(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 367 036 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.08.2018 Bulletin 2018/35

(21) Application number: **18152542.9**

(22) Date of filing: **19.01.2018**

(51) Int Cl.:
F28D 7/16 *(2006.01)* ***F28D 7/00*** *(2006.01)*
F28F 9/00 *(2006.01)* ***F25B 39/00*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

(30) Priority: **24.02.2017 IT 201700021474**

(71) Applicant: **Mitsubishi Electric Hydronics & IT Cooling Systems S.p.A.**
31100 Treviso (IT)

(72) Inventors:
- **COVOLO, Mariano**
  36064 Mason Vicentino (VI) - Italy (IT)
- **DAL FARRA, Federico**
  32014 Ponte nelle Alpi (BL) - Italy (IT)

(74) Representative: **Rapisardi, Mariacristina**
Ufficio Brevetti Rapisardi S.r.l.
Via Serbelloni, 12
20122 Milano (IT)

(54) A DRY-EXPANSION TUBE BUNDLE HEAT EXCHANGER

(57) The dry-expansion tube bundle heat exchanger (1) comprises a shell (2), a front end head (3), a rear end head (4), a first and a second inlet mouth (5, 6) of the secondary fluid and a single outlet mouth (7) of a secondary fluid.

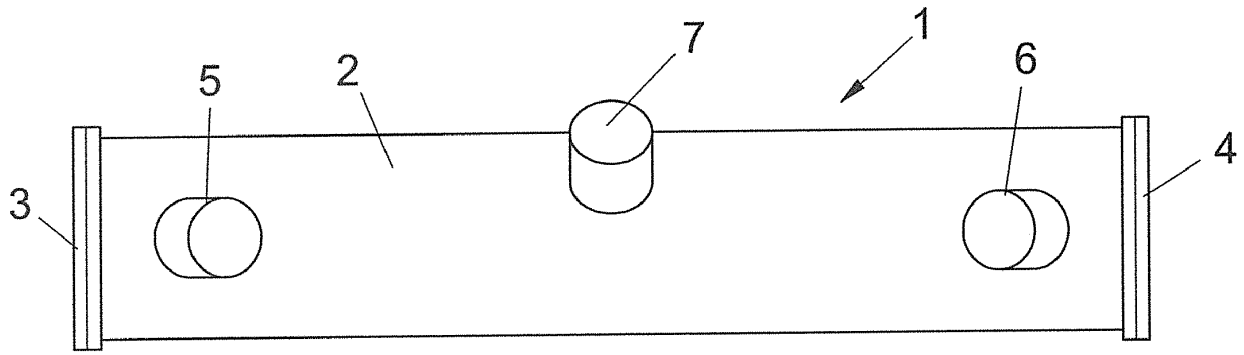

FIG. 1

EP 3 367 036 A1

Description

[0001] The present invention relates to a dry-expansion tube bundle heat exchanger.

[0002] In some types of liquid refrigerating plants dry-expansion tube bundle heat exchangers are used comprising a tube bundle arranged internally of a shell closed by a front end head and a rear end head.

[0003] The refrigerating fluid circulates on the tube side while the secondary fluid, typically water or a non-freezable solution, circulates on the shell side.

[0004] An inlet mouth of the secondary fluid is provided on the shell in proximity of an end head and an outlet mouth of the secondary fluid in proximity of the opposite head end.

[0005] For each refrigerating circuit, the relative tubes extending internally of the shell have an inflow pathway and an outflow pathway positioned at the said end head.

[0006] These heat exchangers have some drawbacks, in particular linked to the size thereof, sometimes excessive with respect to the space available for the installation, to the efficiency thereof which can be negatively impacted by the presence of significant losses of load both on the tube side and on the shell side, and to the possible creation of stagnant zones of the secondary fluid in the corner zone between the shell and the end heads, with a consequent risk of freezing of the secondary fluid.

[0007] The technical task of the present invention is, therefore, to provide a dry-expansion tube bundle heat exchanger which obviates the above-described technical drawbacks of the prior art.

[0008] Within the context of this technical task, an objective of the invention is to provide a dry-expansion tube bundle heat exchanger that is compact and extremely efficient.

[0009] The technical task, as well as these and other aims according to the present invention, are attained providing a dry-expansion tube bundle heat exchanger comprising a shell, a front end head, a rear end head, characterised in that it comprises a first and a second inlet mouth of a shell side secondary circulating fluid and a single secondary fluid outlet mouth.

[0010] With respect to a median plane of the shell perpendicular to the axis of the shell, said first inlet mouth is advantageously positioned on the shell between said front end head and said median plane and said second inlet mouth is positioned on the shell between said rear end head and said median plane.

[0011] Still more advantageously, said first inlet mouth is positioned at a distance from said front end head that is smaller than a distance thereof from said median plane, and said second inlet mouth is positioned at a distance from said rear end head that is smaller than a distance thereof from said median plane.

[0012] The outlet mouth can be positioned on the shell at a median plane of the shell that is perpendicular to the axis of the shell.

[0013] The outlet mouth can also be positioned on the shell at one of two semi-portions which make up one semi-part of the shell comprised between said median plane of the shell that is perpendicular to the axis of the shell and an end of the shell.

[0014] The tube bundle can comprise a single circuit of refrigerating fluid.

[0015] The tube bundle can also advantageously comprise at least a first and at least a second circuit of refrigerating fluid in which the first refrigerating circuit has an inflow pathway at the front end head and the second refrigerating circuit has an inflow pathway at the rear end head.

[0016] The position of the inlet mouths of the secondary fluid in proximity of the end heads enables obtaining the desired extra heating on the aspiration, with a consequent improvement in the efficiency and a reduction of load losses on the tube side and the shell side.

[0017] The flow rate of the secondary fluid is halved with respect to the traditional configuration of a single inlet mouth, so that the tube bundle and consequently the shell can have a smaller diameter, which also allows a reduction of size and an installation in smaller spaces.

[0018] As the inlet point of the secondary fluid, which is the hottest point, is positioned in proximity of the inlet point of the refrigerating fluid, which is the coldest point, the risk of freezing the secondary fluid is eliminated.

[0019] The inlet mouths can have an inclined axis towards the end heads.

[0020] This reduces the stagnant zones of the secondary fluid at the corner zones between the end heads and the shell, thus also improving the coefficient of heat exchange on the shell side.

[0021] Consequently, the refrigerating circuits are also more balanced.

[0022] Consequently, moreover, the possibility of the secondary fluid freezing is even lower.

[0023] Further, the inlet mouths inclined in this way can be connected to an inlet manifold by bends of less than 90°, with a further reduction in loss loads on the inlet manifold.

[0024] The present invention also relates to a refrigerating plant of a liquid which comprises, as an evaporator of the refrigerating fluid, at least a heat exchanger of this type.

[0025] Other characteristics of the present invention are further defined in other claims. Further characteristics and advantages of the invention will more fully emerge from the description of a preferred but not exclusive embodiment of the dry-expansion tube bundle heat exchanger according to the invention, illustrated by way of non-limiting example in the accompanying figures, in which:

figure 1 is a lateral elevation view of the heat exchanger according to an embodiment of the invention;

figure 2 is a front view of the exchanger of figure 1;

figure 3 is a rear view of the exchanger of figure 1;

figure 4 is the exchanger of figure 1 rotated by 90° about the axis of the shell.

[0026] With reference to the mentioned figures, a dry-expansion tube bundle heat exchanger is denoted in its entirety by reference numeral 1.

[0027] The heat exchanger 1 comprises a shell 2 closed at the ends by a front end head 3 and a rear end head 4.

[0028] The tube bundle (not illustrated) is present internally of the shell 2 in which the refrigerating fluid circulates.

[0029] The heat exchanger 1 comprises a first inlet mouth 5 of the secondary fluid which circulates on the shell side 2, a second inlet mouth 6 of the secondary fluid and a single outlet mouth 7 of the secondary fluid.

[0030] With respect to the median plane M of the shell 2 perpendicular to the axis L of the shell 2, the first inlet mouth 5 is positioned on the shell 2 between the front end head 3 and the median plane M of the shell 2 and the second inlet mouth 6 is positioned on the shell 2 between the rear end head 4 and the median plane M of the shell 2.

[0031] In particular, the first inlet mouth 5 is positioned at a distance from the front end head 3 that is smaller than a distance thereof from the median plane M of the shell 2, and likewise the second inlet mouth 6 is positioned at a distance from the rear end head 4 that is smaller than a distance thereof from the median plane M of the shell 2.

[0032] The first inlet mouth 5 and the second inlet mouth 6 are more precisely arranged in a symmetrical position with respect to the median plane M of the shell 2.

[0033] The outlet mouth 7 is in turn positioned on the shell 2 at a median plane M of the shell 2.

[0034] The first inlet mouth 5 and the second inlet mouth 6 have a passage section of a same size, and the outlet mouth 7 has a passage section of a size equal to the passage section of the first outlet mouth 5, and of the second outlet mouth 6. In this case the velocity of the secondary fluid at the outlet is doubled with respect to the velocity of the secondary fluid at the inlet.

[0035] In a possible variant of the invention, in order to maintain the same velocity of the secondary fluid at the inlet and at the outlet the outlet mouth 7 has a passage section equal to the sum of the passage sections of the first inlet mouth 5 and the second inlet mouth 6.

[0036] In the embodiment illustrated the tube bundle comprise a first refrigerating circuit and a second refrigerating circuit.

[0037] Obviously it would be possible to provide a different number of circuits of refrigerating fluid, preferably however more than one.

[0038] The first refrigerating circuit has an inflow pathway 8 at the front end head 3 and the second refrigerating circuit has an inflow pathway 9 at the rear end head 4. The first refrigerating circuit further has an outflow pathway 10 at the rear end head 4, while the second refrigerating circuit has an outflow pathway 11 at the front end head 3.

[0039] The first inlet mouth 5 has an axis B1 orientated towards the front end head 3 and likewise the second inlet mouth 6 has an axis B2 orientated towards the rear end head 4.

[0040] More in general, the first inlet mouth 5 has an axis B1 orientated at an angle α comprised between 60° and 90° with respect to the axis L of the shell 2 and likewise the second inlet mouth 6 has an axis B2 that is orientated at an angle β comprised between 60° and 90° with respect to the axis L of the shell 2.

[0041] The first inlet mouth 5 and the second inlet mouth 6 are arranged with the axes B1, B2 thereof lying in a same plane.

[0042] Instead, the axis B3 of the outlet mouth 7 is offset from the plane in which the axes B1, B2 of the first inlet mouth 5 and second inlet mouth 6 are positioned.

[0043] More in general, the axis B3 of the outlet mouth 7 is orientated at an angle comprised between 0° and 90° with respect to the plane in which the axes B1, B2 of the first inlet mouth 5 and second inlet mouth 6 are positioned.

[0044] The heat exchanger 1 functions as an evaporator in a liquid refrigeration plant. More in general, the heat exchanger can be integrated in a conditioning plant, in a cooling plant, or in a heat pump plant.

[0045] The dry-expansion tube bundle heat exchanger as conceived is susceptible of numerous modifications and variants, all falling within the scope of the inventive concept; furthermore, all the details are replaceable by technically equivalent elements.

[0046] In practice the materials used, as well as the dimensions, can be any according to the needs and the state of the art.

Claims

1. A dry-expansion tube bundle heat exchanger (1) comprising a shell (2), a front end head (3), a rear end head (4), **characterised in that** it comprises a first and a second mouth (5, 6) for inlet of a shell-side secondary circulating fluid (2) and a single secondary fluid outlet mouth (7).

2. The dry-expansion tube bundle heat exchanger (1) according to claim 1, **characterised in that**, with respect to a median plane (M) of the shell (2) perpendicular to the axis (L) of the shell (2), said first inlet mouth (5) is positioned on the shell (2) between said front end head (3) and said median plane (M) and said second inlet mouth (6) is positioned on the shell (2) between said rear end head (4) and said median plane (M).

3. The dry-expansion tube bundle heat exchanger (1) according to the preceding claim, **characterised in**

that said first inlet mouth (5) is positioned at a distance from said front end head (3) that is smaller than a distance thereof from said median plane (M), and said second inlet mouth (6) is positioned at a distance from said rear end head (4) that is smaller than a distance thereof from said median plane (M).

4. The dry-expansion tube bundle heat exchanger (1) according to claim 1, **characterised in that** said outlet mouth (7) is positioned on the shell (2) at a median plane (M) of the shell (2) that is perpendicular to the axis (L) of the shell (2).

5. The dry-expansion tube bundle heat exchanger (1) according to claim 1, **characterised in that** said outlet mouth (7) is positioned on the shell (2) at one of two semi-portions which make up a semi-part of the shell (2) comprised between a median plane (M) of the shell (2) that is perpendicular to the axis of the shell (2) and an end of the shell (2).

6. The dry-expansion tube bundle heat exchanger (1) according to any one of the preceding claims, **characterised in that** said first and second inlet mouth (5, 6) have a passage section of a same size, and said outlet mouth (7) has a passage section of a size equal to the passage section of the first and second inlet mouth (5, 6), or double the passage section of the first or second inlet mouth (5, 6).

7. The dry-expansion tube bundle heat exchanger (1) according to any one of the preceding claims, **characterised in that** at least a first refrigerating circuit is comprised in the tube bundle.

8. The dry-expansion tube bundle heat exchanger (1) according to the preceding claim, **characterised in that** a first and at least a second refrigerating circuit are comprised in the tube bundle, wherein the first refrigerating circuit has an inflow pathway (8) at the front end head (3) and the second refrigerating circuit has an inflow pathway (9) at the rear end head (4).

9. The dry-expansion tube bundle heat exchanger (1) according to the preceding claim, **characterised in that** the first refrigerating circuit has an outflow pathway (10) at the rear end head (4) and the second refrigerating circuit has an outflow pathway (11) at the front end head (3).

10. The dry-expansion tube bundle heat exchanger (1) according to claim 1, **characterised in that** said first and respectively said second inlet mouth (5, 6) have respective axes (B1, B2) that are orientated towards the front end head (3) and respectively towards the rear end head (4).

11. The dry-expansion tube bundle heat exchanger (1) according to claim 1, **characterised in that** said first and respectively said second inlet mouth (5, 6) have respective axes (B1, B2) that are orientated at an angle (α, β) comprised between 60 ° and 90 ° with respect to the axis (L) of the shell (2).

12. The dry-expansion tube bundle heat exchanger (1) according to any one of the preceding claims, **characterised in that** the axes (B1, B2) of said first and second inlet mouth (5, 6) lie on a same plane.

13. The dry-expansion tube bundle heat exchanger (1) according to the preceding claim, **characterised in that** the axis (B3) of said outlet mouth (7) is angularly offset from the plane in which the axes (B1, B2) of said first and second inlet mouth (5, 6) are positioned.

14. A refrigerating or cooling or conditioning or heat-pump plant **characterised in that** it comprises at least a heat exchanger (1) as in any one preceding claim.

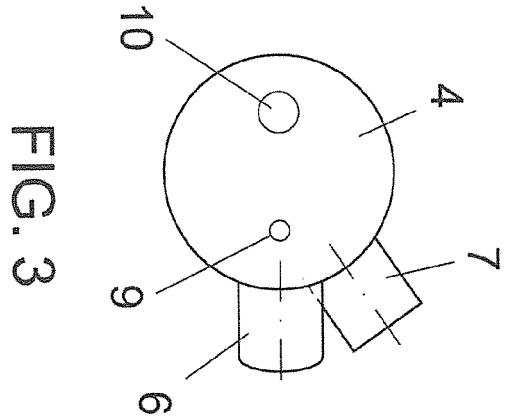

FIG. 3

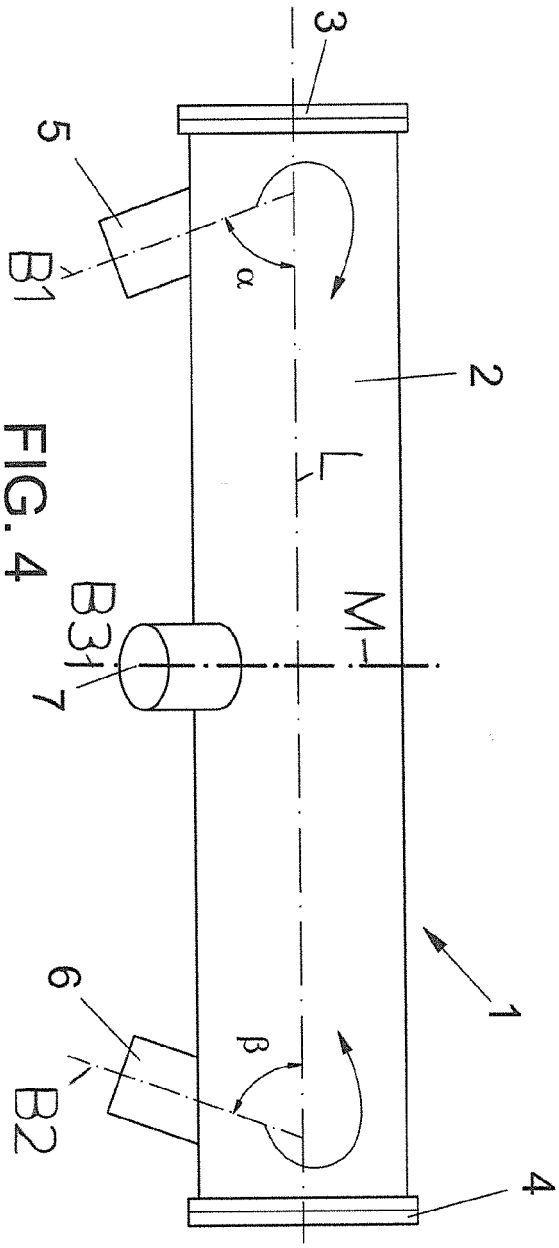

FIG. 4

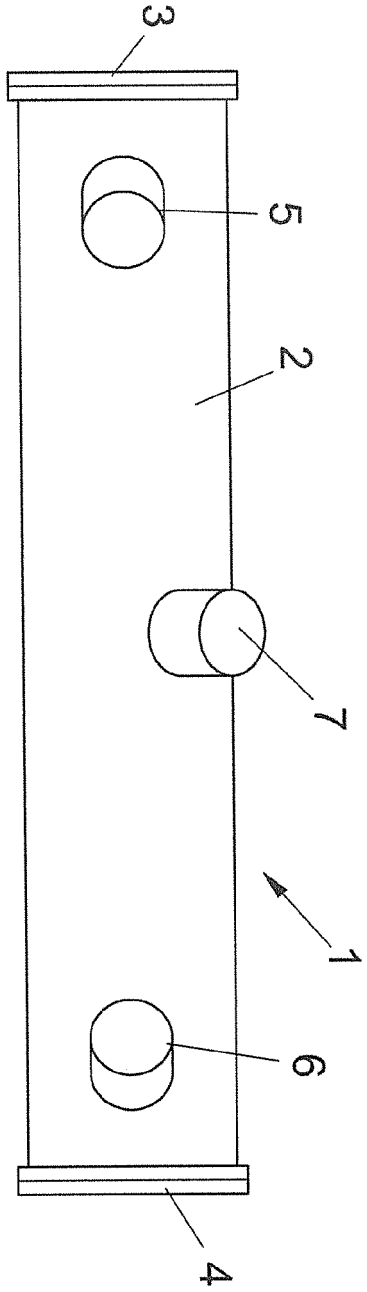

FIG. 1

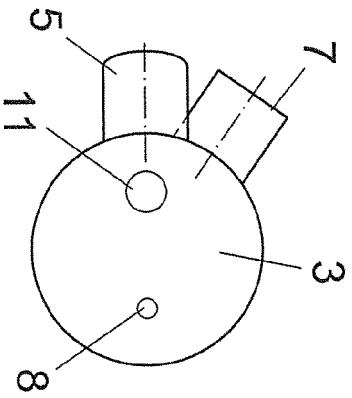

FIG. 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 15 2542

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	GB 918 180 A (CKD PRAHA) 13 February 1963 (1963-02-13) * the whole document * -----	1-7, 12-14 8-11	INV. F28D7/16 F28D7/00 F28F9/00
X	DE 11 90 963 B (GUTEHOFFNUNGSHUETTE STERKRADE) 15 April 1965 (1965-04-15) * figures 1,2 * -----	1,12,14	F25B39/00
Y	US 3 269 135 A (CHUBB DONALD E ET AL) 30 August 1966 (1966-08-30) * claims 1-5; figure 1 * -----	8,9	
Y	WO 2013/022072 A1 (USUI KOKUSAI SANGYO KK [JP]; TAKIKAWA KAZUNORI [JP]; MIYAUCHI YUJI [JP) 14 February 2013 (2013-02-14) * figures 41,42 * -----	10,11	

TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F
F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 May 2018	Bloch, Gregor

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 15 2542

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

31-05-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 918180 A	13-02-1963	NONE	
DE 1190963 B	15-04-1965	NONE	
US 3269135 A	30-08-1966	NONE	
WO 2013022072 A1	14-02-2013	JP 5988296 B2	07-09-2016
		JP 2013053620 A	21-03-2013
		WO 2013022072 A1	14-02-2013

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82