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(54) Evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type

(57) An evaporator (1) for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, comprising at least one coil-shaped tubular element (2), which defines internally a duct for the flow of a coolant fluid and can be accommodated within two passage channels (3, 4) for cooling an air stream (5) that affects the at least one tubular element (2), the evaporator comprising a plurality of segments (12) of the tubular element (2) which are arranged inside the passage channels (3, 4) to prevent the direct passage of the air stream (5) in the passage channels (3, 4) along straight paths.

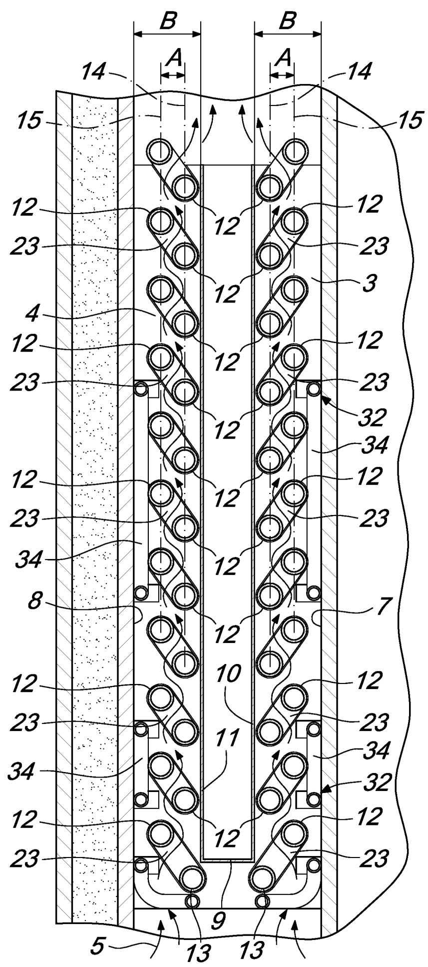

Fig. 4

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Description

[0001] The present invention relates to an evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type.

[0002] Many refrigerating machines, commonly termed "refrigerators", with different power levels and categories, which typically can be divided into traditional refrigerators and so-called "no-frost" refrigerators, are currently widespread in the field of electric household appliances.

[0003] More precisely, refrigerators of the traditional type comprise an evaporator placed in contact with a wall of the enclosed space to be refrigerated.

[0004] In this manner, by circulating a coolant fluid inside the evaporator at very low operating temperatures, the wall cools by conduction, removing heat from the enclosed space to be cooled by radiation.

[0005] This kind of evaporator suffers the main drawback of causing a frost effect inside the enclosed space to be refrigerated at such wall.

[0006] More particularly, ice forms on the wall placed in contact with the evaporator as a consequence of the cooling of the humid air that comes into contact with said wall.

[0007] This drawback is quite inconvenient, not only because during cleaning of the enclosed space to be refrigerated it forces the user to thaw said wall, leading to the formation of water that it is difficult to guide onto an adapted discharge duct, but also because this formation of water can also occur during normal operation if the refrigerator door is accidentally left open.

[0008] As regards refrigerators of the so-called "no-frost" type, they differ from the preceding ones in that they cool the enclosed space to be refrigerated not by conduction but by forced convection of a flow of cold air, avoiding the unwanted formation of frost inside the refrigerator.

[0009] These refrigerators of the "no-frost" type have an evaporator that is interposed in a channel for the passage of a flow of forced air that is directed into the enclosed space to be refrigerated.

[0010] More precisely, with the aid of motorized fans, warm air is blown through the evaporator and cools, and is then directed into the enclosed space to be refrigerated in order to remove heat from it.

[0011] Generally, the evaporators used in refrigerators of the "no-frost" type comprise a coil-shaped tubular element that forms inside it a duct for the passage of a coolant fluid.

[0012] A plurality of fins, typically made of aluminum, is applied to the tubular element, which is typically made of aluminum or copper, and the fins form a plurality of channels for the passage of the forced air stream.

[0013] Cooling of the air blown through the evaporator occurs primarily by contact of the air with the tubular element, whose walls are cold due to their contact with the coolant fluid that circulates within the tubular element, and secondarily due to the contact of the air that circulates between the fins mounted on the tubular element with the fins, since they are cooled by conduction by the tubular element.

[0014] These evaporators used on machines of the "no-frost" type are not devoid of drawbacks, which include the fact that they are structurally complicated, leading to high manufacturing costs and to considerable weight and bulk.

[0015] Another drawback of known types of evaporator resides in that the air that flows through the fins of the evaporator deposits thereon a large amount of frost, which over time, if allowed to accumulate, completely blocks the air flow channels, preventing the generation of cold inside the refrigerator.

[0016] The aim of the present invention is to provide an evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, that is structurally simple, so as to limit the risk of blockages of the air flow channels due to the formation of frost therein.

[0017] Within this aim, an object of the present invention is to provide an evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, that is economically advantageous with respect to the background art, with a performance that is comparable with, if not better than, the background art.

[0018] This aim and these and other objects that will become better apparent hereinafter are achieved by an evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, comprising at least one coil-shaped tubular element, which defines internally a duct for the flow of a coolant fluid and can be accommodated within at least one passage channel for cooling an air stream that affects said at least one tubular element, **characterized in that** it comprises a plurality of segments of said at least one tubular element which are arranged inside said at least one passage channel to prevent the direct passage of said air stream in said at least one passage channel along straight paths.

[0019] Further characteristics and advantages of the present invention will become apparent from the description of a preferred but not exclusive embodiment of an evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a perspective view of the evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, according to the invention;

Figure 2 is an exploded perspective view of the evaporator shown in Figure 1;

Figure 3 is a partially sectional side elevation view of the evaporator shown in Figure 1, installed on a refrigerating machine, according to the invention;

Figure 4 is a partially sectional view of a detail of the refrigerating machine shown in Figure 3.

[0020] With reference to the figures, the evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, generally designated by the reference numeral 1, comprises at least one coil-shaped tubular element 2, which defines internally a duct for the flow of a coolant fluid and can be accommodated within two passage channels 3 and 4 for cooling an air stream 5 that affects the tubular element 2.

[0021] More precisely, as described in greater detail hereinafter, the two passage channels 3 and 4, through which the air stream 5 flows internally, are parallel, are separated one another by a guiding element 6 and can be defined externally by the side walls 7 and 8 of the receptacle of the refrigerating machine 30 in which the evaporator 1 is installed.

[0022] The guiding element 6 comprises a metal plate that is substantially folded in a U-shape, with the base 9 of said U which can face the direction of the air stream 5 to split it into two separate streams that can be guided into the two passage channels 3 and 4, and with the arms 10 and 11 of the U-shape which are oriented substantially parallel to the main direction of the air stream 5 and can face, respectively, the side walls 7 and 8, which also are substantially parallel to the main direction of the air stream 5.

[0023] Advantageously, in a possible variation of the evaporator 1, which is not shown, in order to improve the fluid dynamics efficiency of the guiding element 6, such element can be V-shaped instead of U-shaped.

[0024] In this manner it is possible to reduce the load losses of the air stream 5 due to the stagnation point that can occur at the base 9 of the U-shape.

[0025] According to the invention, the tubular element 2 comprises a plurality of segments 12, which are arranged inside the two passage channels 3 and 4 to prevent the direct passage of the air stream 5 in the two passage channels 3 and 4 along straight paths.

[0026] More precisely, the tubular element 2 comprises at least two groups of segments 12, which can be accommodated respectively in the two passage channels 3 and 4 and are functionally connected one another by end segments 13 arranged at the base 9 of the guiding element 6.

[0027] In other words, the tubular element 2, which is coil-shaped, wraps around the guiding element 6, covering it completely with its turns.

[0028] As regards the segments 12, they lie substantially transversely to the two passage channels 3 and 4 so that their axes alternately lie on two pairs of planes 14 and 15, one for each passage channel 3 and 4, which are contiguous and parallel to each other and to the main direction of the air stream 5.

[0029] More precisely, as mentioned, in order to prevent direct passage of the air stream 5 in the two passage channels 3 and 4 along straight paths, the planes 14 and 15 of each pair are arranged at a maximum distance A that is substantially equal to the outside diameter of the tubular element 2 and each one of the arms 10 and 11 can be arranged at a maximum distance B from the side wall 7 or 8 that faces it which is substantially equal to twice the outside diameter of the tubular element 2.

[0030] In other words, the several segments 12 accommodated in the two passage channels 3 and 4 are arranged so that they are substantially in contact either with the walls of the guiding element 6 or with the side walls 7 and 8 of the receptacle.

[0031] In this manner, the two air streams that cross the two passage channels 3 and 4 are forced to follow substantially sinusoidal paths that pass through the bundle of segments 12 of the tubular element 2.

[0032] As described in greater detail hereinafter, keeping such distance A and B is very important in order to prevent direct passage of the air stream 5 in the two passage channels 3 and 4 along straight paths.

[0033] In this regard, it is possible to provide two supporting elements 16 and 17 of the tubular element 2 and of the guiding element 6, which can be fixed in the receptacle for the positioning of the evaporator 1 in the refrigerating machine 30.

[0034] More particularly, the supporting elements 16 and 17 each comprise an elongated body that extends substantially along the entire length of the evaporator 1 along the main direction of the air stream 5 with a substantially T-shaped cross-section.

[0035] Such supporting elements are connected to the guiding element 6 with the stem 18 of the T-shape inserted between the arms 10 and 11 of the guiding element 6, for example by screw means, and define four series of cavities 19, 20, 21 and 22, two for each one of the two supporting elements 16 and 17, arranged below the heads of the T-shapes to accommodate the bends 23 of the tubular element 2 defined between two mutually adjacent segments 12.

[0036] The orientation of the cavities 19, 20, 21 and 22 is very important in order to allow the tubular element 2 to lie in a coil-shaped configuration on the two pairs of planes 14 and 15.

[0037] Advantageously, the four series of cavities 19, 20, 21 and 22 are symmetrical in pairs with respect to the longitudinal axis of the two supporting elements 16 and 17 and converge toward the base 9 of the guiding element 6, for the first supporting element 16, and diverge toward said base 9, for the second supporting element 17.

[0038] In order to defrost the tubular element 2 if necessary, it is possible to provide a heating coil 32 that wraps externally at least partially around the two groups of segments 12 of the tubular element 2.

[0039] More particularly, the heating coil 32, which can be provided for example by means of a hollow tubular element inside which electrical cables run, comprises a plurality of turns that intersect at least partially the turns of the tubular element 2.

[0040] As for the tubular element 2, the heating coil 32 also can be supported functionally by the two supporting elements 16 and 17.

[0041] More precisely, the supporting elements 16 and 17 comprise lateral cavities 33, which are defined at the end of the heads of the T-shapes in order to accommodate the bends 34 of the heating coil 32.

[0042] As mentioned, the evaporator 1 can be used in a refrigerating machine 30 of the so-called "no-frost" type, such as for example a refrigerator, which comprises a box-like body 32 that defines internally at least one region 24 to be cooled, at least one air cooling region 25 that is adjacent to the region 24 to be cooled and is separated from it by a partition 26.

[0043] The air cooling region 25 defines the receptacle in which the evaporator 1 is installed; the evaporator 1 is interposed between fan means 27, which consist for example of one or more motorized fans, to generate the forced air stream 5 that passes through the evaporator 1 to cool said air stream 5, and an opening 28 provided on the partition 26 on the opposite side with respect to the fan means 27 relative to the evaporator 1 for the passage of the cold air stream 5 from the air cooling region 25 to the region to be cooled 24.

[0044] Operation of the evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, and of the refrigerating machine 30 on which the evaporator 1 is installed, is as follows.

[0045] The coolant fluid, circulating inside the tubular element 2, cools it and in particular cools the segments 12 that are affected by the air stream 5 generated by the fan means 27.

[0046] Thanks to the presence of the guiding element 6, the air stream 5 is split into two distinct streams, which are conveyed respectively into the passage channels 3 and 4.

[0047] As already mentioned, the particular spatial arrangement of the segments 12 within the passage channels 3 and 4 forces the two streams to follow non-straight paths, constantly lapping the segments 12 over the entire path through the evaporator 1.

[0048] In this manner, the cooling of the air stream 5 by direct contact with the walls of the tubular element 2, if compared with the background art, is sufficiently adequate to have a performance that can be compared with that of known evaporators, making it unnecessary to use the finned surfaces used in known types of evaporator.

[0049] More precisely, the performance of an evaporator for refrigerating machines can be measured by means of laboratory tests, which are typically defined by standards.

[0050] In order to measure the performance of the evaporator 1, according to the present invention, verifying actual performance comparability with known types of evaporator that have finned heat exchange surfaces, four tests which are typical of this field were performed in accordance with the standards specified in the ISO 15502 and EN153 standards currently in force, both with an evaporator according to the present invention and with an evaporator of the known type, which were installed on two refrigerating machines of the same model.

[0051] More precisely, the tests were conducted, according to the standards provided for refrigerating machines that can be used with a tropical climate, on two commercially available refrigerators (INDESIT BAAN 33NFP model) that have both the frozen product compartment and the non-frozen product compartment.

[0052] An evaporator of a known type (model BATT-NF-A08-02) and an evaporator according to the present invention were installed respectively on these refrigerators, whose main components are a DANFOSS NLX10KK.2 compressor + R.C. and a Plates/Tubes 560x1000 (10T) condenser, and the following tests were performed:

- coolant fluid load test with external environment at 32 °C;
- energy consumption test with external environment at 25 °C;
- preservation test with external environment at 10 °C;
- preservation test with external environment at 43 °C.

[0053] The first test conducted, i.e., the coolant fluid load test, is intended to establish the amount of coolant fluid to be introduced in the cooling circuit in order to obtain a cooling performance that complies with the standards provided by statutory provisions with an external environment at a temperature of 32 °C.

[0054] Using R600a gas as coolant fluid in order to obtain an average temperature of the non-frozen product compartment of less than -5 °C and an average temperature of the frozen product compartment of less than -25 °C, as prescribed by the standards, 40 g of gas were used for the known type of evaporator and 51 g of gas were used for the evaporator according to the present invention.

[0055] The test yielded, as its outcome, average temperatures of the frozen product compartment that were fully comparable and average temperatures for the non-frozen products that were a few degrees Celsius higher to the disadvantage of the evaporator according to the present invention but in any case compliant with the standards.

[0056] Subsequent tests were conducted with refrigerators configured according to the first test, i.e., respectively with 40 g and 51 g of gas for the two evaporators.

[0057] The second test conducted is the one related to energy consumption in order to determine the relevant energy class.

[0058] In this test, the refrigerators were made to operate with an external environment at 25 °C, introducing packages that simulated the products to be cooled and were equipped with a heat probe to detect the temperature.

[0059] Obtaining fully comparable refrigerating performances, an average consumption of 0.857 kWh/24h was measured for the refrigerator with the known type of evaporator and an average consumption of 0.866 kWh/24h was measured for the refrigerator with the evaporator according to the present invention, making them both fall within the A+ energy class.

[0060] The third and fourth tests were conducted by operating the two refrigerators with an external environment temperature of 10 °C and 43 °C, i.e., respectively equal to the lower limit and to the upper limit provided for tropical climate, obtaining comparable performances which were compliant with the applicable statutory provisions.

[0061] A table summarizing and comparing the tests conducted is provided hereafter.

ISO 15502 TEST COMPARISON TABLE - INDESIT BAAN 33 NFP with R600a coolant fluid		
Evaporator	BATT-NF-A08-02	INVENTION
Coolant fluid load test with external environment at 32 °C		
Quantity of coolant fluid [g]	40	51
Average temp. of refrigerator [°C]	-11.1	-7.6
Average temp. of freezer [°C]	-27.4	-27.3
Operation over 24 hours [%]	100	100
Energy consumption test with external environment at 25 °C		
Average temp. of packages in refrigerator [°C]	+5.0/+5.2	+5.0/+4.8
Average temp. of packages in freezer [°C]	-19.2/-18.0	-17.5/-18.0
Operation over 24 hours [%]	47.6/44.2	43.6/45.2
Energy consumption [kWh/24h]	0.881/0.832	0.857/0.875
Average energy consumption [kWh/24h]	0.857	0.866
Energy class	A+	A+
Preservation test with external environment at 10 °C		
Average temp. of packages in refrigerator [°C]	+4.4	+3.3
Average temp. of packages in freezer [°C]	-21.4	-22.7
Operation over 24 hours [%]	-27.5	-38.5
Preservation test with external environment at 43 °C		
Average temp. of packages in refrigerator [°C]	+4.9	+3.6
Average temp. of packages in freezer [°C]	-18.2	-19.7
Operation over 24 hours [%]	84.0	89.6

[0062] In practice it has been found that the evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, according to the present invention, fully achieves the intended aim and objects, since it has passage channels that are large enough to avoid any blockage thereof due to the formation of frost.

[0063] Another advantage of the evaporator according to the present invention resides in that its provision uses less material than the background art, being thus lighter and economically advantageous, with a refrigerating performance that is fully comparable to that of known types of evaporator.

[0064] The evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

[0065] All the details may further be replaced with other technically equivalent elements.

[0066] In practice, the materials used, so long as they are compatible with the specific use, as well as the contingent shapes and dimensions, may be any according to requirements and to the state of the art.

[0067] The disclosures in Italian Patent Application No. MI2009A000937 from which this application claims priority are incorporated herein by reference.

[0068] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. An evaporator for refrigerating machines, particularly for refrigerators of the so-called "no-frost" type, comprising at least one coil-shaped tubular element (2), which defines internally a duct for the flow of a coolant fluid and can be accommodated within at least one passage channel (3, 4) for cooling an air stream (5) that affects said at least one tubular element (2), **characterized in that** it comprises a plurality of segments (12) of said at least one tubular element (2) which are arranged inside said at least one passage channel (3, 4) to prevent the direct passage of said air stream (5) in said at least one passage channel (3, 4) along straight paths.

2. The evaporator according to the preceding claim, **characterized in that** said segments (12) extend substantially transversely to said passage channel (3, 4) so that their axes alternately lie on at least two planes (14, 15) which are contiguous and parallel to each other and to the main direction of said air stream (5), said at least two planes (14, 15) being arranged at a mutual maximum distance (A) that is substantially equal to the outside diameter of said at least one tubular element (2).

3. The evaporator according to one or more of the preceding claims, **characterized in that** it comprises at least two channels (3, 4) for the passage of said air stream (5) which are parallel and are separated one another by a guiding element (6) and can be defined externally by the side walls (7, 8) of the receptacle of the refrigerating machine (30) in which the evaporator (1) is installed, said side walls (7, 8) being parallel to each other and being substantially parallel to said main direction.

4. The evaporator according to one or more of the preceding claims, **characterized in that** said guiding element (6) comprises a metal plate that is substantially folded in a U-shape, with the base (9) of said U which can face the direction of said air stream (5) and with the arms (10, 11) of said U-shape which are oriented substantially parallel to said main direction and can face said side walls (7, 8), said arms (10, 11) being each arrangeable at a maximum distance (B) from the side wall (7, 8) that faces it which is substantially equal to twice the outside diameter of said at least one tubular element (2).

5. The evaporator according to one or more of the preceding claims, **characterized in that** said at least one coil-shaped tubular element (2) comprises at least two groups of said segments (12), which can be accommodated respectively in said at least two passage channels (3, 4) and are functionally connected one another by end segments (13) of said at least one tubular element (2) which are arranged at said base (9) of said U-shape.

6. The evaporator according to one or more of the preceding claims, **characterized in that** it comprises two supporting elements (16, 17) of said at least one tubular element (2) and of said guiding element (6), said supporting elements (16, 17) being fixable in said receptacle for the positioning of said evaporator (1) in said refrigerating machine (30).

7. The evaporator according to one or more of the preceding claims, **characterized in that** said supporting elements (16, 17) each comprise an elongated body that extends substantially along the entire length of said evaporator (1) along said main direction with a substantially T-shaped cross-section, said supporting elements (16, 17) being connected to said guiding element (6) with the stem (18) of said T-shape inserted between said arms (10, 11) of said guiding element (6) and defining four series of cavities (19, 20, 21, 22), two for each one of said supporting elements (16, 17), arranged below the heads of said T-shapes to accommodate the bends (23) of said at least one tubular element (2) formed between two of said mutually adjacent segments (12).

8. The evaporator according to one or more of the preceding claims, **characterized in that** said four series of cavities (19, 20, 21, 22) are symmetrical in pairs with respect to the longitudinal axis of said supporting elements (16, 17),

which converge in the direction of said base (9) of said U-shape, for the first one (16) of said two supporting elements (16, 17), and diverge in the direction of said base (9) of said U-shape, for the second one (17) of said two supporting elements (16, 17).

9. The evaporator according to one or more of the preceding claims, **characterized in that** it comprises at least one heating coil (32), which surrounds externally at least partially said two groups of segments (12) to defrost said tubular element (2).

10. A refrigerating machine of the so-called "no-frost" type, comprising a box-like body (32) that defines internally at least one region to be refrigerated (24), at least one air cooling region (25) that is adjacent to said at least one region to be cooled (24) and is separated from said at least one region to be cooled (24) by a partition (26), at least one evaporator (1) and fan means (27) accommodated in said at least one air cooling region (25) which generate a forced air stream (5) that passes through said at least one evaporator (1) to cool said air stream (5), said partition (26) defining at least one opening (28) on the opposite side with respect to said fan means (27) relative to said at least one evaporator (1) for the passage of said cold air stream (5) from said at least one air cooling region (25) to said at least one region to be cooled (24), **characterized in that** said at least one evaporator (1) is of the type according to one or more of the preceding claims.

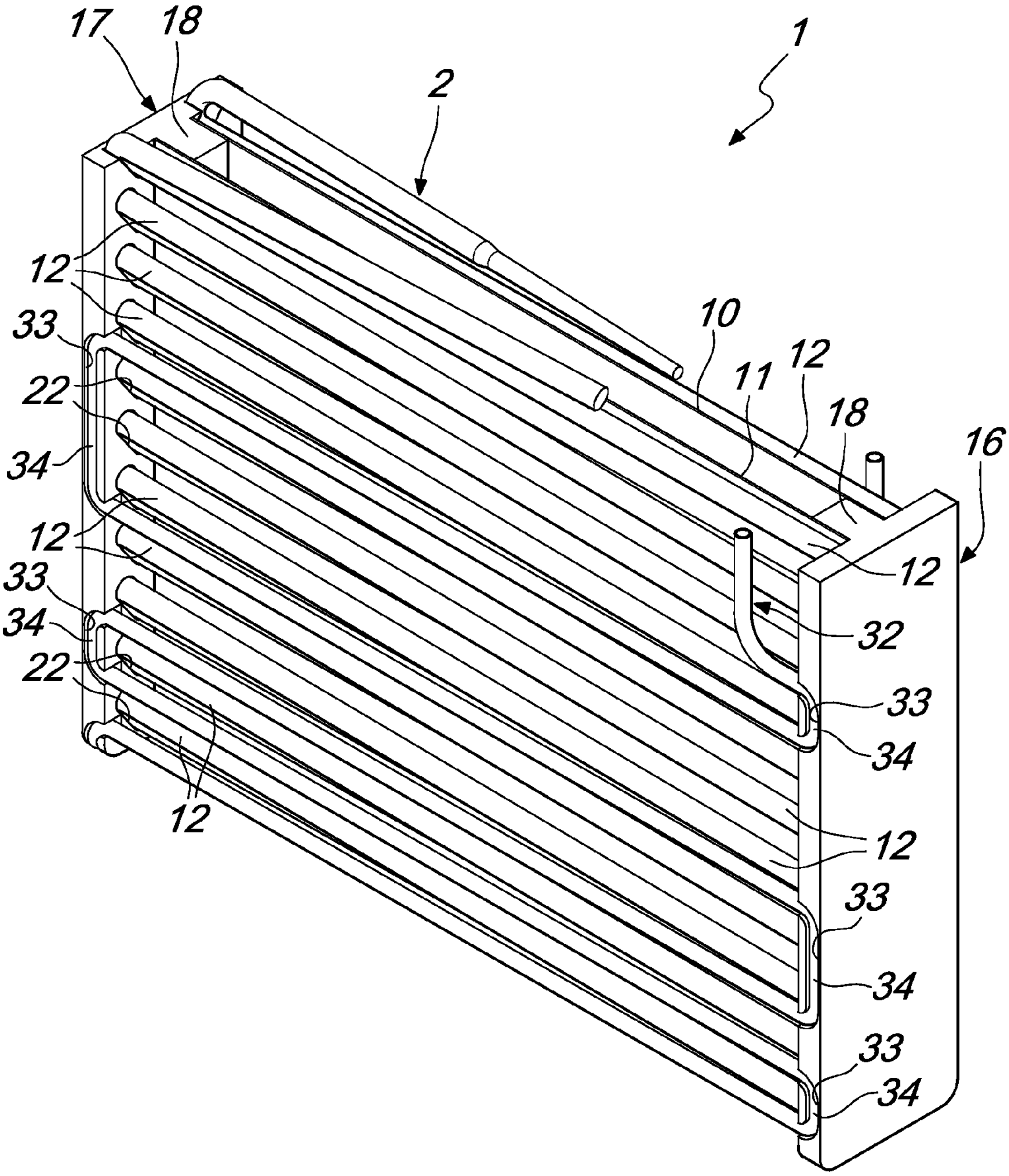
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Fig. 1

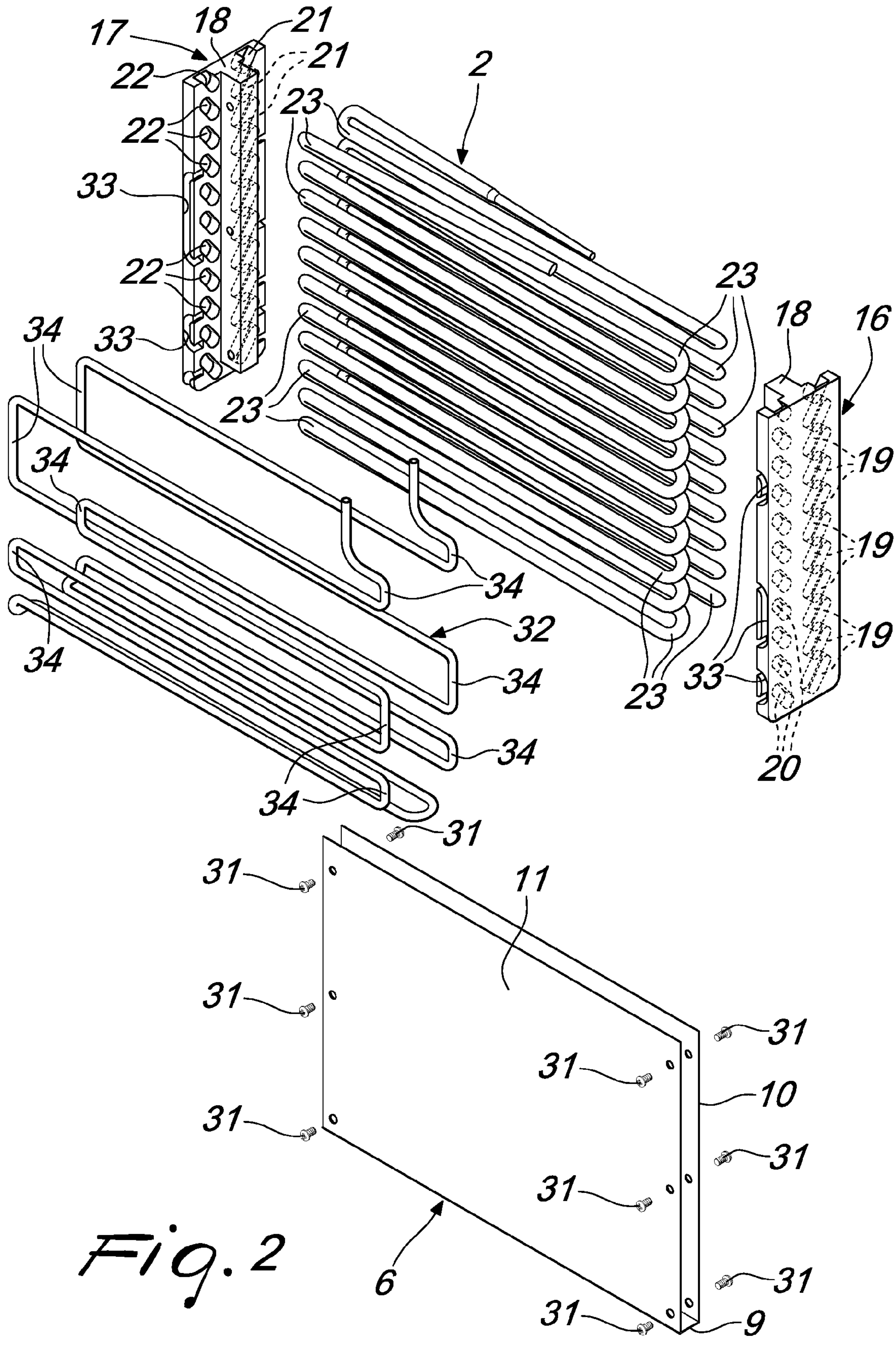
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Fig. 2

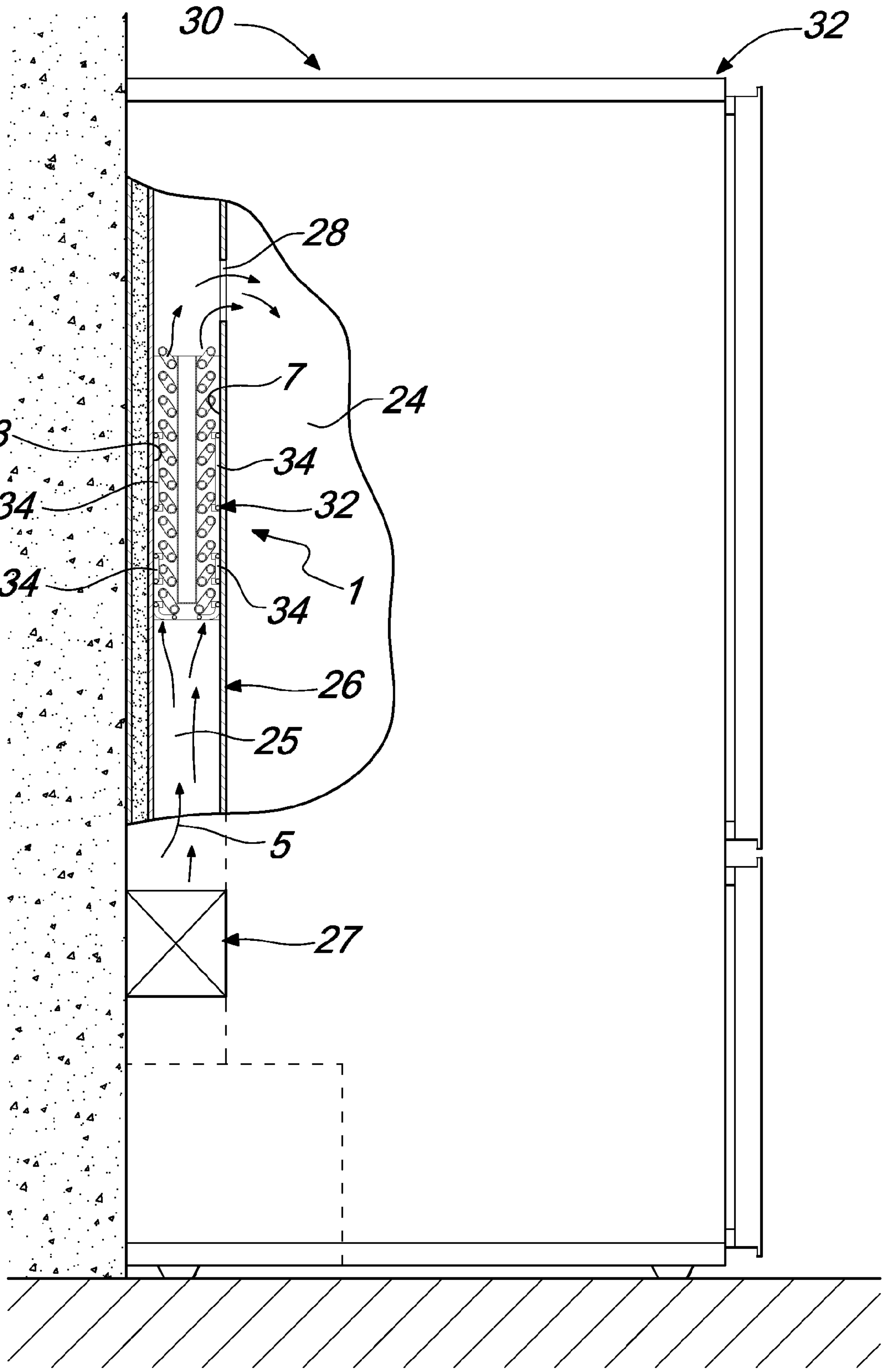

Fig. 3

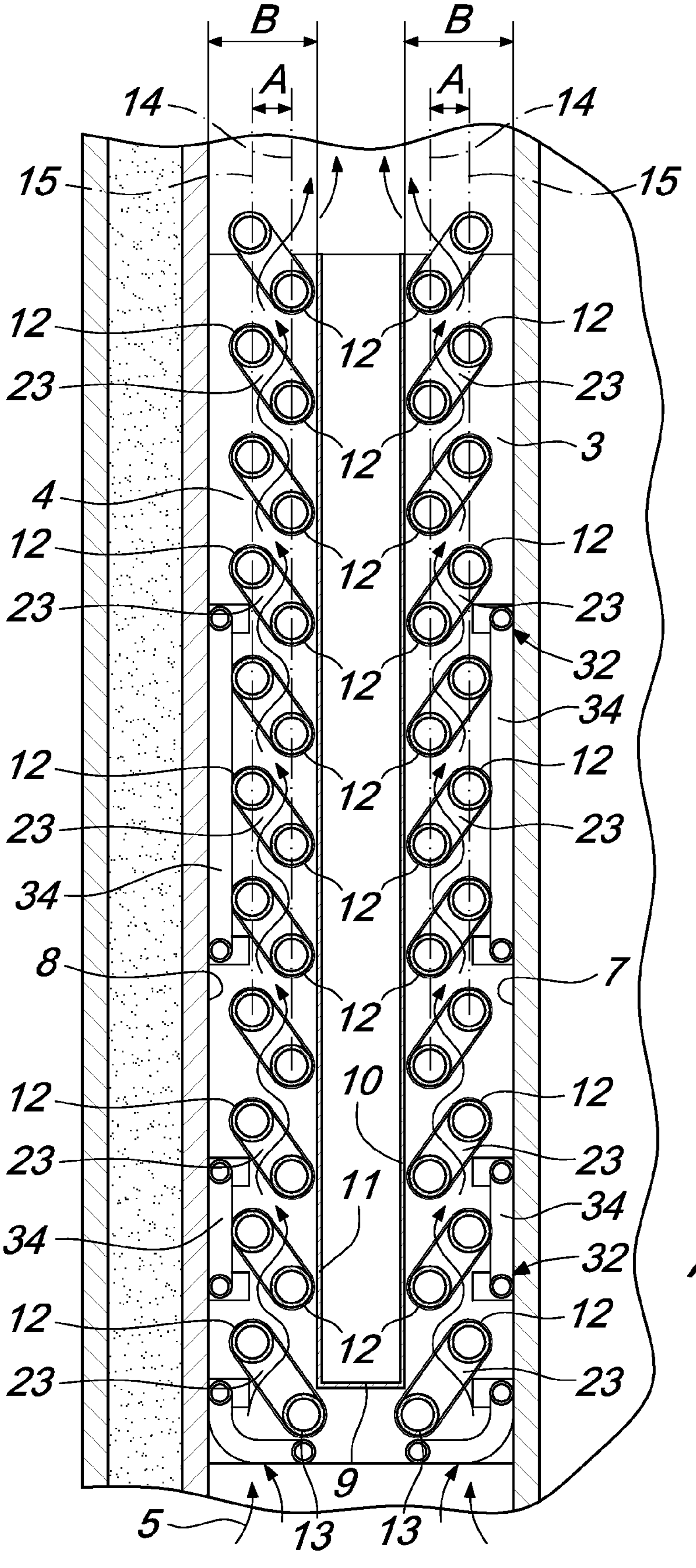

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 10 16 3941

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	US 2008/196866 A1 (WU GUOLIAN [US] ET AL) 21 August 2008 (2008-08-21) * paragraph [0039]; figure 14 *	1-10	INV. F25B39/02 F25D17/06
X	CA 1 235 687 A1 (INGLIS LIMITED) 26 April 1988 (1988-04-26) * the whole document *	1,2,6,9, 10	
X	DE 10 2005 057157 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 31 May 2007 (2007-05-31) * the whole document *	1,2	
X	WO 2004/016996 A1 (MULTIBRAS ELETRODOMESTICOS SA [BR]; HERMES CHRISTIAN JOHANN LOSSO [BR]) 26 February 2004 (2004-02-26) * the whole document *	1,2	
X	DE 198 59 985 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 29 June 2000 (2000-06-29) * the whole document *	1,2	

TECHNICAL FIELDS SEARCHED (IPC)
F25B
F25D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 July 2010	Jessen, Flemming

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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