冷剂的流速。每个流动控制构件可以包括阀。

[0015] 每个热交换器可以包括一系列管道，这些管道包含在使用中制冷剂被传递经过的加热流体(其可以是液体或气体，并且“流体”在下文中包括液体或气体中的任何一个或两个)。这样，随着制冷剂经过管道，热能从热交换器的管道内的流体被传递到制冷剂，使制冷剂加热。按照上面的方程1，制冷剂的温度升高使压力上升或使分子数量减少(因此意味着实现质量流增大)。

[0016] 可替换地，每个热交换器可以包括包含加热流体的罐体。在这样的实施方案中，所述系统的制冷剂管道可以被构造为使得热交换器处的管道的至少一部分被浸在该罐体内。这样的实施方案以与上述方式类似的方式工作，其中来自罐体内的加热流体的热能被传递到流过浸在罐体内的管道的制冷剂。

[0017] 所述阵列内的至少两个热交换器可以被串联安置。可替换地，所述阵列内的至少两个热交换器可以被并联安置。

[0018] 在一些实施方案中，提供有并联的至少两个热交换器以及与并联的热交换器中的至少一个串联安置的至少一个进一步的热交换器来形成热交换器阵列。这样，通过独立地控制每个热交换器的操作，可以改变在使用中制冷剂被热交换器加热的速率。

[0019] 在一些实施方案中，每个热交换器可以可操作来将热能从单个热源传递到制冷剂。可替换地，提供有多个热源。在这样的实施方案中，可以为每个单个的热源提供有一个热交换器。可替换地，每个热源可以作用于多于一个的热交换器上。

[0020] 所述阵列内的热交换器可以包括一个或更多个太阳能板，所述一个或更多个太阳能板在使用中可操作来使用来自太阳光的热能提高板内的流体的温度，该加热流体然后充当热交换器来随后对通过每个热交换器的制冷剂进行加热。太阳能板可以包括平板集热器，所述平板集热器例如具有流体流过其中的一系列流动管子，或者被安置在位于吸收来自太阳光的热能的集热器板下面的罐体中。

[0021] 可替换地，热源可以是能够对每个热交换器内的流体进行加热的任何其他的外部源。在一些实施方案中，热源可以通过燃烧过程来提供热能。在这样的实施方案中，燃烧过程可以放出热气，这些热气可以被用来直接地或间接地对制冷剂管道内的制冷剂进行加热。在进一步的实施方案中，热源可以通过化学过程来提供热能，比如放热化学反应。再次，化学过程可以放出热气，这些热气被用来对制冷剂管道内的制冷剂进行加热。在一些实施方案中，热源可以包括一系列燃料电池，并且可以通过电加热来对制冷剂进行加热。可替换地，热源可以是来自所述系统的部件中的一个或更多个的废热，该废热可以最初被热源储存，或者可以直接按照在使用中它被所述系统生成的样子被使用。进一步的热源可以是被单独的回路中的太阳能热板加热的水或其他液体，该水或其他液体可以传递通过热交换器来对制冷剂进行加热。该回路还可以包含热水储存罐，该热水储存罐将使得在没有太阳光时也可以使用太阳能热。

[0022] 在一些实施方案中，压缩机可以包括第一压缩机，并且所述系统可以附加地包括一个或更多个进一步的压缩机。任何进一步的压缩机可以与第一压缩机串联安置。可替换地，每个进一步的压缩机可以与第一压缩机并联安置。在一些实施方案中，提供有与第一压缩机并联的至少一个进一步的压缩机以及与第一压缩机串联安置的至少一个进一步的压

缩机以使得提供有压缩机阵列。这样，通过控制第一压缩机和所述一个或更多个进一步的压缩机中的每个的操作，可以改变在使用中压缩制冷剂的速率。

[0023] 在其他实施方案中，第一压缩机的运行速率是可变的，去除了使一个或更多个进一步的压缩机在使用中改变制冷剂的压缩速率的要求。然而，在一些实施方案中，除了可变速率的第一压缩机之外还具有一个或更多个进一步的压缩机可能仍是可取的。

[0024] 在一些实施方案中，所述系统可以包括多个蒸发器。在使用中，蒸发器可以物理地间隔开以便用来对要被冷却/加热的环境内的各种不同的区域进行冷却或加热。在这样的实施方案中，所述系统可以附加地包括分配器，该分配器可操作来将制冷剂流分为多个单独的流，对于所述多个蒸发器中的每个有至少一个流。分配器可以直接放置在冷凝器之后。在这样的实施方案中，可以为每个蒸发器提供有膨胀阀。所述系统可以附加地包括集合器，该集合器在使用中可操作来将来自每个蒸发器的所述多个单独的流组合回为单个主制冷剂流。

[0025] 在一些实施方案中，所述系统可以包括若干制冷剂管道，制冷剂在使用中可以流过这些制冷剂管道。所述多个制冷剂管道中的至少两个可以被相互平行地放置在所述系统中。这样，所述系统内的总阻力或对制冷剂围绕所述系统或至少通过所述系统的包括平行制冷剂管道的部分的流动的阻力减小，因为所述系统的有效热传递表面增大。

[0026] 在一些实施方案中，所述系统可以包括一个或更多个阀。所述一个或更多个阀可以可操作来在使用中控制制冷剂流过所述系统的流动。在一些实施方案中，所述一个或更多个阀中的至少一个可以包括单向阀。所述/每个单向阀可以在使用中可操作来防止制冷剂在不合需要的方向上流动。在一些实施方案中，所述一个或更多个阀中的至少一个可以包括截止阀。所述/每个截止阀可以在使用中可操作来控制制冷剂在期望的方向上流过所述系统的流动。这样的控制可以包括控制制冷剂流过哪些部件以及任何给定时间的流速。在提供压缩机阵列并且要求控制制冷剂的压缩速率的实施方案中，这可能是可取的。类似地，这对于控制制冷剂被传递到热交换器中的哪个以控制压缩制冷剂的加热程度可以是可取的。

[0027] 在一些实施方案中，所述一个或更多个阀中的至少一个包括安全阀。所述/每个安全阀可以在使用中可操作来引导给定制冷剂管道内的制冷剂离开所述管道。在使用中，这对于确保在制冷剂管道内没有可能造成管道变得损坏或在最坏情况下变得破裂的不想要的压力积累可以是可取的。所述/每个安全阀可以被安置在热交换器的后面以防止来自热交换器的过度加压的制冷剂通过冷凝器和/或蒸发器(一个或更多个)以及可能对冷凝器和/或蒸发器引起损坏。

[0028] 在一些实施方案中，温度控制系统在使用中可操作来充当使它所放置的环境冷却的冷却系统。例如，温度控制系统可以形成冰箱或空调机组的一部分。可替换地，温度控制系统在使用中可操作来充当对它所放置的环境进行加热的加热系统。例如，温度控制系统可以形成加热器(比如对流加热器)的一部分。

[0029] 在一些实施方案中，温度控制系统可以在不同的时间充当冷却系统和加热系统这二者。例如，温度控制系统可以形成空调机组或气候控制机组的在使用中可操作来对它在其中被放置到预定水平面的环境进行加热或冷却的一部分。为了使得可以实现这，所述系统可以包括四通阀，该四通阀在使用中可操作来在第一方向或第二方向上引导制冷剂围绕

所述系统的流动。第一方向可以包括冷却方向，在该方向上，制冷剂从压缩机流到热交换器，流到冷凝器，流过膨胀阀，流到蒸发器，并且流回压缩机。第二方向可以包括冷却方向，在该方向上，制冷剂从压缩机流到热交换器，流到蒸发器，然后流过膨胀阀，流到冷凝器，并且最后流回压缩机。

[0030] 所述系统可以附加地包括控制单元。控制单元可以在使用中可操作来控制所述系统的部件(包括压缩机、每个热交换器、冷凝器、膨胀阀和/或蒸发器)中的一个或更多个的操作。在相关的实施方案中，控制单元可以附加地或可替换地可操作来控制所述一个或更多个进一步的压缩机、所述多个蒸发器中的每个的操作和/或所述一个或更多个阀中的任何一个的操作。例如，控制单元可以控制压缩机用来压缩制冷剂的速率，和/或可以控制制冷剂通过阀流到每个部件的流动。

[0031] 在一些实施方案中，所述系统附加地包括安置在制冷剂流动内的一个或更多个传感器。所述一个或更多个传感器可以在使用中可操作来监控制冷剂在所述系统内的某个点处的一个或更多个参数，比如制冷剂的温度和/或压力。在一些实施方案中，传感器可以被连接到控制单元。在这样的实施方案中，控制单元可以可操作来响应于所述一个或更多个传感器测得的参数的值来控制所述系统的部件中的一个或更多个的操作。

[0032] 在一些实施方案中，所述系统可以被构造为防止被分配的油在不利的位置解隔离，并且这因此可能引起压缩机的供油缺乏。例如，在每个热交换器包括U形管道或导管的实施方案中，每个制冷剂管道可以被定位为使得热交换器中的U形管道被放置在上部区域中，所以油可能不会解隔离并且像这样累积于其中，这可以阻挡管道以防制冷剂流过。另外，进出U形管道的管道可以向下延伸，以使得油可以由于重力而向下流动，并且被收集在容器中，油可以从这些容器被运输到压缩机。

[0033] 所述系统可以附加地包括隔离油或其他液体成分与制冷剂和/或将油或其他液体成分分配到制冷剂的装置。可能有必要确保足够的油被提供给压缩机、而不是留在整个管道系统中的其他地方，以确保所述系统的每个部件正在正确地操作。例如，油或其他流体可能是压缩机润滑压缩机所必需的，但是不是管道系统和/或热交换器的U形弯道所必需的。隔离过程意味着这可以包括用于隔离的分离器和/或用于收集油或流体的捕集器。在一些实施方案中，分离器和捕集器可以被安置在热交换器阵列的前面或热交换器阵列中。这样，所述系统确保油在它流过热交换器之前被回收，在热交换器中，油将是不想要的，然后将被返回到压缩机。

[0034] 根据本发明的第二方面，提供有一种温度控制系统，所述系统包括：压缩机、冷凝器、膨胀阀以及蒸发器，这些全都通过多个制冷剂管道串联连接；位于压缩机和冷凝器之间的一个或更多个热交换器，所述一个或更多个热交换器在使用中可操作来并且在离开压缩机的制冷剂进入冷凝器之前将热能从一个或更多个外部热源传递到制冷剂；以及一个或更多个流动控制构件，所述一个或更多个流动控制构件在使用中可操作来引导制冷剂的流动以使得它要么被传递通过所述一个或更多个热交换器中的至少一个、要么绕开所述一个或更多个热交换器中的至少一个直接从压缩机被传递到冷凝器。

[0035] 在一些实施方案中，制冷剂可以被以全速率传递通过所述或每个热交换器中的至少一个。

[0036] 在一些实施方案中，制冷剂可以被以可变速率传递通过所述或每个热交换器中的

至少一个。

[0037] 在一些实施方案中，所述系统包括单个热交换器。在这样的实施方案中，所述一个或更多个流动控制构件可以在使用中可操作来引导制冷剂的流动以使得它要么被传递通过所述单个热交换器、要么绕开所述单个热交换器直接从压缩机被传递到冷凝器。

[0038] 本发明的第二方面根据需要或视情况合并了本发明的第一方面的特征中的任何一个或全部。例如，在一些实施方案中，本发明的第二方面的温度控制系统可以包括热交换器阵列。热交换器阵列可以包括本发明的第一方面的热交换器阵列的特征中的任何一个或全部。类似地，在一些实施方案中，本发明的第二方面的系统的所述一个或更多个流动控制构件可以包括本发明的第一方面的所述一个或更多个流动控制构件的特征中的任何一个或全部。

[0039] 在一些实施方案中，温度控制系统可以在不同的时间充当冷却系统和加热系统这二者。为了使得可以实现这，所述系统可以包括四通阀，该四通阀在使用中可操作来在第一方向或第二方向上引导制冷剂围绕所述系统的流动。第一方向可以包括冷却方向，在该方向上，制冷剂从压缩机流流到热交换器，流到冷凝器，流过膨胀阀，流到蒸发器，并且流回压缩机。第二方向可以包括冷却方向，在该方向上，制冷剂从压缩机流到热交换器，流到蒸发器，然后流过膨胀阀，流到冷凝器，并且最后流回压缩机。

[0040] 在温度控制系统可以既充当加热系统、又充当冷却系统的实施方案中，所述一个或更多个流动控制构件可以在使用中可操作来引导制冷剂的流动以使得当所述系统用作冷却系统时制冷剂被传递通过所述一个或更多个热交换器中的至少一个。另一方面，在所述系统用作加热系统的情况下，所述一个或更多个流动控制构件可以在使用中可操作来引导制冷剂的流动以使得它要么被传递通过所述一个或更多个热交换器中的至少一个、要么绕开所述一个或更多个热交换器中的至少一个直接从压缩机被传递到冷凝器。

[0041] 根据本发明的第三方面，提供有一种使用根据本发明的第一方面或第二方面的系统来对环境进行冷却的方法，所述方法包括以下步骤：

[0042] (a)使用压缩机来对制冷剂进行压缩或加热；

[0043] (b)通过使制冷剂通过将热能从一个或更多个外部热源传递到制冷剂的一个或更多个热交换器来提高压缩的制冷剂的温度；

[0044] (c)通过使制冷剂通过冷凝器来使加热的制冷剂冷凝；以及

[0045] (d)通过使制冷剂通过蒸发器来使冷凝的制冷剂蒸发；

[0046] 其中使冷凝的制冷剂蒸发包括使来自环境的空气、气体或另一流体经过蒸发器以将流体内的热能传递到冷凝的制冷剂，从而降低经过蒸发器的流体的温度，所述流体随后被供应回要被冷却的环境。

[0047] 根据本发明的第四方面，提供有一种使用根据本发明的第一方面或第二方面的系统来对环境进行加热的方法，所述方法包括以下步骤：

[0048] (a)使用压缩机来对制冷剂进行压缩或加热；

[0049] (b)通过使制冷剂通过将热能从一个或更多个外部热源传递到制冷剂的一个或更多个热交换器来提高压缩的制冷剂的温度；

[0050] (c)使加热的制冷剂通过蒸发器；以及

[0051] (d)通过使离开蒸发器的制冷剂通过冷凝器来使制冷剂冷凝；

[0052] 其中使加热的制冷剂通过蒸发器进一步包括使来自环境的空气或另一流体经过蒸发器以将制冷剂内的热能传递到流体制冷剂，从而提高经过蒸发器的流体的温度，所述流体随后被供应回要被加热的环境。

[0053] 本发明的第三方面或第四方面的方法可以包括使制冷剂经过一个或更多个热交换器，所述一个或更多个热交换器包括其中安置有加热流体的一系列管道。可替换地，任一种方法可以包括使制冷剂通过一个或更多个热交换器，所述一个或更多个热交换器包括包含加热流体的罐体。在两种情况下，来自加热流体的热能被传递到制冷剂。

[0054] 任一种方法可以包括独立地控制所述/每个热交换器的操作。这样，制冷剂被热交换器(一个或更多个)加热的速率可以被改变。

[0055] 在任一种方法的实施方案中，制冷剂可以使用通过燃烧过程提供热能的热源来加热。在这样的实施方案中，燃烧过程可以放出热气，这些热气可以被用来直接地或间接地对制冷剂管道内的制冷剂进行加热。在进一步的实施方案中，制冷剂可以使用通过化学过程(比如放热化学反应)提供热能的热源来加热。再次，化学过程可以放出热气，这些热气被用来对制冷剂管道内的制冷剂进行加热。在一些实施方案中，热源可以包括一系列燃料电池，并且制冷剂可以通过电加热来加热。可替换地，制冷剂可以使用从来自所述系统的部件中的一个或更多个的废热提供热能的热源来加热，废热可以最初被热源储存，或者可以直接按照它被所述系统生成的样子被使用。进一步的热源可以是可以被单独的回路中的太阳能板加热的水或其他液体，该水或其他液体可以被传递通过热交换器来对制冷剂进行加热。该回路还可以包含热水储存罐，该热水储存罐将使得在没有太阳光时也可以使用太阳能热。

[0056] 本发明的第三方面或第四方面的方法可以使用包括多个压缩机的系统、包括独立地控制每个压缩机的操作的方法来执行。这样，制冷剂在使用中被压缩的速率可以被改变。在其他实施方案(比如其中所述系统仅包括单个压缩机的那些实施方案)中，所述方法可以包括改变所述单个压缩机的运行速率。

[0057] 本发明的第三方面或第四方面的方法可以包括控制环境内的多于一个的位置处的温度。在这样的实施方案中，所述方法可以使用包括多个蒸发器的系统来执行。

[0058] 本发明的第三方面或第四方面的方法可以包括使用一个或更多个阀来控制制冷剂流过所述系统的流动。在一些实施方案中，所述一个或更多个阀中的至少一个可以包括单向阀，或者可以包括例如截止阀。在这样的实施方案中，所述方法可以包括控制制冷剂在任何给定时间流过哪些部件。在提供有压缩机阵列并且要求控制制冷剂的压缩速率的实施方案中，这可能是可取的。类似地，这对于控制制冷剂被传递到所述一个或更多个热交换器中的哪个以控制压缩制冷剂的加热程度可以是可取的。

[0059] 在本发明的第三方面或第四方面的一些实施方案中，所述方法包括使用安全阀来引导给定制冷剂管道内的制冷剂离开所述管道。这对于确保在制冷剂管道内没有可能造成管道变得损坏或在最坏情况下变得破裂的不想要的压力积累可以是可取的。在一些实施方案中，所述方法可以包括使用安全阀来以防止来自所述一个或更多个热交换器中的至少一个的过度加压的制冷剂通过冷凝器和/或蒸发器(一个或更多个)以及可能对冷凝器和/或蒸发器引起损坏。

[0060] 本发明的第三方面或第四方面中任一方面的方法可以包括使用控制单元来控制

所述系统的部件(包括压缩机、所述/每个热交换器、冷凝器、膨胀阀和/或蒸发器)中的一个或更多个的操作。在相关的实施方案中,所述方法可以还包括附加地或可替换地使用控制单元来控制所述一个或更多个进一步的压缩机、所述多个蒸发器中的每个的操作和/或所述一个或更多个阀中的任何一个的操作。例如,所述方法可以包括使用控制单元来控制压缩机用来压缩制冷剂的速率,和/或控制制冷剂通过阀流到每个部件的流动。

[0061] 在本发明的第三方面或第四方面的一些实施方案中,所述方法可以包括监控制冷剂的一个或更多个参数,比如其温度和/或压力。在这样的实施方案中,所述方法可以包括使用位于制冷剂流动内的一个或更多个传感器来监控所述参数。在一些实施方案中,所述系统的部件中的一个或更多个响应于所述一个或更多个传感器测得的参数的值的操作。所述方法可以包括使用与传感器(一个或更多个)通信的控制系统来监控并且随后控制所述系统的操作。

[0062] 本发明的第三方面或第四方面的方法可以包括将油或其他液体成分与制冷剂隔离和/或将油或其他液体成分分配到制冷剂。可能有必要在特定位置将油或其他流体与制冷剂隔离以防止它们行进到回路内的不利位置,从而确保所述系统的每个部件正在正确地操作,并且足够量的油被返回到压缩机以确保其足够润滑。

[0063] 根据本发明的进一步的方面,提供了一种温度控制系统,所述系统包括:压缩机、冷凝器、膨胀阀以及蒸发器,这些全都通过多个制冷剂管道串联连接;其中所述系统进一步包括多个热交换器,所述多个热交换器在使用中可操作来将热能从外部热源传递到制冷剂,其中所述热交换器中的至少两个被构造为传递来自不同外部热源的热能。

[0064] 在实施方案中,热交换器中的至少一个被安置在压缩机和冷凝器之间以(并且在离开压缩机的制冷剂进入冷凝器之前)将热能从外部热源传递到制冷剂中。在实施方案中,所有热交换器都被安置在压缩机和冷凝器之间以(并且在离开压缩机的制冷剂进入冷凝器之前)将热能从外部热源传递到制冷剂中,在这种情况下,热交换器可以被布置成阵列。

[0065] 外部热源可以包括以下中的任何两个或更多个:太阳能、燃烧过程、化学过程、电加热器、燃料电池、地热能、来自所述系统的部件中的一个或更多个的废热。

[0066] 根据本发明的更进一步的方面,提供有一种温度控制系统,所述系统包括:压缩机、冷凝器、膨胀阀以及蒸发器,这些全都通过多个制冷剂管道串联连接;其中压缩机包括第一压缩机和一个或更多个进一步的压缩机。所述/每个进一步的压缩机可以与第一压缩机串联安置,或者可以与第一压缩机并联安置。在实施方案中,至少一个进一步的压缩机与第一压缩机并联连接,并且至少一个进一步的压缩机与第一压缩机串联连接,以使得提供有压缩机阵列。每个压缩机的运行速率可以是可变的。在实施方案中,所有压缩机的操作都由单个控制单元控制。

[0067] 根据本发明的更进一步的方面,提供有一种温度控制系统,所述系统包括:压缩机、冷凝器、膨胀阀以及蒸发器,这些全都通过多个制冷剂管道串联连接;其中所述系统包括将油或其他添加的成分与制冷剂隔离以收集制冷剂并且将制冷剂供应给回路处的其他期望位置的装置。在实施方案中,隔离装置包括分离器和/或捕油器,所述分离器和/或捕油器被安置在所述一个或更多个热交换器的前面或所述一个或更多个热交换器的后面或热交换器内。分离器和/或捕油器可以用供油线被连接到压缩机。在捕油器存在的情况下,它可以是制冷剂管线中的U形弯道。

附图说明

[0068] 为了使本发明被更清楚地理解，现在将仅以举例的方式来参照附图描述本发明的实施方案，其中：

[0069] 图1是温度控制系统的示意图。

[0070] 图2是本发明的温度控制系统的实施方案的示意图。

[0071] 图3是本发明的温度控制系统的第二实施方案的示意图。

[0072] 图4是本发明的温度控制系统的第三实施方案的示意图。

[0073] 图5是根据本发明的温度控制系统中使用的热交换器的实施方案的透视图。

[0074] 图6A是本发明的温度控制系统中使用的热源的透视图。

[0075] 图6B是图6A所示的热源的进一步的透视图。

[0076] 图7是本发明的温度控制系统的第四实施方案的示意图。

[0077] 图8是本发明的温度控制系统的第五实施方案的示意图。

[0078] 图9是本发明的温度控制系统的第六实施方案的示意图。

[0079] 图10是本发明的温度控制系统的第七实施方案的示意图。

[0080] 图11是本发明的温度控制系统的第八实施方案的示意图。

具体实施方式

[0081] 图1图示说明了温度控制系统10。系统10包括压缩机1、冷凝器4、膨胀阀5以及蒸发器6，每个用若干制冷剂线21被连接以形成压缩循环。系统10附加地包括热交换器3，热交换器3位于压缩机1和冷凝器4之间的循环内。热交换器3可操作来从外部热源(在图1上标号为热源2)获得热能。为了控制系统10的操作，该系统还包括控制单元7，控制单元7经由信号线22电连接到压缩循环的每个部件以控制部件在使用中的操作。

[0082] 在使用中，压缩机1用来压缩制冷剂并且通过制冷剂管道将制冷剂释放到热交换器3，制冷剂可以是任何流体(并且当它从其通过时，最优选地为气体)。热交换器3传递通过用制冷剂与热源2相互作用而获得的热量，导致制冷剂温度升高。加热的制冷剂然后被传递通过冷凝器4，并且随后被传递通过膨胀阀5，并且被朝向蒸发器6传递。当通过膨胀阀5时，制冷剂膨胀，并且在这样做时，快速地冷却下来。冷却的制冷剂然后被传递通过蒸发器6，在蒸发器6中，它通过吸收来自蒸发器6的周围环境的热能而被加热。当制冷剂被以这种方式加热时，周围环境的温度下降。加热的制冷剂然后被向回传递通过压缩机1以重新开始所述过程。

[0083] 因为制冷剂优选为气态流体，所以其物理状态可以使用理想的气体定律(详情参见上面)来近似，理想的气体定律声明气体的压力和其内包含气体的体积的乘积与所存在的气体的分子数量和气体的温度的乘积是成比例的。实际上，在体积保持不变的环境中，比如在温度控制系统的制冷剂管道中，根据后面的膨胀阀的打开，温度的升高可以具有两种正面效果。

[0084] 温度控制系统10通过利用热交换器3和外部热源2在制冷剂已经被传递通过压缩机1之后进一步对制冷剂进行加热来使用该事实。通过这样提高制冷剂的温度，并且因为膨胀阀被关闭，所以将体积和体积内存在的气体的分子数量两者近似为大致不变，温度的升

高也导致压力增大。期望压力在现有技术的系统中通常是仅通过压缩机1来实现的,然而,通过附加地还如本发明中那样对制冷剂进行加热,你可以在不需要压缩机执行所有工作的情况下实现期望压力。当膨胀阀被打开时,加热的气体的分子传递通过膨胀阀的趋势将高得多,因为在膨胀阀的前面和后面之间存在非常大的压力差,以便积累额外的压力。该增大的质量流意味着,更多的制冷剂分子现在在没有加热效果的蒸发器中,所以使蒸发器中冷却容量更高。整个空调器的控制通过减小压缩机的质量流以重新实现最初的目标冷却容量来对所述增大做出反应。两种效果,压力增大和质量流增大,都使压缩机的耗电降低。其速率取决于非常特定的情形、在其数秒内改变的操作中膨胀阀是否被打开以及打开程度。因此,通过这样利用热交换器3,使压缩循环的压缩过程的效率提高,因为压缩机现在需要较少的能量来提供与其中没有提供热交换器的系统中的冷却容量相同的冷却容量。

[0085] 许多不同类型的热源2可以被使用。例如,热源2可以包括一个或更多个内燃机、化学过程、电加热器、燃料电池或太阳能热热源(比如太阳能热板)。在图6A所示的实施方案中,热源502包括一系列真空玻璃管501,而在图6B所示的实施方案中,热源502包括平坦玻璃窗格511,平坦玻璃窗格511在一系列管道的下面和上面具有吸收层522。在两种情况下,热源502可操作来从太阳辐射吸收热量。该热量被传递到贯穿玻璃管502或管道522或置于玻璃管502或管道522中的流体,并且通过传递来自流体的热量经过/围绕热交换器533中的制冷剂流过的管道而被用来提高制冷剂的温度。

[0086] 如图1所示的热交换器3的尺寸必须足够有效地大,但是不可以太大以至于损害控制系统10的性能和/或部件。热交换器传递到制冷剂的热量的总量由交换器的大小、而且还由所用热交换器的数量限定。因此,根据本发明的一些实施方案的温度控制系统利用热交换器阵列。增加热交换器的数量使所述系统的加热容量增大,而且还提供对制冷剂在使用中的加热程度的更大控制。在进一步的实施方案中,本发明的系统可以利用一个或更多个热交换器、或热交换器阵列以及控制制冷剂被传递通过所述系统中存在的所述一个或更多个热交换器中的哪个的装置。这再次提供对压缩制冷剂在使用中的加热的更大控制。下面详细地描述这样的系统。

[0087] 本发明的其中使用包括一系列热交换器233的热交换器阵列203的温度控制系统210的这样的实施方案在图3中被示出。图3所示的系统210包括由各种制冷剂线212、218连接的一系列热交换器233,这些在附图中被定义为管道系统211。管道系统211还包括一系列单向阀213,这些单向阀213被安置在阵列203内的每个热交换器233的后面以防止制冷剂通过系统210回流。类似的单向阀213可以被安置在阵列203的前面来执行类似的功能。另外,系统210进一步包括一系列电子激活阀202,这些电子激活阀202被安置在热交换器阵列203内的每个热交换器233的紧接前面。阀202的操作由控制单元260控制。这样,传递到制冷剂的热量可以被以可变的方式控制。额外的热交换器240也可以被利用,如图3所示,在单向阀213的下游。图3所示的系统210图示说明热交换器阵列203的一个实施例。然而,应理解,阵列的许多不同的构造是可能的,并且不限于该图所示的构造。

[0088] 图2示出了图1所示的前述系统10、210的变体。具体地说,图2所示的系统110利用一系列压缩机101,这些压缩机101的操作由单个控制单元107控制。这样利用一系列压缩机101进一步提高了对制冷剂的压缩效果。

[0089] 图4示出了本发明的温度控制系统310的进一步的实施方案的一部分,温度控制系

统310还包括具有多个热交换器333的热交换器阵列303。另外，管道系统311和热交换器333是以油和其他液体成分可以根据需要与制冷剂隔离的这样的方式构造的。这样的成分然后可以被运输到期望位置以提高成分和管道系统311的耐用性。为了使得能够实现这，图示说明的实施方案包括油分离器343，油分离器343不仅被连接到制冷剂线322，而且还经由供油线352被连接到压缩机301。类似地，制冷剂线312在热交换器阵列303的下游的点处被构造为包括捕油器351。这可以被形成为制冷剂线312中的U形弯道以隔离和累积来自制冷剂线322内的油。捕油器351也可以如所示那样被连接到压缩机301。

[0090] 图3和4还图示说明了本发明的进一步的特征。具体地说，这些图所示的系统210、310包括各自的制冷剂线218、318，这些制冷剂线绕开热交换器阵列203、303内的一个或更多个热交换器233、333。在使用中，可能可取的是使系统210、310内的制冷剂不传递通过热交换器233、333，而是相反在压缩之后直接传递到冷凝器。在不需要或不期望压缩的制冷剂的加热的情况下，这样的情况可能是可取的。这些图所示的电子激活阀202、302在一些实施方案中可以形成本发明的一方面的流动控制构件。阀202、302可以被切换以使制冷剂可以以全速率或可变速率传递通过所述一个或更多个热交换器中的至少一个和/或使制冷剂可以绕开所述一个或更多个热交换器中的至少一个从压缩机直接被传递到冷凝器。

[0091] 应理解，尽管被示为包括多个热交换器，但是本发明的系统还包括其中提供单个热交换器以及绕开所述单个热交换器的装置的实施方案。

[0092] 热交换器433的实施方案在图5中被示出，并且可以被用在如下温度控制系统(比如图4所示的温度控制系统)中，该温度控制系统包括隔离来自制冷剂管道内的油和其他液体、从而防止在不期望的地方累积并且将它供应给管道系统中的期望位置的额外装置。热交换器433包括歧管421、423以及在其制冷剂管道422中的一个或更多个U形弯道425。管道422可以被这样构造以在最小的可能的空间中提供最大长度的管道422。

[0093] 在使用中，热交换器433可以被定位为使得U形弯道425被放置得高于歧管421、423。当热交换器被用在包括返回来自制冷剂管道内的油和其他液体的额外装置的温度控制系统(比如图4所示的温度控制系统)中时，这是特别有利的。通过以这种方式定位管道422，使得制冷剂内的油和其他液体可以从U形弯道425流回到歧管421、423中、然后向前流到冷却循环中的指定的部件。这样，油或其他液体被防止阻挡U形弯道中的质量流以及以上述方式流回以被收集和运输到管道系统中的其他期望位置。

[0094] 本发明的温度控制系统的进一步的实施方案在图7至11中被示出。这些图所示的系统中的每个尽管有差异，但是以基本上类似的方式操作，下面详细描述这些差异的操作效果。所述系统还包含所有系统共有的某些部件，所以相似的标号一直被用来标识每个系统中的相似部件。在附图中，热交换器阵列是用单个部件描绘的，然而，应理解，如本发明的上面图示说明的实施方案中那样，所述单个部件意图是一个热交换器阵列。

[0095] 图7所示的温度控制系统610进一步包括安全阀624，安全阀624被连接到热交换器阵列603的歧管。阀624被连接到放泄管625，放泄管625本身然后通向蒸发器606后面的和压缩机601前面的制冷剂线621。阀624可以被机械地和/或电子地激活，并且可以在使用中可操作来在热交换器阵列603中的超过临界压力的制冷剂进入压缩机610之前将制冷剂释放到放泄管625中。这防止热交换器阵列603本身内的不想要的过大压力，并且还防止过度加压的制冷剂离开热交换阵列603并且传递到冷凝器604。

[0096] 图8展示了温度控制系统710的进一步的实施方案，在温度控制系统710中，膨胀阀705和/或压缩机701被用一系列信号传输线722连接到中央控制单元700。控制单元700可操作来控制阀705和/或压缩机701的操作以超控如系统710的原始中央控制单元707给出的信号和命令。这是有益的，因为它使得可以对这些部件进行以避免这些部件的性能中的故障为目的的额外控制。系统710可以附加地包括在制冷剂线721内的温度和/或压力传感器(未示出)或系统710的被连接到逻辑控制器700以向其提供数据的部件。该数据可以继而被控制器700解释，控制器700可以基于制冷剂线721内的传感器提供的数据来控制压缩机701和/或膨胀阀705的操作。

[0097] 图9示出了温度控制系统810的进一步的实施方案，温度控制系统810附加地包括旁路分支820，旁路分支820被连接到制冷剂线821，并且具有单独的电激活膨胀阀811。膨胀阀811只是为制冷剂提供被朝向蒸发器传递通过的额外路线，从而给予对制冷剂流过系统810的流动的增大控制。膨胀阀811继而被连接到逻辑控制器800(其与图8所示的逻辑控制器700基本上是相同的，并且执行类似的功能)，逻辑控制器800还控制制冷剂平行流过额外的膨胀阀811的流动。

[0098] 图10示出了温度控制系统910的进一步的实施方案。系统910与其他上述系统基本上是类似的，不过制冷剂线921在离开冷凝器904之后通过使用分配器被划分到各种子循环中，每个子循环具有单个的膨胀阀905、蒸发器906以及连接制冷剂线921。制冷剂线921中的每个还可以包括温度和/或压力传感器，这些传感器继而被连接到控制单元907和/或子控制单元973，以用于监控和控制制冷剂流过线921的流动并且实际上是作为整体的、还有单个的子循环内的温度控制过程，子控制单元973本身被连接到中央控制单元907。单个的子循环的制冷剂线921集合在集合器972中，并且从那以后集合在压缩机901的公共制冷剂线921中。通过提供多个蒸发器906，系统910可以提供若干不同空间位置上的温度控制。例如，在单个区域内的不同位置上，或者实际上在环境内的单独的区域内，比如不动产内的不同房间。

[0099] 图11示出了本发明的温度控制系统1010的进一步的实施方案。系统1010与上述实施方案的不同之处在于，它进一步包括使制冷剂流过系统1010的一部分的方向反向以使得系统1010能够既被用作冷却系统、又被用作加热系统。为了实现这，系统1010包括额外的四通阀1101，四通阀1101被连接到一系列制冷剂线1021，并且还通过传输线1022被连接到中央控制单元1007以用于控制阀1101。制冷剂线1021连接四通阀1101与热交换器阵列1003、冷凝器1004、蒸发器1006以及压缩机1001。四通阀1101可操作来将制冷剂构造为在两个单独的方向中的一个上流过系统1010。第一方向是制冷剂通过管道1021从热交换器1003流到冷凝器1004、然后流到膨胀阀1005、然后流到蒸发器1006、最后流回四通阀1101、然后流到压缩机1001。在该设置中，系统1010充当冷却系统，因为冷凝的制冷剂通过从其周围环境移除热能被传递通过导致制冷剂加热的蒸发器。可替换地，四通阀可以通过系统1010将制冷剂从热交换器阵列1003引导到蒸发器1006，然后引导到膨胀阀1005，然后引导到冷凝器1004，然后引导回四通阀1101，并且引导到压缩机1001上。在该设置中，制冷剂在它进入蒸发器1006时被加热和加压，在蒸发器1006中，它随后随着制冷剂向周围环境传递热量而冷却。在加热构造中，热交换器阵列1003用来在压缩机1001后面进一步对气体进行加热，该气体然后如上所述那样在蒸发器1006中被传递。热交换器阵列1003向压缩机1001后面的制冷

剂添加的热量越多，压缩机1001必须对制冷剂进行的加热越少。理想地，压缩机1001仅在热交换器阵列1003接管加热要求时将制冷剂向前移动。四通阀1101的设置、所以冷却或加热操作之间的区别由中央控制单元1007设置，并且可以是基于用户的要求和/或在位于冷却循环或其部件中的制冷剂线1021内的传感器处测得的温度和/或压力。

[0100] 类似地，在温度控制系统可以既充当加热系统、又充当冷却系统的情况下，比如在图11所示的系统1010中，系统1010可以附加地包括一个或更多个可以为阀的形式的流动控制构件，所述一个或更多个流动控制构件在使用中可操作来引导制冷剂的流动以使得它要么被传递通过所述一个或更多个热交换器中的至少一个、要么绕开所述一个或更多个热交换器中的至少一个直接从压缩机被传递到冷凝器。所述一个或更多个热交换器的绕开可以使用与图3和4所示的布置类似的或等同的布置来执行，该布置包括将制冷剂不通过热交换器、直接从压缩机运送到冷凝器的额外的制冷剂线。在系统1010用作冷却系统的实施方案中，可能可取的是所有制冷剂都被传递通过至少一个热交换器。因此，在这样的情况下，流动控制构件或阀可以操作来这样引导制冷剂。可替换地，在系统1010用作加热系统的情况下，可能可取的是使制冷剂中的至少一些不传递通过热交换器。因此，在这些情况下，流动控制构件或阀可以操作来引导制冷剂中的至少一些以使得它绕开所述/每个热交换器。

[0101] 上面的实施方案仅仅是作为实施例描述的。在不脱离如所附权利要求书中限定的本发明的范围的情况下，许多变化是可能的。

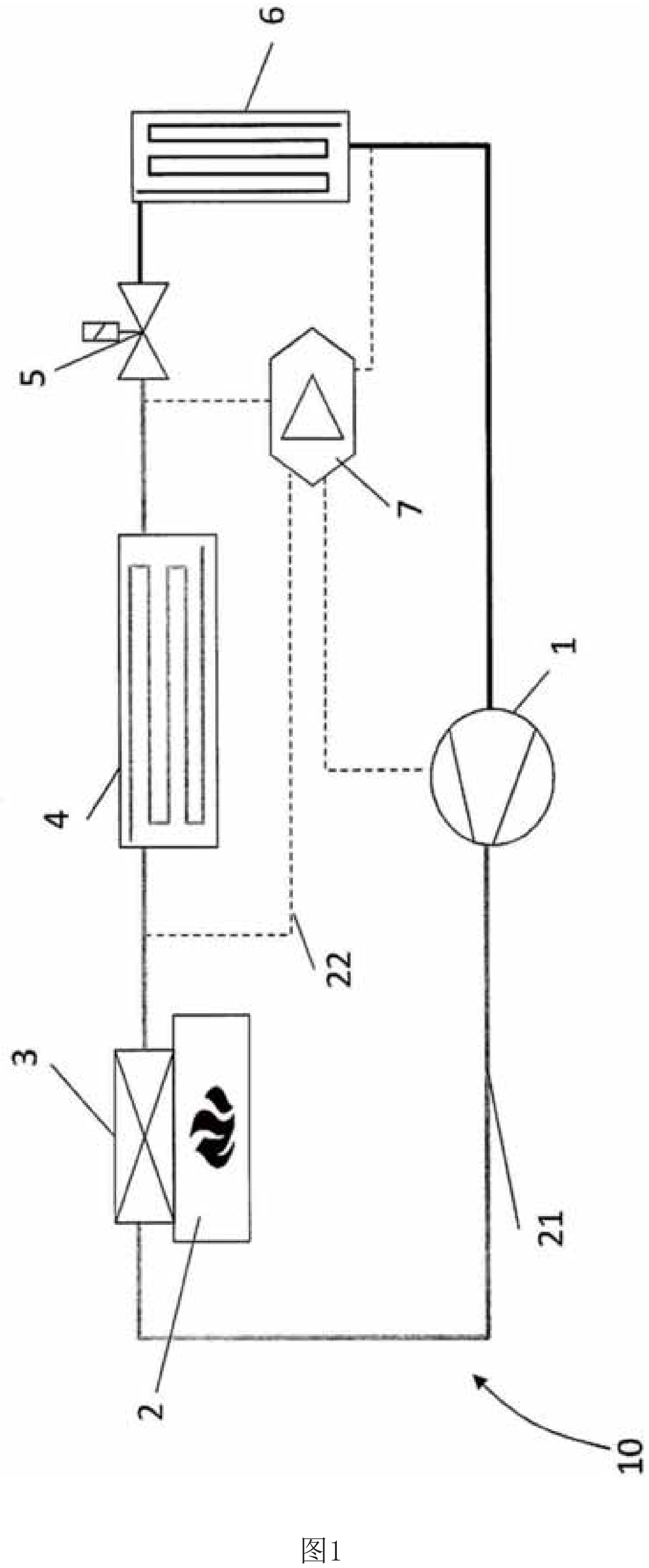


图1

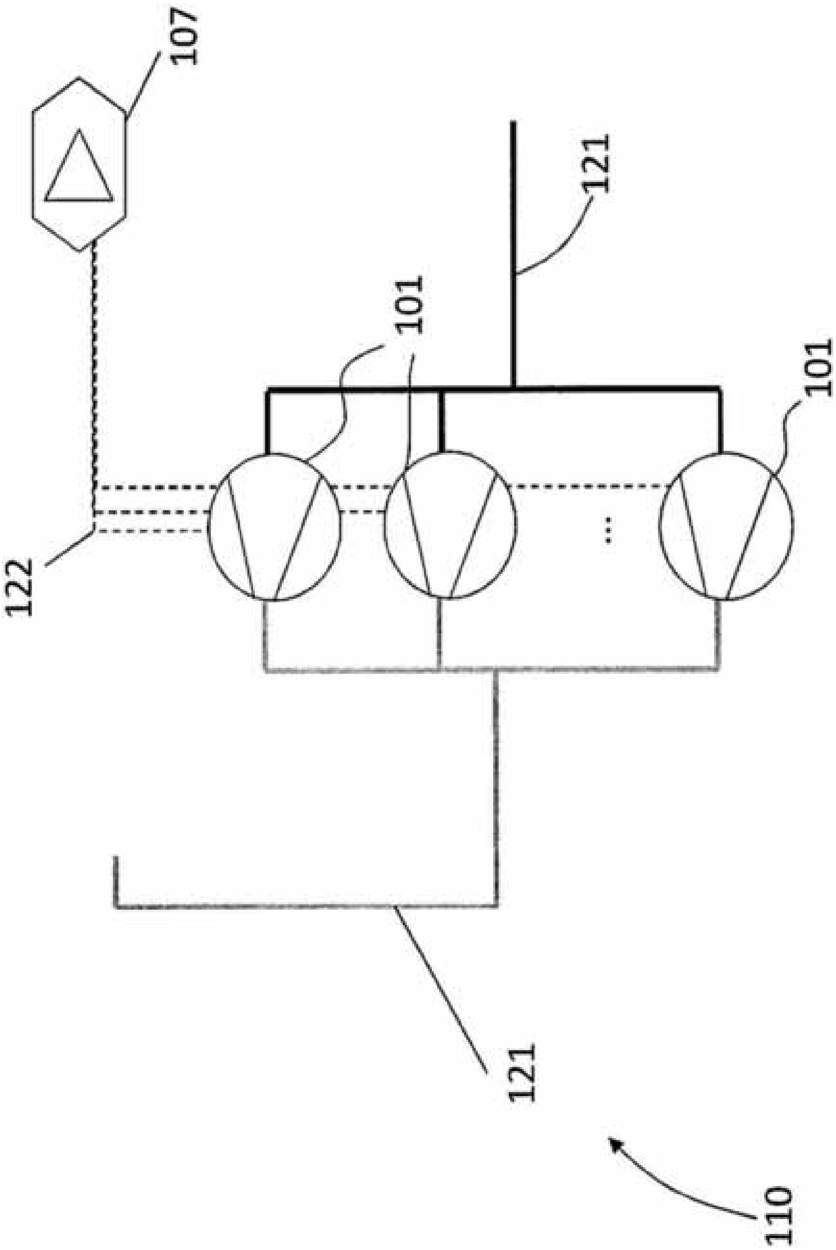


图2

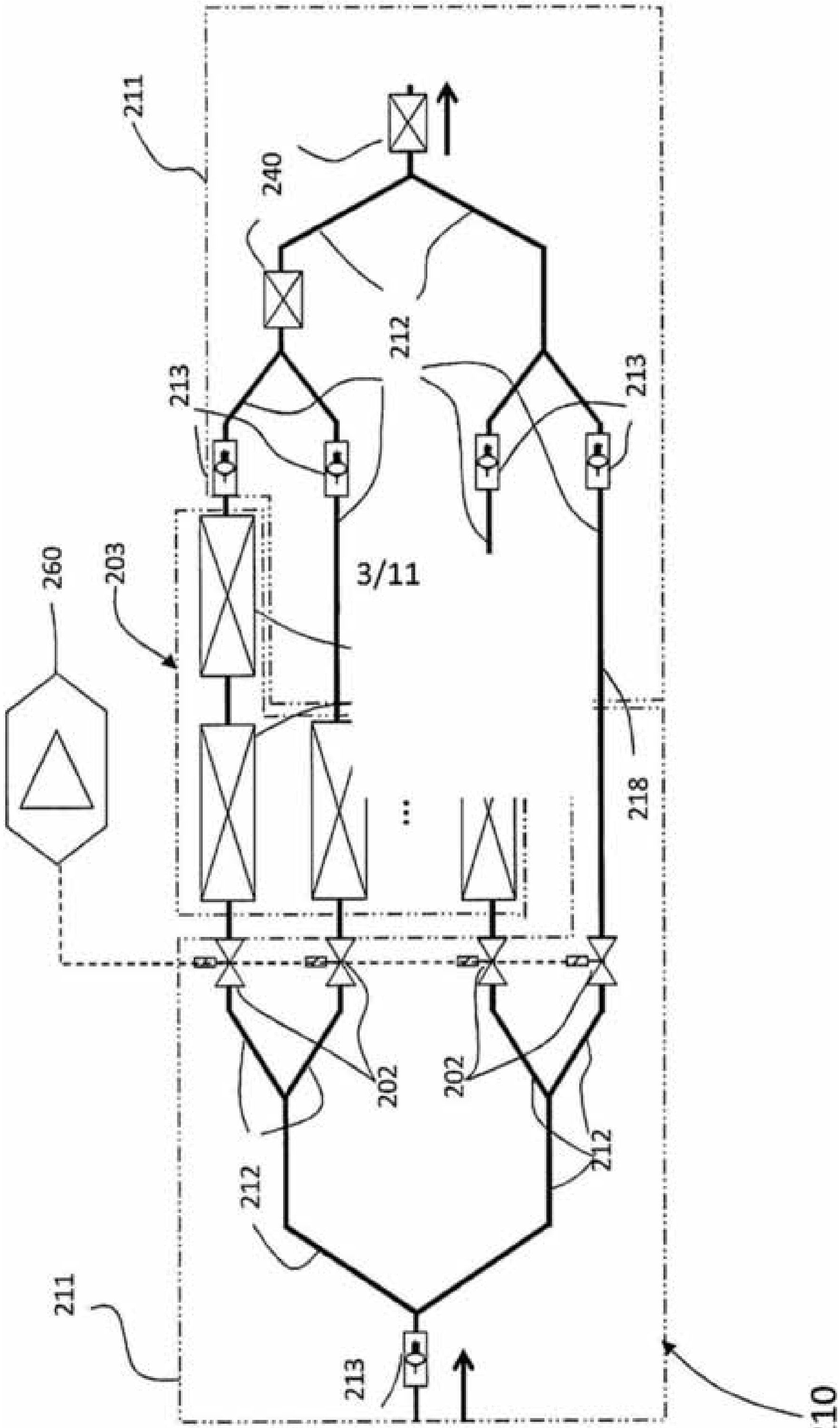


图3

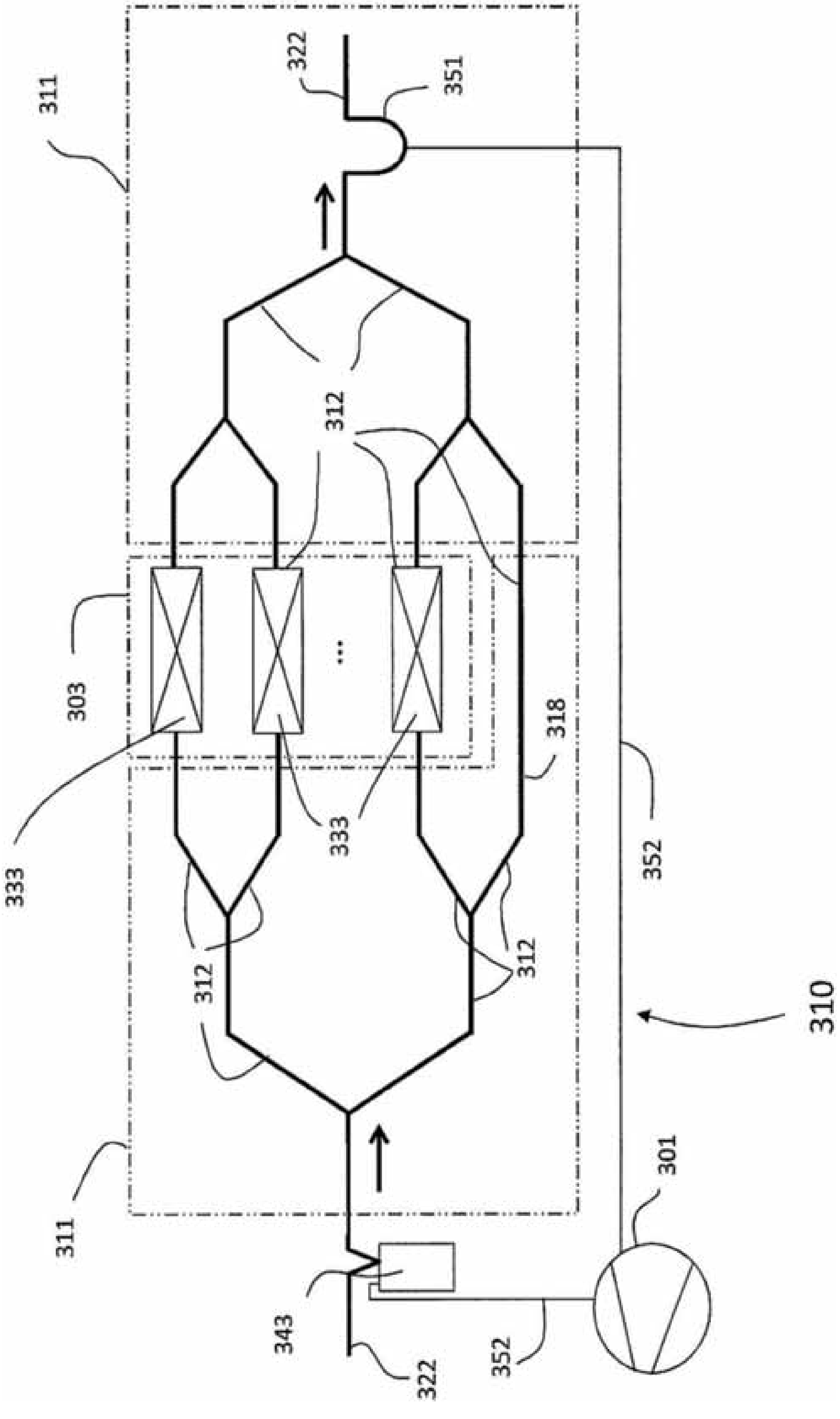


图4

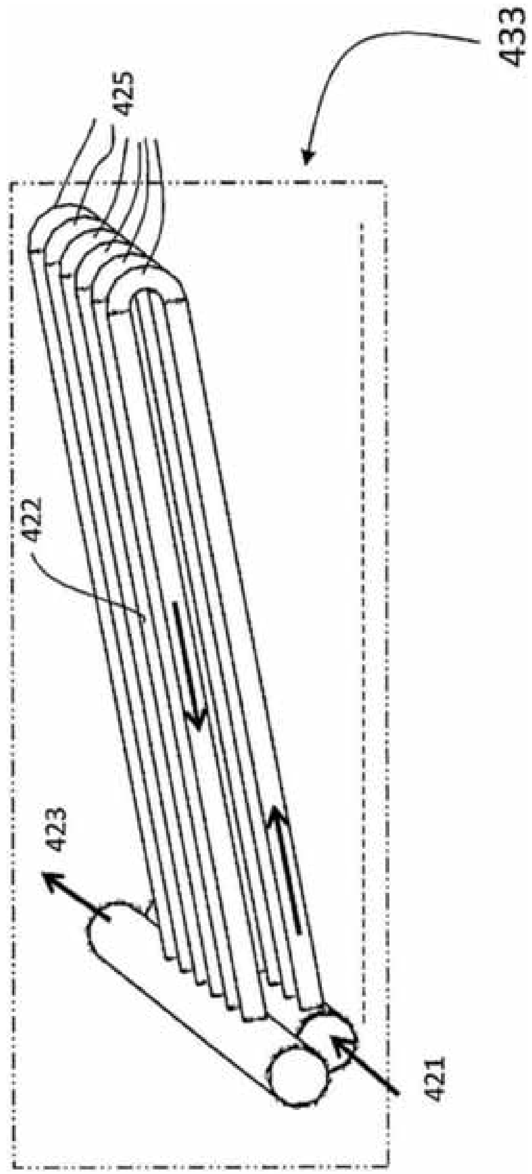


图5

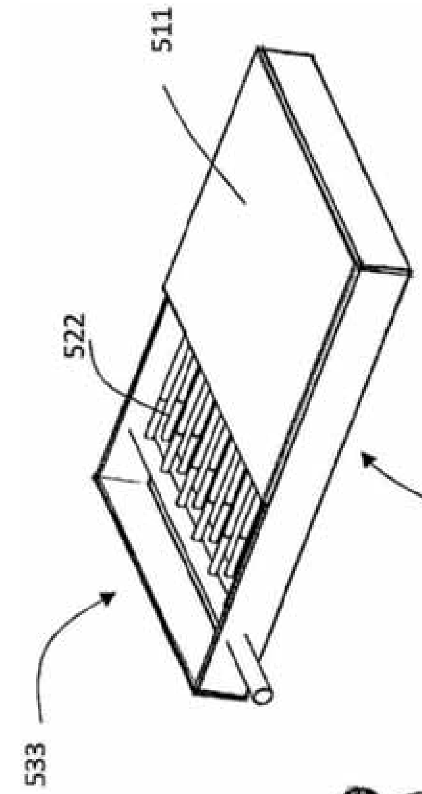


图 6B

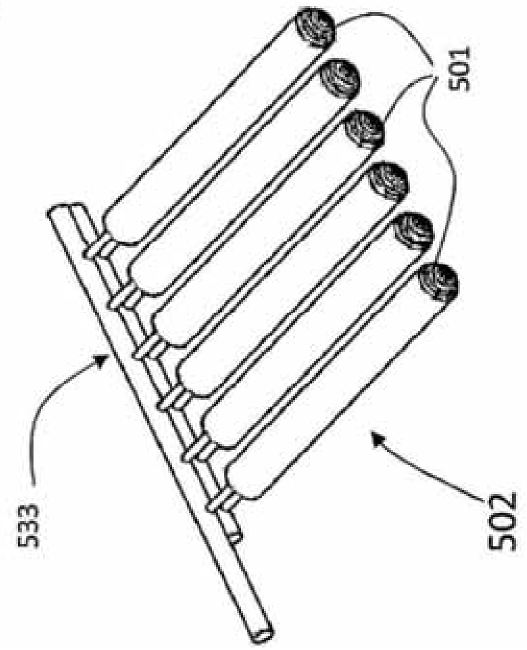


图 6A

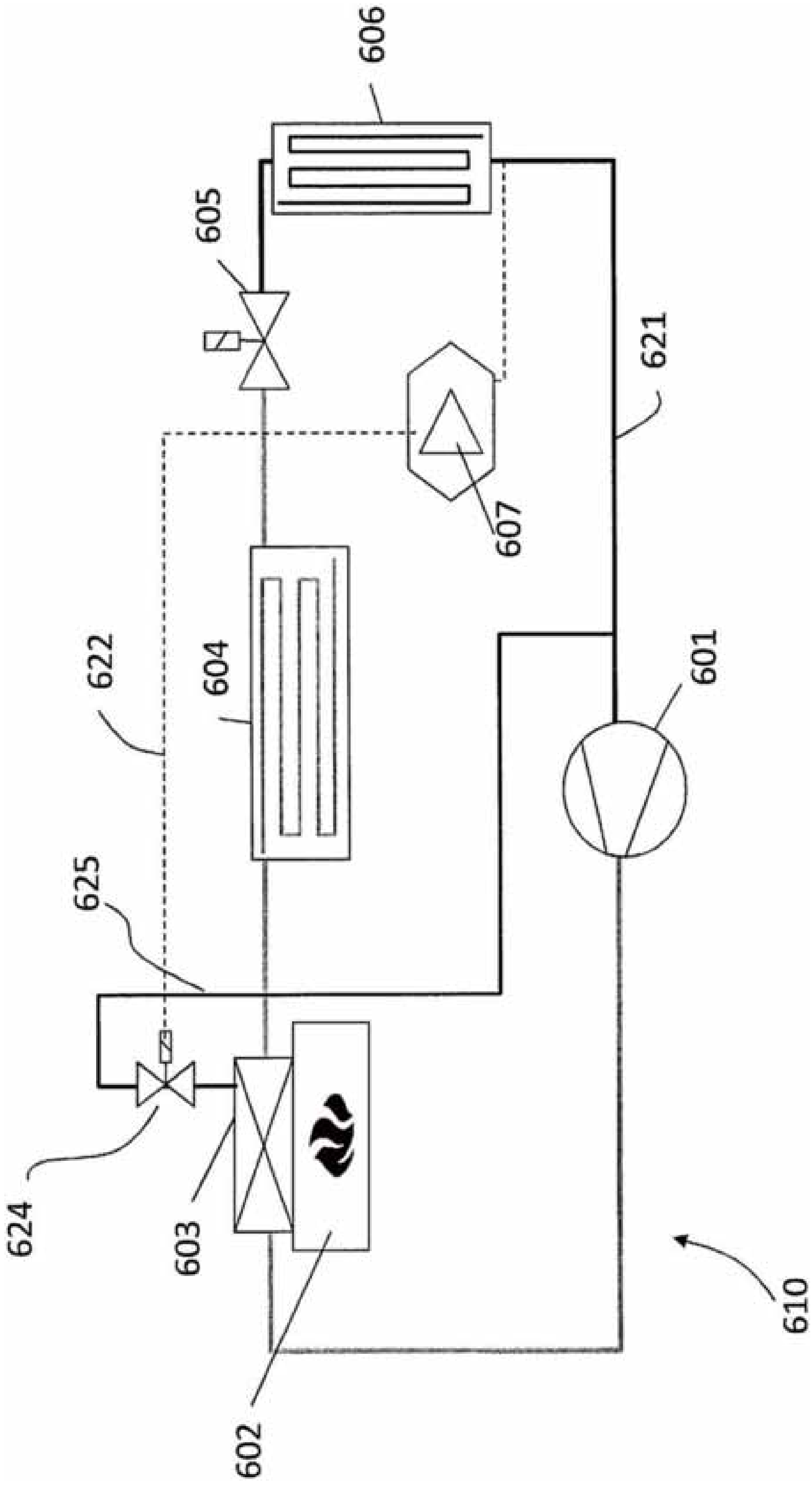


图7

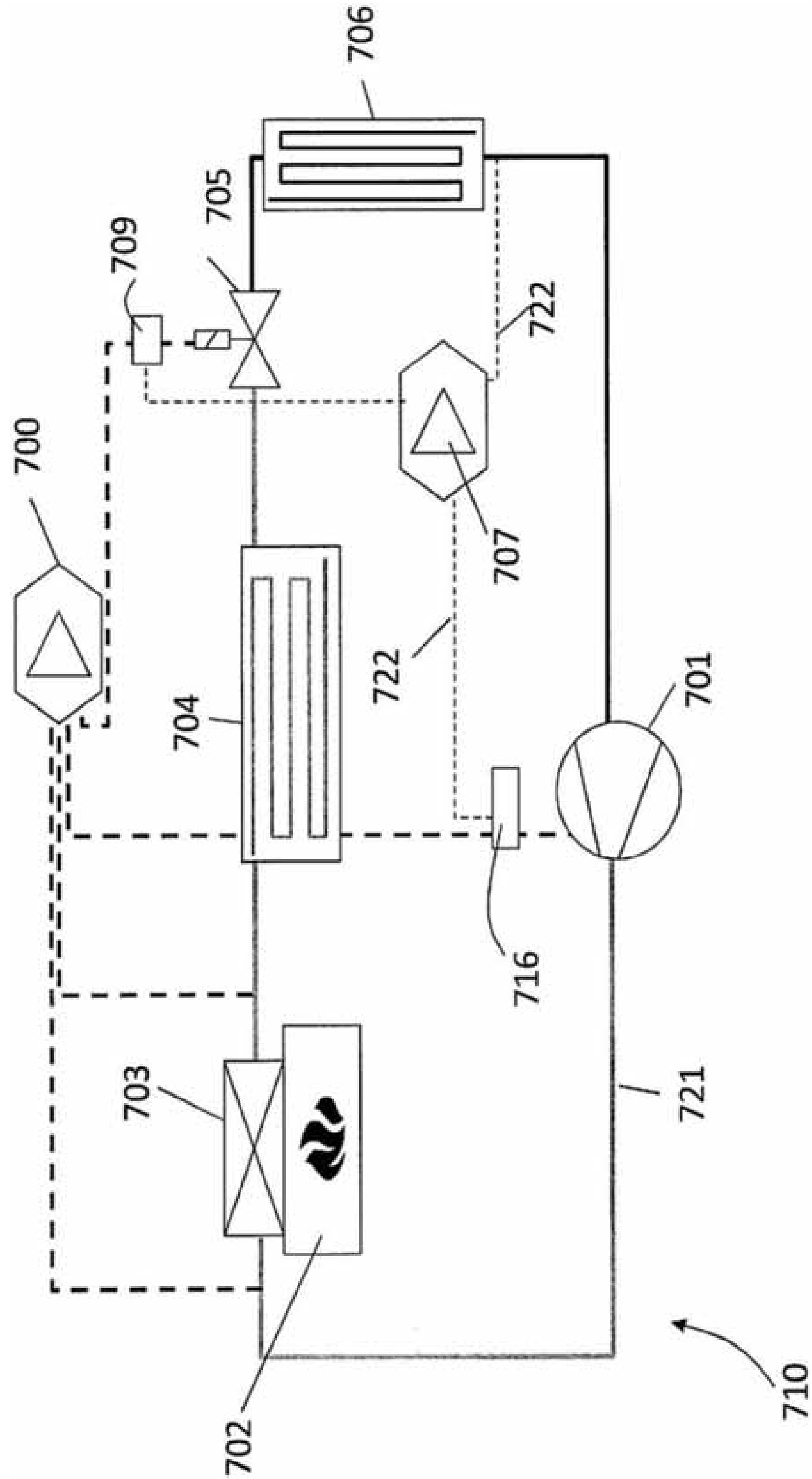


图8

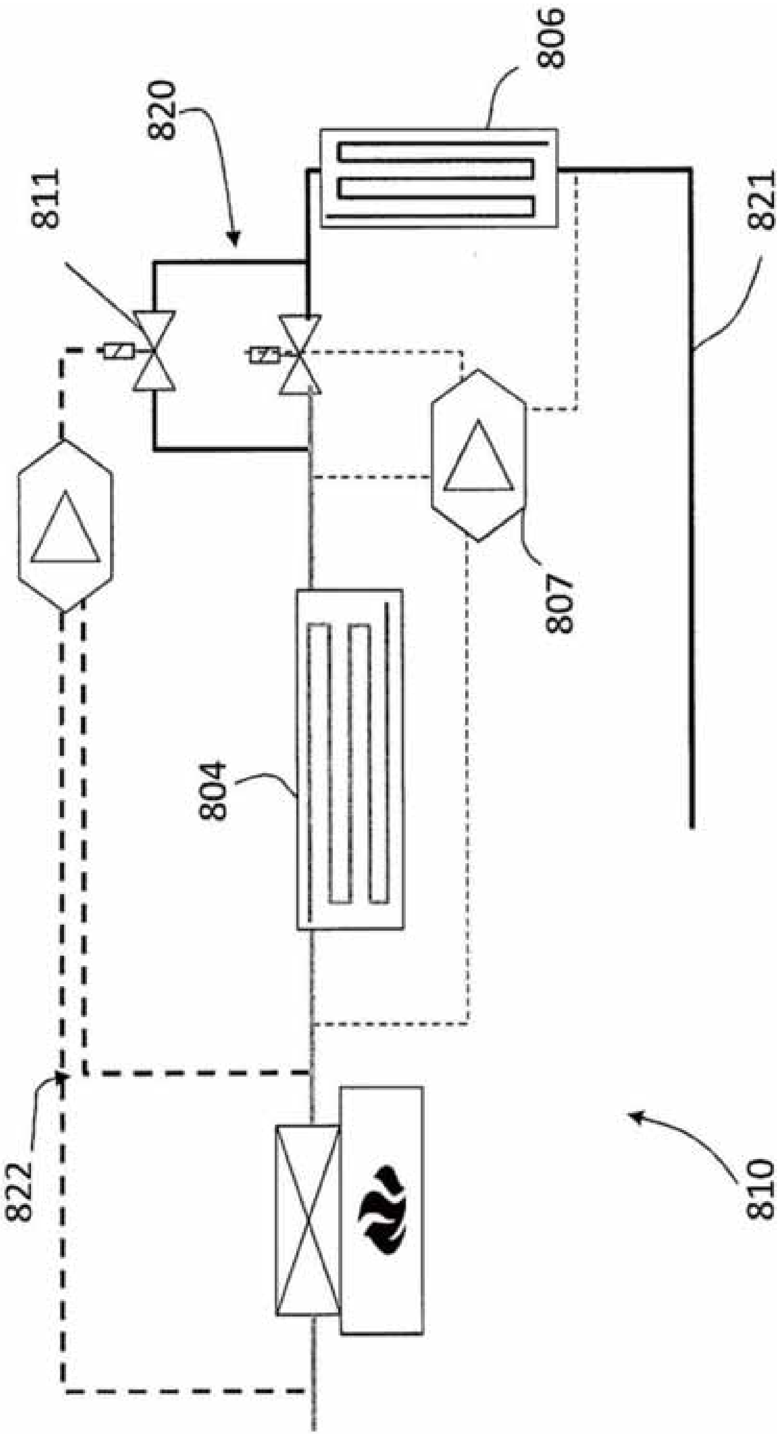


图9

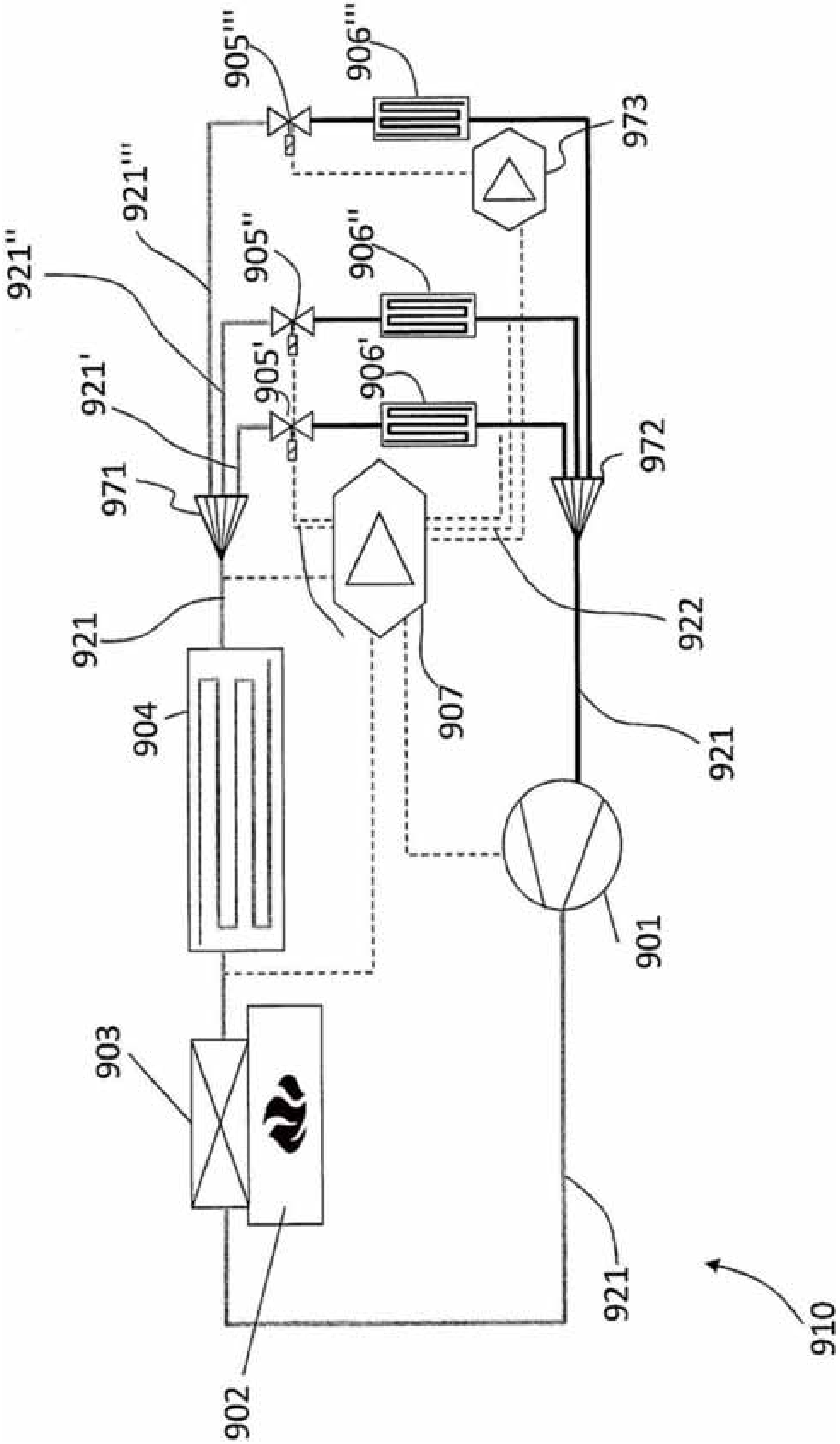

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图10

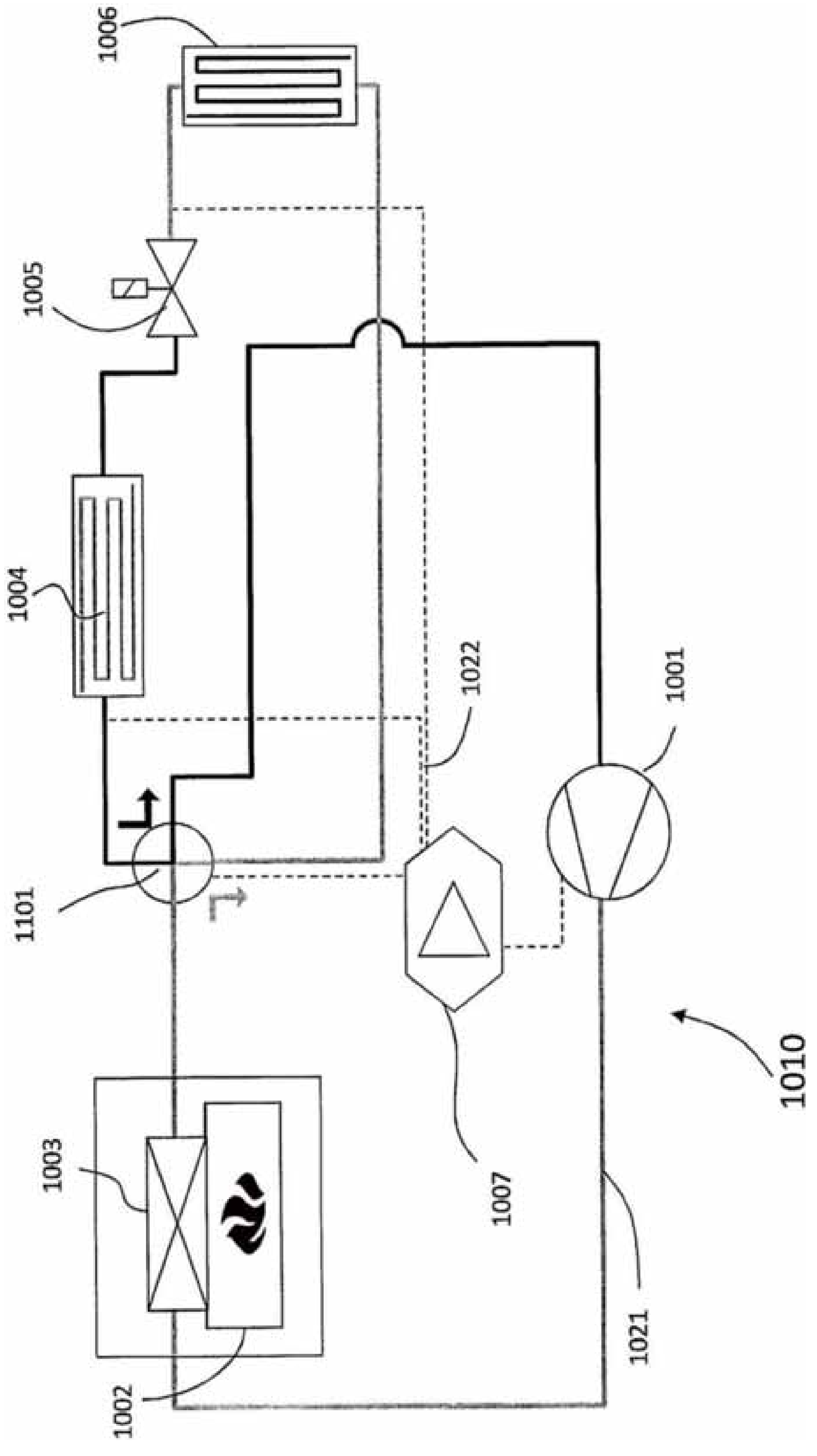

图11