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(54) Title: IMPROVED STATIC EVAPORATOR WITH EVAPORATING SHELVES

(57) Abstract: A static evaporator (1) with evaporating shelves (2a, 2b) of a refrigerating apparatus is described, comprising a double supply composed of at least one first and one second circuit (3a, 3b) of a refrigerating fluid, each one of which is shaped in order to obtain a respective shelf (2a, 2b), supplied by a single compressor (4), such two circuits (3a, 3b) being symmetrical and having the same length and the same thermal working conditions.

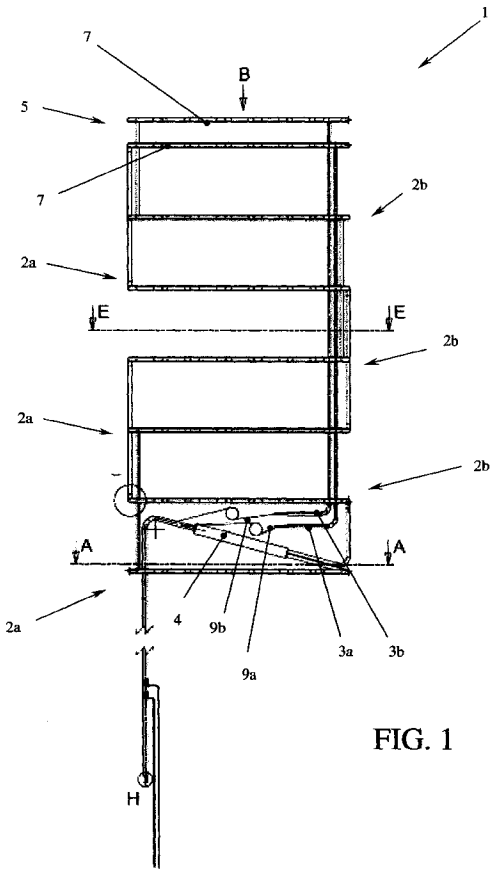

FIG. 1

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— *of inventorship (Rule 4.17(iv))*

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IMPROVED STATIC EVAPORATOR WITH EVAPORATING SHELVES

The present invention referes to an improved static evaporator with evaporating shelves.

As known, in the technical sector of both household and commercial refrigeration for negative uses, namely for preserving foodstuff at a reference temperature of -18°C, normally in vertical apparatuses, the art proposed static evaporators with evaporating shelves, commonly used with manual defrosting.

In particular, such known evaporators are composed of a tube, normally made of iron, aluminium, copper or alloys thereof, whose external diameter is usually equal to 8 mm with a wall of 0.75 mm, inside which a refrigerating fluid flows, such tube being suitably shaped in order to make the shelf on which goods must be placed. For such purpose, in order to confer shape and stiffness to such tube, it is normally equipped with welded wires, suitably cut and bent aluminium sheets or plastic or metallic profiles and/or manufactured

items.

A known evaporator therefore appears as a set of evaporating shelves, mutually connected, supplied as input by an expansion valve of the vapour compression cycle, normally a capillary tube with an inside diameter between 0.6 and 1.5 mm depending on the necessary mass flow-rate. The capillary tube in turn is supplied by the liquid line, namely the terminal condenser section.

The evaporator output is then connected to the suction pipe that leads overheated dry vapours to the compressor. Normally, the suction pipe and the capillary tube, in order to ensure the coolant overheating to prevent the compressor from sucking liquid, are mutually in contact as counter-current, forming the suction line. In the terminal part of the evaporator, normally an accumulator, or a boiler, or a volume that makes the liquid stagnation and its evaporation easier, is placed, always to prevent the compressor from sucking liquid, especially upon the thermostatic cycle startup.

In addition to shelves and suction line, another major component is the brine-catching device: the brine-catching device, usually shaped

as one or more shelves, is placed above the first shelf useful for depositing goods starting from the top.

This element, given its position, firstly cools the hot humid air entering the apparatus following the door opening and, for such reason, is subjected to a greater deposit of ice with respect to the other shelves.

Even without door opening, it is possible to verify that the natural air circulation anyway implies a greater deposit of ice with respect to the remaining evaporator.

Another function, that makes the brine-catching device important for the global performance of the evaporator as regards the product temperature, is linked to its space position. It must be taken into account that the refrigerating system is static, therefore the thermal exchange occurs due to natural convection, namely for air movements that create with motive force the temperature gradients and the floating forces. The field of air temperatures that occurs inside the apparatus is therefore decreasing downwards, and therefore the hotter goods will be placed on the first shelf.

Cooling of goods placed on the first shelf is therefore function of the thermal exchange which the hotter air inside the apparatus benefits when passing through the brine-catching device.

The resulting heat exchange is given by formula K*S*DT, from which it appears:

- the importance of improving the heat exchange coefficient K, increasing for example the air turbulence, reducing the passage sections;
- the importance of increasing the global surface of the brine-catching device;
- with the same resulting heat exchange, it is possible to change the multipliers.

As regards the DT, it must be taken into account that, if due to thermostatic cycle reasons, it is advisable to start firstly supplying the brine-catching device with the refrigerating fluid (otherwise the hotter area could never be correctly supplied for stopping the thermostatic cycle), this brings about a temperature of the brine-catching device, with a completely equalised evaporator, that is higher than the temperature of the shelves, since, being the evaporator in question a long tube, a strong pressure drop occurs inside it, that implies that the evaporation temperature of the

brine-catching device is by some degrees higher than the working temperature of the compressor (suction pressure).

In order to reduce the pressure drop, it must be taken into account that this latter one is function, with other conditions (fluid and motion characteristics) being the same, of the internal tube diameter (it decreases when the pressure drop increases), of the tube roughness (it increases when the pressure drop increases) and of the tube length (it increases when the pressure drop increases). However, since it is not possible to modify the tube characteristics for reasons of commercial availability, the art has proposed to reduce the tube length. It is however immediate to observe how the reduction of the pipe length implies disadvantages, particularly at brine-catching device level, in which the length decrease implies the reduction of the surface and therefore of the heat exchange.

Therefore, object of the present invention is solving the above prior art problems by providing an improved static evaporator with evaporating shelves separated into two parts in order to proportionally reduce the pressure drop by using a

single compressor and a single condenser.

The above and other objects and advantages of the invention, as will result from the following description, are obtained with an improved static evaporator with evaporating shelves as claimed in claim 1. Preferred embodiments and non-trivial variations of the present invention are the subject matter of the dependent claims.

It will be immediately obvious that numerous variations and modifications (for example related to shape, sizes, arrangements and parts with equivalent functionality) can be made to what is described without departing from the scope of the invention as appears from the enclosed claims.

The present invention will be better described by some preferred embodiments thereof, provided as a non-limiting example, with reference to the enclosed drawings, in which:

- Figure 1 shows a front and schematic view of a preferred embodiment of the improved static evaporator with evaporating shelves according to the present invention;
- Figure 2 shows a sectional view along line B-B of the static evaporator with evaporating shelves of Figure 1;

- Figure 3 shows a sectional view along line E-E of the static evaporator with evaporating shelves of Figure 1;
- Figure 4 shows a sectional view along line A-A of the static evaporator with evaporating shelves of Figure 1.

With reference to the Figures, it is possible to note that the improved static evaporator 1 of a refrigerating apparatus with evaporating shelves 2a, 2b according to the present invention comprises a double supply composed of at least one first and one second circuit, respectively 3a, 3b, of a refrigerating fluid suitably supplied by a single compressor 4 and cooperating with a single condenser depending on their specific thermal load and according to the prior art teachings. In particular and advantageously, in order to simply and efficiently obtain the above condition, it is necessary that such two circuits 3a, 3b of the evaporator 1 are symmetrical: such two circuits 3a, 3b are therefore characterised by having the same lengths and thermal working conditions: in order to obtain such equal thermal working conditions, it is necessary to take into account that the evaporating shelves 2a and 2b, respectively obtained from such

suitably shaped first circuit 3a and second circuit 3b, are in an air temperatures range with such a thermal gradient that temperatures decrease from top to bottom.

Therefore, in order to obtain the two above stated conditions in a coherent mode with common production procedures with the lower number of weldings between shelves, it is advantageous to provide for interlacing and offsetting the two circuits 3a, 3b. Thereby, when the height changes inside the refrigerating apparatus a shelf 2a composed of the first circuit 3a and a shelf 2b composed of the second circuit 3b are alternately placed.

In order to optimise the circuit balancing, it is therefore necessary to provide that the brine-catching device 5 is composed of an equal number of shelves 7 due to its functional specificity, and the number of shelves 2a, 2b for goods in deposit is equal.

Possibly, an odd number of shelves 7 composing the brine-catching device 5 can be provided, keeping the process of interlacing the shelves 7 between the circuits 3a, 3b, at the cost of a higher degree of asymmetry and taking into account

the global circuit lengths.

Therefore, in order to use a single compressor 4 and a single condenser, each one of the two circuits 3a, 3b of the evaporator 1 is supplied by such compressor 4 by interposing a respective capillary 9a, 9b with the same flow-rate (about half of the flow-rate used for a single circuit, to be optimised), both in contact with the suction pipe, in order to form the suction line, preferably connected, at the end of the evaporator 1, with a single accumulator that therefore will have one input and two outputs of the coolant side.

The evaporator 1 according to the present invention as previously described therefore allows obtaining a smaller pressure drop and, with the same evaporation temperature of the compressor 4 (suction pressure), obtaining a lower temperature in the most critical section for the performance of the apparatus composed of the brine-catching device 5, such critical points being the relationship between the temperature of the brine-catching device 5 and the temperature of the hottest goods, that from experience is assumed being the one placed on the first shelf.

This therefore brings about an increase of

energy efficiency, since the evaporation temperature is linked to the performance coefficient of the cycle in a direct sense (the lower the evaporation temperature, the smaller the system COP).

CLAIMS

1. Refrigerating apparatus comprising a static evaporator (1) composed of a plurality of evaporating shelves (2a, 2b), characterised in that said refrigerating apparatus comprises:

a. a double supply composed of at least one first and one second circuit (3a, 3b) of a refrigerating fluid, each one of said circuits (3a, 3b) being shaped to obtain said respective shelf (2a, 2b); and

b. a single compressor (4) that supplies both said first and said second circuit (3a, 3b), said first and second circuits (3a, 3b) being symmetrical and having the same lengths and the same thermal working conditions.

2. Refrigerating apparatus with static evaporator (1) according to claim 1, characterised in that said two circuits (3a, 3b) are interlaced and offset, said shelf (2a) composed of said first circuit (3a) and said shelf (2b) composed of said second circuit (3b) being arranged alternatively and in succession when the height changes inside said refrigerating apparatus.

3. Refrigerating apparatus with static evaporator (1) according to claim 1, characterised in that a

brine-catching device (5) of said evaporator (1) is composed of an even number of shelves (7).

4. Refrigerating apparatus with static evaporator (1) according to claim 1, characterised in that the number of said shelves (2a, 2b) is even.

5. Refrigerating apparatus with static evaporator (1) according to claim 1, characterised in that each one of said two circuits (3a, 3b) is supplied by said compressor (4) by interposing a respective capillary (9a, 9b) with the same flow-rate.

6. Refrigerating apparatus with static evaporator (1) according to claim 5, characterised in that each one of said capillaries (9a, 9b) is in contact with a suction pipe to form a suction line.

7. Refrigerating apparatus with static evaporator (1) according to claim 6, characterised in that said suction line is connected at the end of said evaporator (1) to a single accumulator having one input and two outputs on the coolant side.

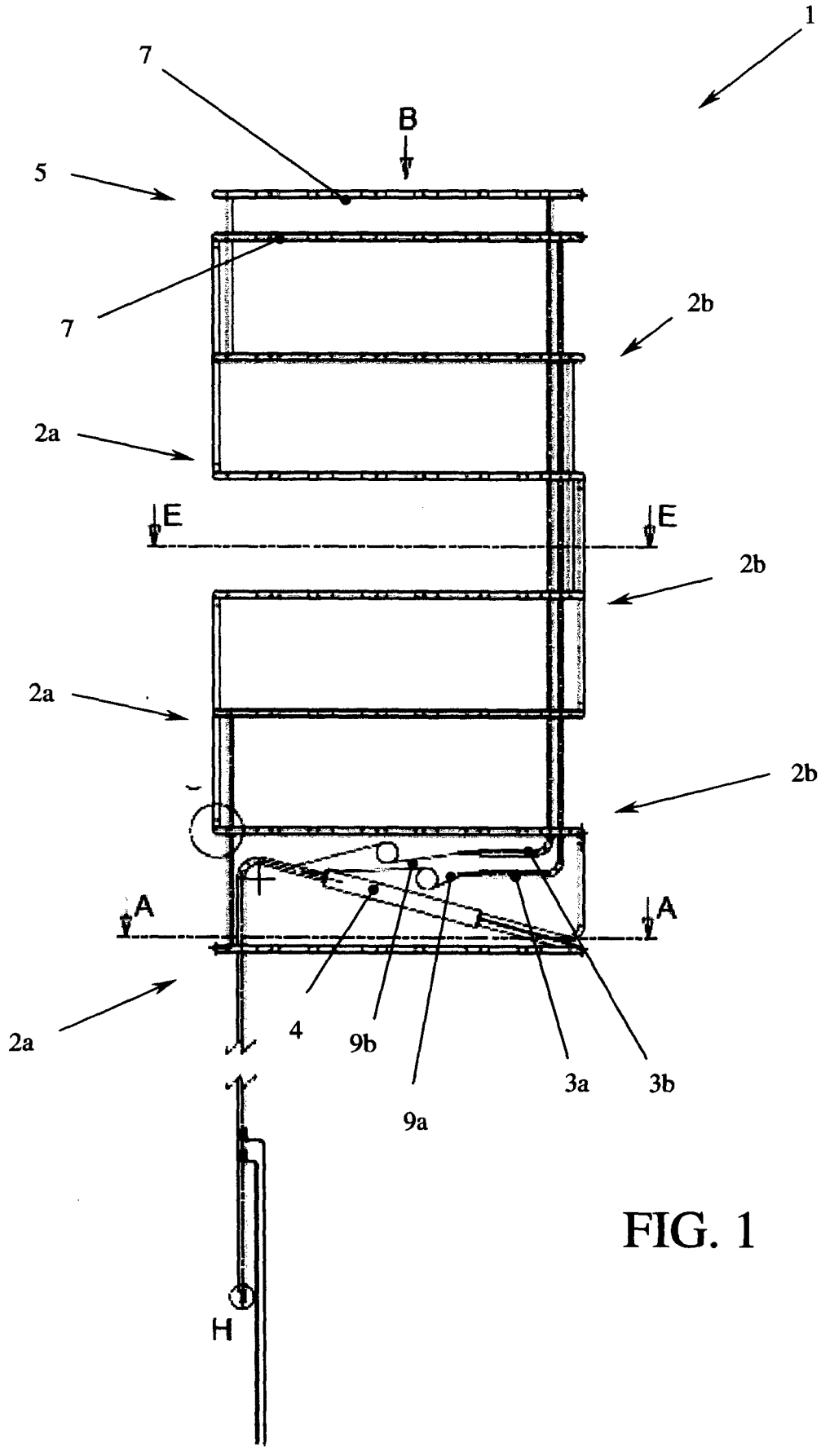

FIG. 1

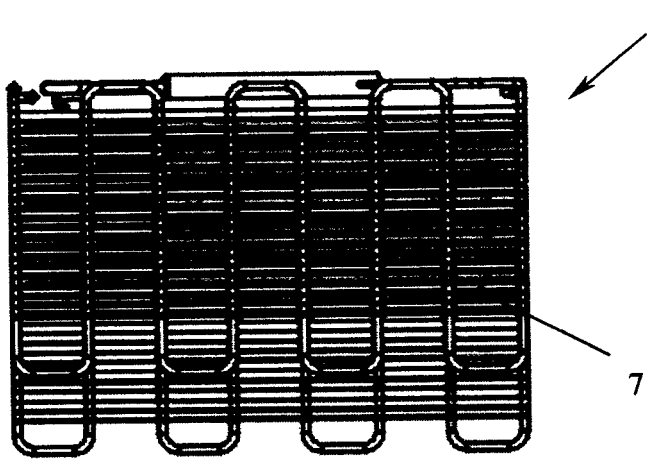

FIG. 2

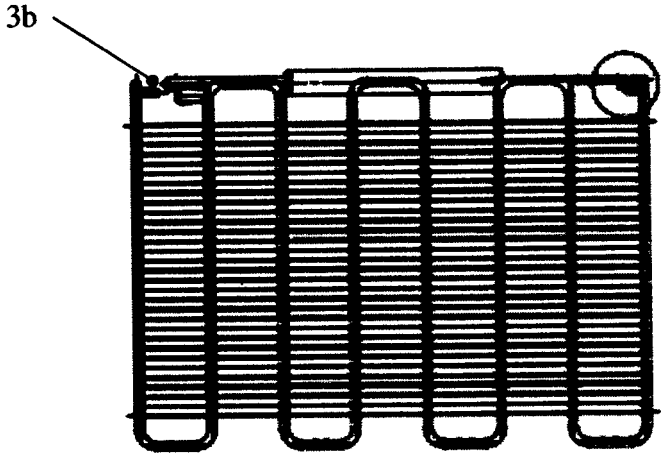

FIG. 3

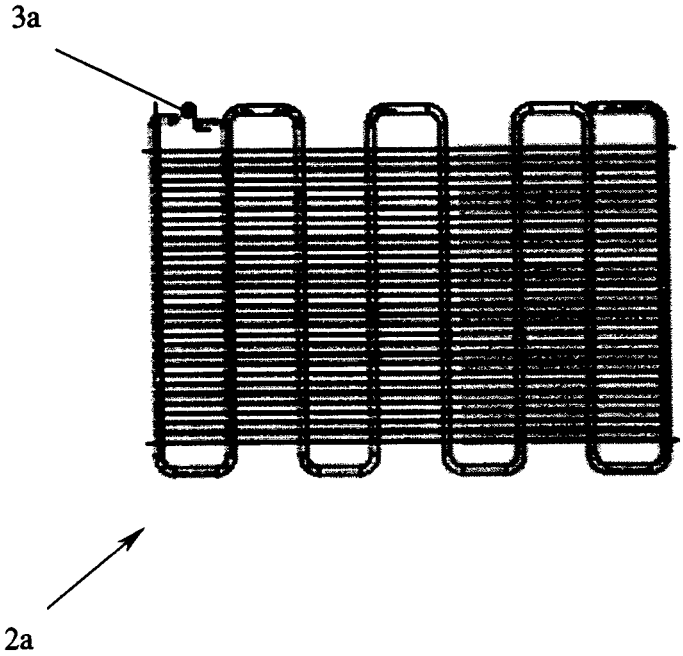

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2011/000239

A. CLASSIFICATION OF SUBJECT MATTER
INV. F25D25/02 F25B39/02 F25B5/02
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)
F25D 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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/114065 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]; EBERLE JUERGEN [DE]; KRANZ THOMAS) 1 December 2005 (2005-12-01) paragraph [0012] - paragraph [0022]; claims 1,2,3,7,8; figures 1,2	1-7
A	DE 33 05 764 A1 (SCHMOELE METALL R & G [DE]) 23 August 1984 (1984-08-23) page 10 - page 11; figures 1-4,7	1-7

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

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 September 2011	05/10/2011

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	Amous, Moez

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2011/000239

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005114065 A1	01-12-2005	CN 1954181 A	25-04-2007
		DE 102004024397 A1	08-12-2005
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