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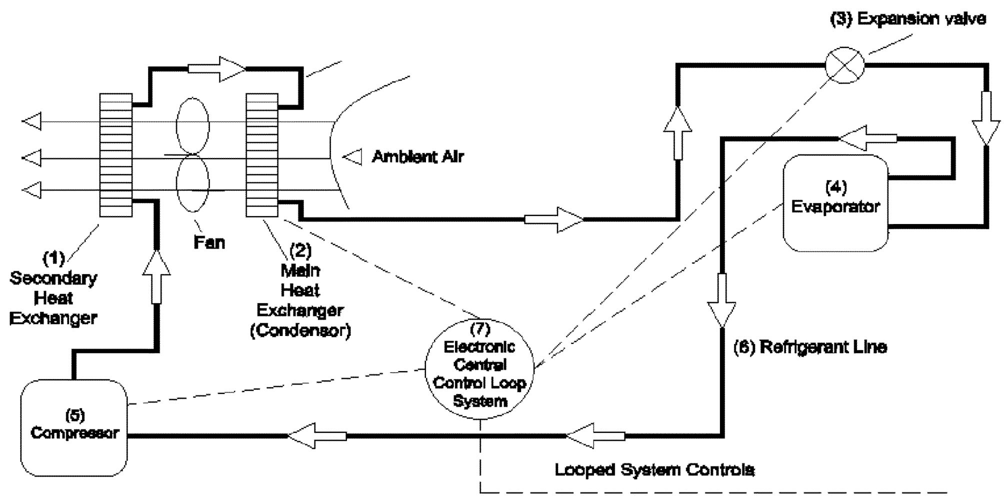
(56) Documents Cited:
GB 2332048 A **EP 2846111 A**
EP 2693134 A **EP 2679933 A**
WO 2005/116547 A

(58) Field of Search:
INT CL **F25B**
Other: **EPODOC, WPI, INTERNET**

(54) Title of the Invention: **Dual heat exchanger (condenser)**
Abstract Title: **Heating/cooling system with secondary heat exchanger**

(57) Heat pumps, refrigerators, air conditioners and other cooling and heating systems which include a compressor or other heat source 5, a main heat exchanger 2, an expansion valve 3, an evaporator 4, and refrigerant pipes 6. One or more additional heat exchangers 1 are included. The additional heat exchangers may be connected in series or in parallel, further cooling or heating the fluid which increases efficiency measured by the delta T value. The pipe work uses materials suitable for the various fluids such as stainless steel for ammonia. A method for a cooling or heating system is also included.



Cooling Mode

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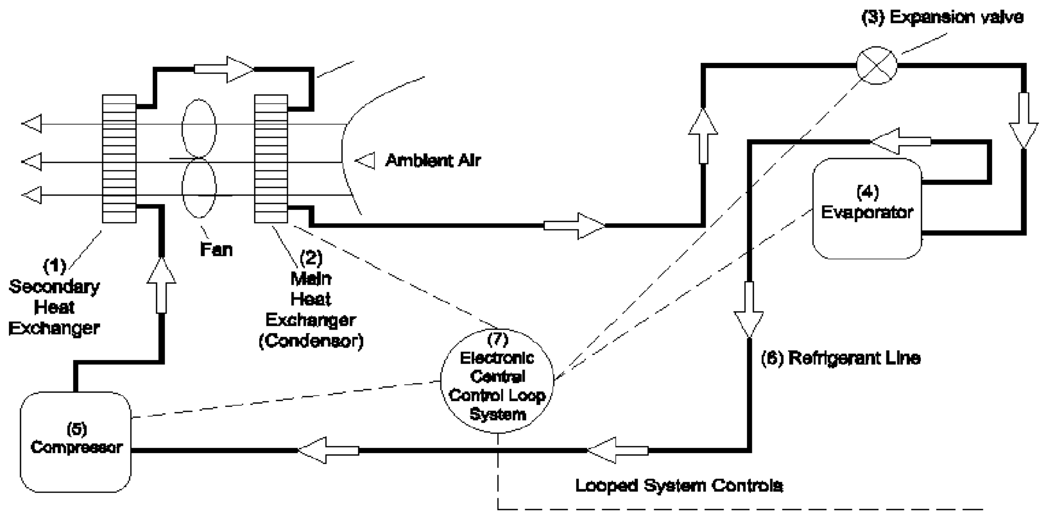
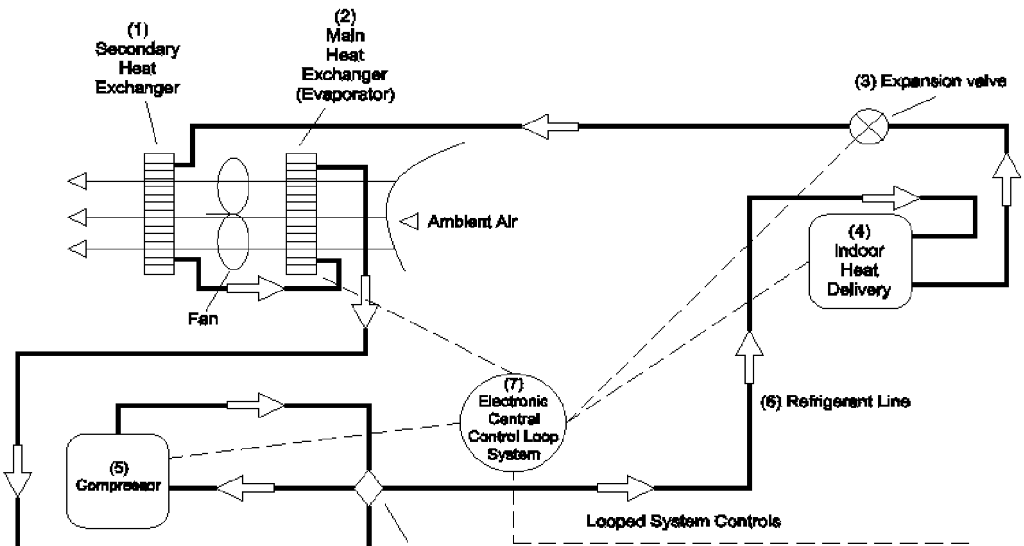


Cooling Mode



Heating Mode

Summary

The method herein uses a secondary heat exchanger in the air conditioning, heat pump and/or refrigeration process to assist in increasing heat via waste heat released from the main heat exchanger produced by the compressor or other heat source. Alternatively when the system is in heating mode cooling the liquid further prior to entering the main heat exchanger via the evaporation process already taking pace in the main heat exchanger. Using this method further enhances the efficiency of the heating and/or cooling cycle when properly sized and constructed. The rate of efficiency of the total heating/cooling/refrigeration system depends heavily on the sizing and construction of the heat exchanger array, ambient temperature and the pipe work to and from these heat exchangers along with the ambient temperature.

Background of the invention

Field of the invention

001 - The invention describes the set-up of a cooling or heating system using the compression cycle process combined with a double heat-exchanger or condenser array connected to it with a specific pipe work enhancing the efficiency of the cooling/heating system by reducing the electrical consumption of the compressor

Description of the prior art

002 - Air conditioning, cooling and refrigeration systems of today use mainly the compression cycle principle. A refrigerant in gaseous state is compressed by a compressor and or other heat source and afterwards liquefied in a condenser. The gas being pressurized changes to liquid and is injected through an expansion valve into an evaporator. By evaporating the liquid refrigerant extracts heat from the surrounding. Air or liquids being passed around the evaporator get cool and transport so the coolness into the room or apparatus.

The compression of the refrigerant requires a high amount of energy. Typically 80% of the total energy used by air conditioning or refrigeration system is consumed by the compressor, independently if the drive is direct or indirectly flanged to the hydraulic part of the compressor.

For a good efficiency of an air conditioning or cooling system it is very important to heat up the gas as much as possible, without creating detrimental effects in the cooling circle or to its components. It is important that the size of the heat source applied to the refrigerant matches with the overall capacity of the cooling system.

Description

003 - Cooling mode

This invention takes advantage of the Delta T within the refrigeration cooling process. Creating an improved Delta T by adding a secondary heat exchanger (1) within the cooling process, thus generating a more efficient collective heat exchanger (1 & 2), and therefore improving the efficiency of the overall system. A cooling system following the compression cycle process. The compressor &/or other heat source (5) heats the gas through this process, which then proceeds onto the secondary heat exchanger (1) and thereafter onto the main heat exchanger (2). At the point of entering the main heat exchanger, the refrigerant gas has passed through the secondary heat exchanger (1) and increased in temperature due to the heat released via the main heat exchanger (2), the refrigerant gas now mixed with the refrigerant liquid is then cooled down to a liquid via the ambient temperature passing through the main heat exchanger (2). Therefore regardless of the ambient temperature at this point in the systems process, the Delta T in the main heat exchanger (2) is higher than that of a normal cooling system which does not contain a secondary heat exchanger (1). Hereafter the cooled liquid created via the main heat exchanger (2) passes through the expansion valve (3) as a super cooled liquid form into the evaporator (4), creating a more comfortable state in the evaporator, and therefore increasing the overall efficiency through the generation of enhanced cooling. As the liquid starts to leave the evaporator (4) the liquid returns to a gaseous state, proceeds onto the compressor and the process repeats over again.

An example of the above is as follows – if we assume the temperature leaving the compressor or other heat source is 80°c with an ambient temperature of 30°c, the Delta T of the main heat exchanger (2) at this point is 50°c. In the case here, the gas is superheated via the main heat exchanger (2) blowing waste heat onto the secondary heat exchanger (1), the heat gain we achieve from this process prior to the refrigerant gas entering the main heat exchanger lifts the Delta T resulting in the improved efficiency of the overall system.

The purpose of the invention is to physically increase the Delta T – the refrigerant gas temperature vs. ambient air temperature, thus enhancing the capacity of the main heat exchanger (2).

<u>004 - Heating or heat pump mode</u>

The heating cycle works in the same way as the cooling cycle but in reverse. The refrigerant gas enters the compressor (5) and then directly into the reverse cycle valve, also known as 4-way valve (8), from here the process continues through to the indoor heat delivery (4). Thereafter the hot gas returns to liquid and state passes through the expansion valve (3), through into the secondary heat exchanger (1). At this stage the liquid leaving the secondary heat exchanger is super cooled via the cold air expelled from the main heat exchanger (2), therefore the liquid entering the main heat exchanger (2) is fully liquefied and super cooled. Therefore regardless of the ambient temperature at this point in the systems process the Delta T in the main heat exchanger (2) is higher as the temperature gap is wider than that of a normal cooling system which does not contain a secondary heat exchanger (1), hence having full the evaporation process of the liquid half way through the process and therefor delivering much higher refrigerant gas temperatures to the compressor than conventional systems, therefore the temperatures and pressures leaving the compressor are significantly increased, thus delivering enhanced capacity to the evaporator (4) where the heat is delivered.

An example of the above is as follows – if we assume the ambient temperature is 4°C, and the refrigerant liquid now mixed with the refrigerant gas leaving the expansion valve (3) is 0°C, when entering into the secondary heat exchanger (1) this mixed liquid and gas refrigerant enters at 0°C, however the temperature will now reduce further due to the main heat exchanger (2) blowing waste cold air onto the secondary heat exchanger (1), consequently the mixed gas & liquid refrigerant passing through the secondary heat exchanger (1) now becomes super cooled as low as minus °C digits. Therefore with the ambient air at 4°C, this is significantly warmer as it hits the main heat exchanger (2), in comparison to a conventional system without the secondary heat exchanger (1).

Again the purpose of the invention is to physically increase the gap of the Delta T, thus evaporating the refrigerant liquid much faster. This process increases the amount refrigerant gas in comparison to refrigerant liquid entering the liquid receiving process, hence reducing the workload on the compressor, creating improved head pressure and higher temperatures.

005 – The heat exchange array (1 & 2) must be sized large enough to be effective, but not too large to harm the system or its performance and components. The total amount of heat transferred is defined by the size and number of heat exchangers (1 & 2) used and arranged in the total cooling/heating circle The aim is to heat up the refrigerant to an optimum level and to have at the same time a low additional pressure build up caused by the pipes and components used in the heat exchanger array (1 & 2). Also the diameters for the various pipe branches (6) may vary from one to the other, when different pipe lengths and components are used in the various respective pipe branches (6).

006 – Creating the initial heat in the refrigerant (5) can be one or a mixture of many different types – compressors, combustion engines, chemical processes, electrical heaters, fuel cells, or solar thermal heat sources like solar thermal panels, for example with vacuum glass tubes or flat glass pane having an absorption layer and so creating heat out of solar radiation.

007 – The heat exchanger array can be used on all types of liquids and/or gases used in the process of the heating, cooling and refrigeration compression cycle.

Claims

1. Cooling system following the compression cycle process, which contains at least the components compressor or other heat source (5), one or more secondary heat exchanger/s (1), main heat exchanger or condenser (2), expansion valve (3), evaporator (4), refrigerant pipes (6), and which are connected to each other in a cooling circle, where the refrigerant pipes (6) connect the compressor or other heat source (5) with the heat exchanger array (1 & 2), the heat exchanger array (1 & 2) with the expansion valve (3), the expansion valve (3) with the evaporator (4), the evaporator (4) with the compressor or other heat source (5).
2. Cooling system characterized by claim 1, where the evaporator (4) may cool surrounding air or gas or liquids or a mixture of both coming into touch with the evaporator (4).
3. Cooling system characterized by claim 1, where the compressor (5) may be any type of refrigeration, heating or cooling compression system.
4. Cooling system characterized by claim 1, where the cooling system may consist of more than one evaporator (4), where the refrigerant lines (6), after having left the heat exchanger array (1 & 2) are split into several sub-circles, which each consist of an expansion valve (3), an evaporator (4), refrigerant lines (6), which connect in each sub-circle after the condenser with the expansion valve (3), the expansion valve (3) with the evaporator (4), the evaporator (4), where all sub-circles come together ahead the compressor (1), whereas each sub-circle may contain separate pressure and temperature sensors being connected with the central control unit (7) of the cooling system and so allowing a proper operation of the cooling system according to the user's requirements and measured temperatures and pressures in the cooling circle.
5. Method for a cooling system as characterized by claim 1, creating energy consumption reduction in the compressor by taking advantage increased Delta T created in the heat exchanger array (1 & 2).
6. Method for a cooling system as characterized by claim 1, creating energy consumption reduction in the compressor by using an increased temperature difference of the refrigerant at the points directly after the heat exchanger (1) due to the refrigerant gas being been further heated by the waste heat dispersed from the main heat exchanger (2).
7. Heating system following the compression cycle process, which contains at least the components compressor or other heat source (5), one or more secondary heat exchanger/s (1), main heat exchanger or condenser (2), expansion valve (3), evaporator (4), refrigerant pipes (6), and which are connected to each other in a cooling circle, where the refrigerant pipes (6) connect the compressor or other heat source (5) with the heat exchanger array (1 & 2), the heat exchanger array (1 & 2) with the expansion valve (3), the expansion valve (3) with the evaporator (4), the evaporator (4) with the compressor or other heat source (5).
8. Heating system characterized by claim 7, where the evaporator (4) may heat surrounding air or gas or liquids or a mixture of both coming into touch with the evaporator (4).
9. Heating system characterized by claim 7, where the compressor (5) may be any type of, heating or cooling compression system.
10. Heating system characterized by claim 7, where the heating system may consist of more than one evaporator (4), where the refrigerant lines (6), after having left the heat exchanger array (1 & 2) are split into several sub-circles, which each consist of an expansion valve (3), an evaporator (4), refrigerant lines (6), which connect in each sub-circle after the condenser with the expansion valve (3), the expansion valve (3) with the evaporator (4), the evaporator (4, where all sub-circles come together ahead the compressor (1), whereas each sub-circle may contain separate pressure and temperature sensors being connected with the central control unit (9) of

the heating system and so allowing a proper operation of the heating system according to the user's requirements and measured temperatures and pressures in the heating circle.

11. Heating system characterized by claim 7, creating energy consumption reduction in the compressor by taking advantage increased Delta T created in the heat exchanger array (1 & 2).
12. Heating system characterized by claim 7, creating energy consumption reduction in the compressor by using an increased temperature difference of the refrigerant at the points directly after the heat exchanger (1) due to the refrigerant gas being been further heated by the waste heat dispersed from the main heat exchanger (2).
13. The heat exchanger array (1 & 2) may be used with all types of liquids and/or gases used in the process of the heating, cooling and refrigeration compression cycle.
14. The heat exchanger array (1 & 2) in the cooling system as characterized by claim (1), consisting of heat exchangers (1 & 2), the pipework (6) to and from the heat exchangers (1 & 2), all properly dimensioned and constructed to the cooling system's capacity and requirement
    - 14.1. The heat exchangers (1 & 2) being two or more heat exchanger placed in a serial or parallel manner. Depending on the cooling capacity of the total cooling system they may be one or several separate heat exchangers placed in parallel or serial and connected to the cooling system as characterized in claim 1 through the pipework (6).
    - 14.2. The heat exchangers (1 & 2) and pipes of the pipework (6) made of copper or any other relevant material capable of complying with the requirements of the refrigerants used in the cooling systems, e.g. ACR copper for R410 or stainless steel for ammonia
    - 14.3. The pipework (6) may contain electrically activated valves connected to a logic controller to allow or disallow full or partial refrigerant flowing through the pipework which connects the separate heat exchangers (1 & 2) to the cooling system as characterized in claim 1.

Intellectual Property Office

Application No:	GB1509730.6	**Examiner:**	Mrs Margaret Phillips
Claims searched:	1-14	**Date of search:**	24 November 2015

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-14	GB 2332048 A (BAILEY et al) Whole document,
X	1-14	WO 2005/116547 A (ICE ENERGY LLC) Whole document
X	1-14	EP 2693134 A (MITSUBISHI) Whole document
X	1-14	EP 2846111 A (HITACHI) Whole document
X	1-14	EP 2679933 A (HITACHI) Whole document

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F25B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, INTERNET

International Classification:

Subclass	Subgroup	Valid From
F25B	0013/00	01/01/2006