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(54) Title: HEAT EXCHANGER, HOUSEHOLD APPLIANCE, METHOD FOR MANUFACTURING A HEAT EXCHANGER, AND METHOD FOR INSTALLING A HEAT EXCHANGER

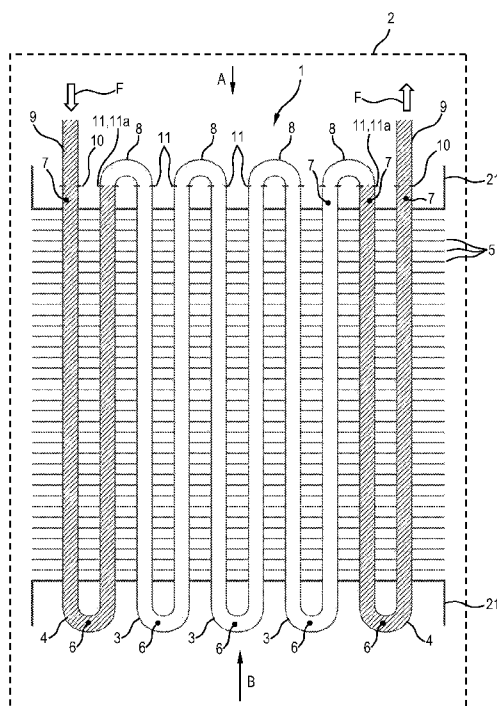


Fig.1

(57) Abstract: A heat exchanger (1) comprises at least one set of pipes (3; 4), each set of pipes (3; 4) comprising at least one metal intermediate pipe and two metal terminal pipes, wherein the two metal terminal pipes (4) are fluidically connected by the at least one metal intermediate pipe (3), the pipes (3, 4) are mechanically connected by at least one connection structure (5), and the at least one intermediate pipe (3) and the terminal pipes (4) are made from different metals. The method is used for manufacturing a heat exchanger (1), comprising at least the following steps: connecting at least one metal intermediate pipe and two metal terminal pipes to a connection structure, wherein the at least one intermediate pipe and the terminal pipes are made from different metals; serially and/or parallelly connecting the pipes to each other, wherein the terminal pipes comprise one open end (7) and are connected to an intermediate pipe with their other end.



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Heat Exchanger, Household Appliance, Method for Manufacturing a Heat Exchanger, and Method for Installing a Heat Exchanger

The invention relates to a heat exchanger, in particular a finned tube heat exchanger. The invention further relates to a household appliance, in particular a clothes treatment appliance, comprising the heat exchanger. The invention also relates to a method for manufacturing a heat exchanger, in particular a finned tube heat exchanger. The invention furthermore relates to a method for installing a heat exchanger in a household appliance.

Usually, finned tube heat exchangers (e.g. as used in air conditioning appliances, ice makers, refrigeration / freezing appliances, or heat pumps of clothes dryers) use a combination of materials for their fins and pipes as follows:

- Aluminium fins and copper pipes;
- Copper fins and copper pipes;
- Aluminium fins and aluminium pipes;
- Aluminium fins and stainless steel pipes; or
- Stainless steel fins and stainless steel pipes.

Normally, the price of aluminium is lower than the price of copper or stainless steel. Therefore, there is a cost advantage in using aluminium pipes in heat exchangers. However, the use of aluminium pipes in heat exchangers also has some drawbacks, including that aluminium has a lower conductivity as compared to copper; that a higher thickness is required to withstand a high pressure (although aluminium pipes still weigh less than pipes made from the other metals), and that galvanic corrosion can appear in joints between the aluminium pipes and objects of another metal, especially when they are brazed (e.g. at heat exchanger elbows, at connections to cooling circuit refrigerant lines etc.).

In particular, the aluminium to copper brazing entails difficulties due to a lower melting point of aluminium in comparison to copper and a high temperature dependency of the joint on a final microstructure. Thus, a brazed joint between aluminium and copper may result in structurally weak areas concerning tensile and vibration strength. When such brazing is implemented in areas submitted to tension, flexion, torsion and/or vibration

forces, there is a considerable risk of creating fissures or breakages in these areas and/or in their proximities. Stress and/or the fatigue may, for example, be introduced by fluid lines and may be produced by a vapour compression system either for a heat pump or a refrigerating machine, for example. Stress and/or fatigue may also be introduced by deformations during a manufacturing process, by vibrations or shock caused during transport etc.

Up to now, these problems are partially circumvented by using mechanical connections which provide joints by pressure or a combination of pressure and glue (i.e. using a Vulcan Lockring), which is relatively complex and has a relatively low reliability as compared to brazing. Another known solution is the use of controlled brazing/soldering processes that are not always accessible to brazing areas or do not create enough brazing penetration to withstand required pressures (e.g. induction brazing, ultrasonic brazing).

It is the object of the present invention to at least partially overcome the limitations of the prior art and to particularly provide a cost effective, compact, and reliable heat exchanger, in particular a finned tube heat exchanger.

The object is achieved according to the features of the independent claims. Preferred embodiments can be derived, inter alia, from the dependent claims, the subsequent description, and a combination thereof.

The object is achieved by a heat exchanger, comprising at least one set of pipes, each set of pipes comprising at least one metal intermediate pipe and two metal terminal pipes, wherein the two metal terminal pipes are fluidically connected by the at least one metal intermediate pipe; the pipes are mechanically connected by at least one connection structure, and the at least one intermediate pipe and the terminal pipes are made from different metals.

The pipes of one set can be interconnected in series and/or parallelly and are mechanically connected by at least one connection structure, wherein the at least one intermediate pipe and the terminal pipes are made from different metals.

This heat exchanger has the advantage that the mechanical connection between the intermediate pipe(s) and the two terminal pipes provided by the connection structure limits or restricts their relative movements such that mechanical stresses (tensile forces, flexions, torsions and/or vibration forces) and stress cycle fatigue at the joints between a terminal pipe and an intermediate pipe connected to it can be greatly reduced / damped or even avoided.

Thus, the (positive-fitting) joint at an interface between a terminal pipe and another object of the heat exchanger of a different metal (e.g. a pipe elbow or an intermediate pipe) is an 'internal' joint and is protected against externally introduced mechanical stresses by the mechanical fixation to and stiffness of the connection structure. In particular, the two terminal metal pipes are integral parts of the heat exchanger.

By interconnecting the pipes of one set in series, an open fluid channel is formed. The end sections of this fluid channel are provided by the terminal pipes.

The fluid may be a liquid, a vapour or other gas, or a combination thereof.

The connection structure may be a heat exchange structure. The connection structure may in particular comprise a stack of fins.

The heat exchanger may comprise one set of pipes, e.g. in case of a fluid-to-air heat exchanger. Alternatively, the heat exchanger may comprise more than one set of pipes, in particular two sets of pipes, e.g. in case of a fluid-to-fluid or liquid-to-liquid heat exchanger.

Generally, the cross-section of the pipes can have any desired form (e.g. circular, oval, angular etc.). The cross-section may within one set of pipes and/or over different sets of pipes.

It is a preferred embodiment that the two terminal pipes are made from a material that can be easily connected to respective fluid lines, in particular made from the same material as the respective fluid line. This embodiment has the advantage that the joint between the

fluid lines and the respective terminal pipe can be made particularly rugged and fail-safe to withstand mechanical stresses (in particular by brazing).

According to a second preferred embodiment, the at least one intermediate pipe comprises aluminium and the terminal pipes do not comprise aluminium. This embodiment has the advantage that the at least one intermediate metal pipe is relatively inexpensive while the open ends of the terminal metal pipes each may be robustly connected to often used copper or steel fluid lines.

According to another preferred embodiment, the at least one intermediate pipe is made of aluminium and the terminal pipes are made of copper. Thus, the terminal metal pipes each have a very good thermal conductivity and may be robustly connected to often used copper fluid lines. The at least one intermediate pipe may be made of aluminium having a purity grade of 95% or above. Alternatively, the at least one intermediate pipe may be made of an aluminium alloy. The terminal pipes may be made of copper having a purity grade of 95% or above. Alternatively, the at least one intermediate pipe may be made of a copper alloy.

According to yet another preferred embodiment, the heat exchanger is a finned tube-type heat exchanger, wherein the connection structure comprises a stack of fins that are penetrated by the pipes. Such a heat exchanger is very compact and efficient. The fins act as a heat exchange structure for the pipes. Within the finned tube-type heat exchanger, the pipes are preferably oriented in the same direction to achieve a particularly compact form.

According to even another preferred embodiment, the heat exchanger is a fluid/air heat exchanger that comprises one set of pipes to transport the fluid.

According to still another preferred embodiment, the pipes are of the same basic form. This gives the advantage that an adaptation of known heat exchangers using only pipes of the same metal to accommodate the terminal pipes of the different metal can be implemented with only small or negligible design changes.

According to yet another preferred embodiment, the pipes are of a 'U' form and are connected by respective pipe elbows. The intermediate pipes are connected on both ends while the terminal pipes are only connected at one end (to a respective intermediate pipe, e.g. via a pipe elbow). This embodiment has the advantage that the heat exchanger is easy to assemble and may be of a compact form. In particular, the joints between the terminal pipes and the respective intermediate pipes can easily be accessed and joint. The connection between the pipes can be effected e.g. by pipe elbows that are bent at least approx. 180°. The pipe elbows (or any other suitable connection or connecting element) may in particular be of the same material as the at least one intermediate pipe. Generally, the elbows are not restricted to a 180° bend ('U' shaped bend or 'C' shaped bend). The elbows may have two or more connection ends. Elbows may cross each other.

According to an alternative preferred embodiment, the set of pipes comprises one intermediate pipe and two terminal pipes. The intermediate pipe may be of a multiple 'U' form (meander-like form) and may comprise different branches. The terminal pipes may be of a 'U' form or of a straight form (straight pipe or tube). To connect the intermediate pipe into the connection structure (in particular the stack of fins), the connection structure may have one or more slits into which the intermediate pipe may be inserted. This embodiment has the advantage that the heat exchanger is even easier to assemble. In particular, only the joints between the terminal pipes and the intermediate pipe need to be accessed and joint. The connected pipes may be expanded to more strongly contact the connection structure.

According to even another preferred embodiment, one of the intermediate pipes and one of the terminal pipes are joined by flame brazing. This enables a particular easy joining of the pipes. The joining can, for example, be effected by flame brazing the pipe elbows to the open ends of the pipes. If the pipe elbows are of the same material as the at least one intermediate pipe, the joint between the aluminium comprising metal and the metal not comprising aluminium is located at an interface of a pipe elbow and the terminal pipe.

One or more heat exchangers may preferably be intended for use or be used in a household appliance, in particular in a clothes treatment appliance, in particular in a clothes drying appliance, in particular in a tumble dryer. The heat exchanger may

preferably be part of a heat pump. Then, the pipes are preferably intended to guide or hold a working fluid or refrigerant.

The object is also achieved by a household appliance, in particular a clothes treatment appliance, comprising at least one heat exchanger as described above, wherein the terminal pipes are connected to fluid lines of basically the same material.

This gives the advantage that the joint between the fluid lines and the respective terminal metal pipe shows no material mismatch and can thus be made particularly rugged and fail-safe to withstand mechanical stresses. In particular, galvanic corrosion at or around the joints can be reduced. Fluid lines are often made from copper.

In particular, the household appliance may be a clothes drying appliance. The heat exchanger may in particular be part of a heat pump. Fluid lines in heat pumps of clothes drying appliances are often made from copper.

The object is further achieved by a method for manufacturing a heat exchanger, comprising at least the following steps:

- Connecting at least one metal intermediate pipe and two metal terminal pipes to a connection structure, wherein the at least one intermediate pipe and the terminal pipes are made from different metals;
- (Serially and/or parallelly) connecting the pipes to each other, wherein the terminal pipes comprise one open end and are connected to an intermediate pipe with their other end.

The connecting step may also be formulated to read: Connecting the pipes to each other such that the terminal pipes are connected by the at least one intermediate pipe.

Alternatively, the pipes may be assembled or connected to each other and then be connected to the connection structure, e.g. by inserting them into slits of the connection structure.

It is a preferred embodiment that the method further comprises, in particular after the connecting step:

- Expanding at least some of the (intermediate and/or terminal) pipes (in particular by mechanical means).

This achieves an improved good contact between the pipes and the connection structure.

It is one more preferred embodiment that the pipes are connected by pipe elbows, the pipe elbows being made of basically the same material as the at least one intermediate pipe. This gives an easy to manufacture and reliable heat exchanger. Alternatively, the terminal pipes may be directly connected to a respective intermediate pipe.

It is another preferred embodiment that the terminal pipes are connected to the respective intermediate pipe by flame brazing. If using pipe elbows, the terminal pipes may be connected to the respective intermediate pipe by flame brazing a pipe elbow to one of the terminal pipes and a respective intermediate pipe. The materially mismatched joint is then between the terminal pipe and its pipe elbow.

The object is furthermore achieved by a method for installing a heat exchanger in a household appliance, wherein the heat exchanger is manufactured by the above method, comprising at least the following step: connecting a fluid line to an open end of a respective terminal pipe, wherein the fluid line is made of basically the same material as the respective terminal pipe.

The invention may in particular show one or more of the following advantages:

- Price reduction due to the possibility to use aluminium pipes without incurring additional costs or investments associated with a brazing/soldering/joining process different than direct flame brazing to connect the fluid lines. Rather, a widely used and cheap brazing/welding process can be applied to the joints of the terminal pipes.
- These joints are located in areas with reduced stresses (tensile, flexion, torsion, vibration) that may in particular be introduced via fluid (in particular refrigerant) lines.
- A possible galvanic corrosion is restricted to areas that are submitted to reduced stresses or that are stress-free such that the joints are even more resistant during their lifetime.
- This enables a cheaper heat exchanger with a reduced risk of fluid (in particular refrigerant) leak over its lifetime.

In the Figures shown in the accompanying drawing certain embodiments of the invention are schematically described in greater detail.

- Fig.1 shows a schematic diagram of a heat exchanger according to a first embodiment;
- Fig.2 shows a schematic diagram of a heat exchanger according to a second embodiment;
- Fig.3 shows a schematic diagram of a heat exchanger according to a third embodiment;
- Fig.4a shows a frontal view onto a heat exchanger according to the first, second, or third embodiment;
- Fig.4a-c show structural elements of fig.4a; and
- Fig.5 shows a frontal view onto a heat exchanger according to a fourth embodiment.

Fig.1 shows a sectional top view onto a heat exchanger 1 or heat exchanger section according to a first embodiment. The heat exchanger 1 is of the finned tube type and may be used, for example, as part of a heat pump or a clothes dryer 2.

The heat exchanger 1 comprises five pipes 3, 4 of basically the same 'U'-shape that have the same orientation and are aligned in the same direction. Although the pipes 3, 4 are shown in the same plane for the sake of simplicity, they are generally arranged in a three-dimensional structure. The pipes 3, 4 are mechanically and thermally connected to a connection structure formed by a stack of fins 5. At its frontal side A and its rearward side B, the stack of fins 5 is covered by a respective end plate 21 for mechanical protection. The straight legs of the pipes 3, 4 penetrate the fins 5 in a perpendicular fashion. Thus, the bends or bent sections 6 of the pipes 3, 4 are all situated on one side of the stack of fins 5 while the (open) ends 7 of the pipes 3, 4 are all situated on the other side of the stack of fins 5. The stack of fins 5 provides stiffness to the heat exchanger 1 and restricts relative movement of the pipes 3, 4. Thus, the stack of fins 5 restricts or dampens a propagation of externally induced forces and movements to elements of the heat exchanger 1.

The pipes 3, 4 are connected to form an open-ended fluid channel. To this extent, the pipes 3, 4 are connected in pairs such that intermediate pipes 3 are connected to a respective pipe 3, 4 on both ends 7 and two terminal (or terminally located) pipes 4 are each connected to an intermediate pipe 3 on one end 7. The other end 7 of each terminal pipe 4 is not connected to a pipe 3, 4. Thus, a meander-like fluid channel 3 is formed that has two open ends 7 at the terminal pipes 4 which may be used as an inlet opening and outlet opening for the fluid F, respectively.

The connection between the pipes 3, 4 is effected using pipe elbows 8 that are bent 180° ('U'-shaped or 'C'-shaped pipe elbows 8). The pipe elbows 8 can be attached to the open ends 7 of the pipes 3, 4 by any suitable kind of connection, preferably by positive fitting for a particularly durable, compact and cost-effective connection. The positive fitting may comprise brazing, in particular flame brazing, of the pipes 3, 4 and pipe elbows 8.

To (fluidically) connect the heat exchanger 1 as such, external fluid lines 9 may be fitted to the (yet) open ends 7 of the terminal pipes 4. By means of the external fluid lines 9, fluid F may be introduced into and discharged from the fluid channel 3, 4, 8, as indicated by the straight arrows.

Up to now, if the fluid channel(s) of a heat exchanger was/were completely made of aluminium there existed a material mismatch at a joint between the end of the terminal pipes and the external fluid lines 9 that were mostly made of copper. The joints often showed a reduced stability and a high susceptibility to cracks. This was particularly disadvantageous since mechanical stresses are regularly imposed onto the joints, e.g. by vibration of the external fluid lines during operation of a vapour compression system, for example. The joints 11 between the pipe elbows 8 and the pipes were not critical since the pipe elbows and the pipes were made from the same material, i.e. aluminium.

To overcome the problems associated with the joints between the terminal pipes 4 and the external fluid lines 9, the terminal pipes 4 are made of copper (or more generally of the same or a similar material as the external fluid lines 9), as indicated by the hatchings. Thus, the joints 10 between the terminal pipes 4 and the external fluid lines 9 do not show a material mismatch or a significant material mismatch anymore. It follows that these

joints 10 are much more resistant against mechanical stresses than known from the prior art.

Mismatched joints 11a now exist between the terminal pipes 4 and the respective pipe elbows 8 connected to it since the pipe elbows 8 are made from aluminium. However, since the terminal pipes 4 and thus also these joints 11a are an integral part of the heat exchanger 1 and held in place by the stack of fins 5, a relative movement (e.g. in modes one to three) between the terminal pipes 4 and the respective pipe elbows 8 is greatly reduced. The copper/aluminium mismatch at the joints 11a is therefore not critical anymore for the operation of the heat exchanger 1.

The joints 10 and 11 are advantageously easily accessible from the outside.

Fig.2 shows a sectional top view onto a heat exchanger 12a or heat exchanger section according to a second embodiment. The heat exchanger 12a has a generally similar form to the heat exchanger 1 and is also of the finned tube type and may be used, for example, as part of a heat pump of a clothes dryer 2.

However, the heat exchanger 12a now only uses one intermediate pipe 13 that is shaped as a meander having multiple 'U' or 'C' shaped bent sections 6. There is thus no need anymore to connect the multiple intermediate pipes 3 of the heat exchanger 1. The only two remaining joints 14 are between the intermediate pipe 13 and the two terminal pipes 4, respectively. The terminal pipes 4 are of the same 'U' shape as used for the heat exchanger 1.

The intermediate pipe 17 has been inserted into slits 18 within the stack of fins 19 for connection such that each 'U'-shaped section of the intermediate pipe 17 is inserted into a respective slit 18. Thus, the heat exchanger 12a may be manufactured by connecting the pipes 4, 13, followed by inserting the connected pipes 4, 13 into the connection structure (the stack of fins 19). To fastly hold the pipes within the stack of fins 19, the pipes 4, 13 may be expanded mechanically after having been inserted.

Fig.3 shows a sectional top view onto a heat exchanger 12b or heat exchanger section according to a third embodiment. Here, the terminal pipes 4 are formed as straight pipes 15 or tubes, connected at joints 16 to the intermediate pipe 17.

Alternatively to the shown heat exchangers 12a and 12b, the intermediate pipes 13 or 17 may have a straight end and may, for example, be connected to the terminal pipes 4 via a pipe elbow, e.g. a pipe elbow 8.

Fig.4a shows a frontal view in direction A of fig.1 onto the heat exchanger 1 (now comprising six instead of three intermediate pipes 3). The frontally projecting 'U' shaped or 'C' shaped pipe elbows 8 are depicted as shown in fig.4b while the intermediate pipes 3 with their rearward projecting bent sections 6 are depicted as shown in fig.4c. The aluminium intermediate pipes 3 and pipe elbows 8 of fig.4b and fig.4c are depicted by open faces while the copper terminal pipes 4 are depicted by hatched faces, as e.g. seen in fig.4d.

The heat exchanger 1 has a three-dimensional structure for good thermal exchange and for easy placement in the clothes dryer 2. The same basic structure may also apply to the heat exchangers 12a and 12b.

Fig.5 shows a frontal view onto a heat exchanger 22 according to a fourth embodiment. The heat exchanger 22 may be of a generally similar outline as the heat exchangers 1, 12a, or 12b. However, the elbows 8, 20 may now also comprise branched (three-point or three-ended) elbows 20 to allow for a parallel arrangement of the intermediate pipes 3.

Of course, the invention is not restricted to the shown embodiment.

For example, the number of the intermediate pipes may vary greatly and may comprise one or more than one, in particular five or more, intermediate pipes.

While the preferred embodiment shows a fluid/air heat exchanger comprising one set of pipes forming one fluid channel, the invention is not restricted to it. The heat exchanger may also be a fluid/fluid heat exchanger. The heat exchanger may comprise two or more sets of pipes forming a respective fluid channel.

Instead of copper, any other suitable material (except aluminium) may be used, e.g. steel.

Generally, the pipes may be connected in series and/or in parallel.

Also, joints and pipes may be of a different form or position.

Furthermore, the heat exchanger is not restricted to be a finned tube heat exchanger but may, for example, also be another type of tube heat exchanger.

The heat exchanger may in particular be a part of a heat pump, but is not restricted to it. For example, the heat exchanger may be a condenser of a condenser clothes dryer.

The heat exchanger may in particular be a part of a household appliance, e.g. a clothes dryer or a refrigerator.

The pipe elbows or branched bends may be of another form, e.g. crossed or four- or more-pointed.

Reference Numerals

1	heat exchanger
2	clothes dryer
3	pipe
4	pipe
5	fin
6	bent section
7	open end
8	pipe elbow
9	external fluid line
10	joint
11	joint
11a	joint
12a	heat exchanger
12b	heat exchanger
13	intermediate pipe
14	joint
15	straight pipe
16	joint
17	intermediate pipe
18	slit
19	fin
20	pipe elbow
21	end plate
22	heat exchanger
F	fluid
A	frontal side
B	rearward side

Claims

1. A heat exchanger (1; 12a; 12b; 19), comprising at least one set of pipes (3, 4; 13; 15), each set of pipes (3, 4; 13) comprising at least one metal intermediate pipe (3; 13) and two metal terminal pipes (4; 15), wherein
 - the two terminal pipes (4; 15) are fluidically connected by the at least one metal intermediate pipe (3; 13) ,
 - the pipes (3, 4; 13; 15) are mechanically connected by at least one connection structure (5; 19), and
 - the at least one intermediate pipe (3; 13) and the terminal pipes (4; 15) are made from different metals.
2. The heat exchanger (1; 12a; 12b; 19) according to claim 1, wherein the at least one intermediate pipe (3; 13) comprises aluminium and the terminal pipes (4; 15) do not comprise aluminium.
3. The heat exchanger (1; 12a; 12b; 19) according to claim 2, wherein the at least one intermediate pipe (3; 13) is made of aluminium and the terminal pipes (4; 15) are made of copper.
4. The heat exchanger (1; 12a; 12b; 19) according to any of the preceding claims, wherein the heat exchanger (1; 12a; 12b; 19) is a finned tube-type heat exchanger, wherein the connection structure (5; 19) comprises a stack of fins (5; 19) that are penetrated by the pipes (3, 4; 13; 15).
5. The heat exchanger (1; 12a; 12b; 19) according to claim 4, wherein the heat exchanger (1; 12a; 12b; 19) is a fluid/air heat exchanger (1; 12a; 12b; 19) that comprises one set of pipes (3, 4; 13; 15) to transport the fluid (f).
6. The heat exchanger (1) according to any of the preceding claims, wherein the pipes (3; 4) are of the same basic form.

7. The heat exchanger (1; 12a; 12b; 19) according claim 6, wherein the pipes (3, 4) are of a 'U' form and wherein the pipes (3, 4) are connected by respective pipe elbows (8).
8. The heat exchanger (1) according to any of the preceding claims, wherein one of the intermediate pipes (3; 13) and one of the terminal pipes (4; 15) are joined by flame brazing.
9. A household appliance (2), in particular clothes treatment appliance, comprising at least one heat exchanger (1; 12a; 12b; 19) according to any of the preceding claims, wherein the terminal pipes (4; 15) are connected to fluid lines (9) of basically the same material.
10. The household appliance (2) according to claim 9, wherein the household (2) appliance is a clothes drying appliance and the heat exchanger (1; 12a; 12b; 19) is part of a heat pump.
11. A method for manufacturing a heat exchanger (1; 12a; 12b; 19), comprising at least the following steps:
 - connecting at least one metal intermediate pipe (3; 13) and two metal terminal pipes (4; 15) to a connection structure (5; 19), wherein the at least one intermediate pipe (3; 13) and the terminal pipes (4; 15) are made from different metals;
 - connecting the pipes (3, 4; 13; 15) to each other, wherein the terminal pipes (4; 15) comprise one open end (7) and are connected to an intermediate pipe (3; 13) with their other end (7).
12. The method according to claim 11, wherein the pipes (3, 4; 13; 15) are connected by pipe elbows (8), the pipe elbows (8) being made of basically the same material as the at least one intermediate pipe (3; 13).
13. The method according to any of the claims 11 or 12, wherein the terminal pipes (4; 15) are connected to the respective intermediate pipe (3; 13) by flame brazing.

14. A method for installing a heat exchanger (1; 12a; 12b; 19) in a household appliance (2), wherein the heat exchanger (1; 12a; 12b; 19) is manufactured by the method according to any of the claims 11 to 13 or is a heat exchanger (1) according to any of the claims 1 to 8, comprising at least the following step:
- connecting a fluid line (9) to an open end (7) of a respective terminal pipe (4), wherein the fluid line (9) is made of the same material as the respective terminal pipe (4).

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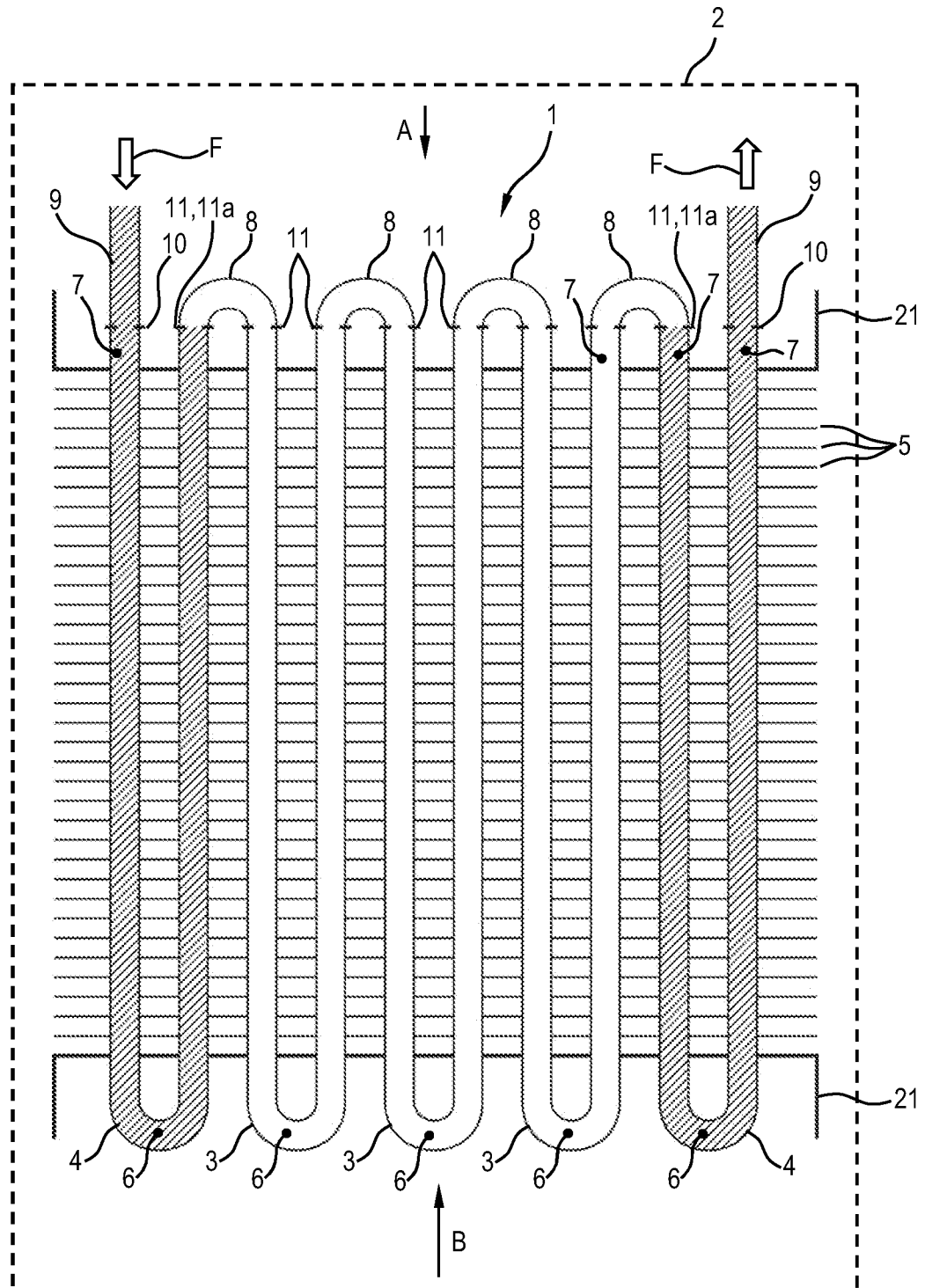


Fig.1

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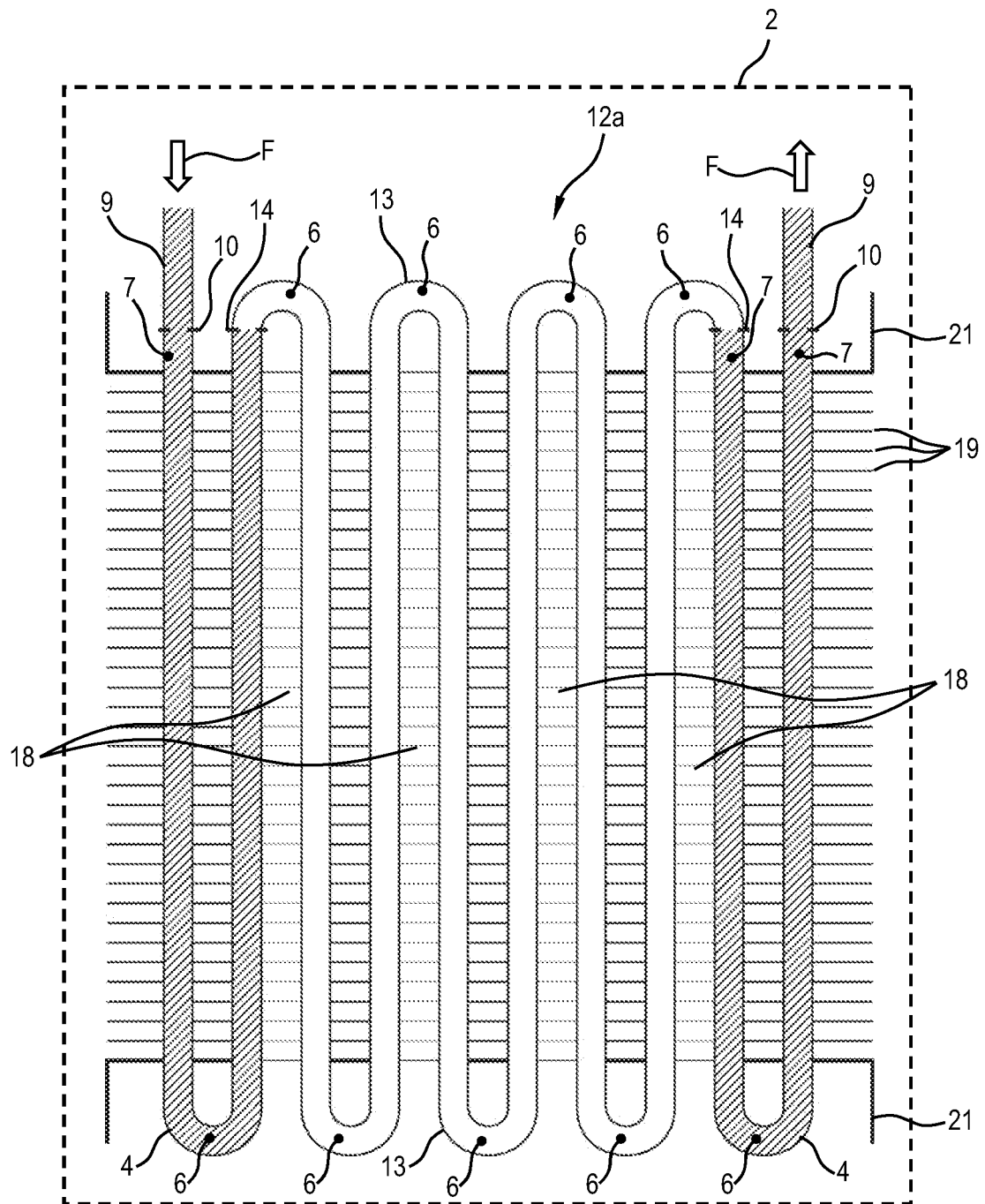


Fig.2

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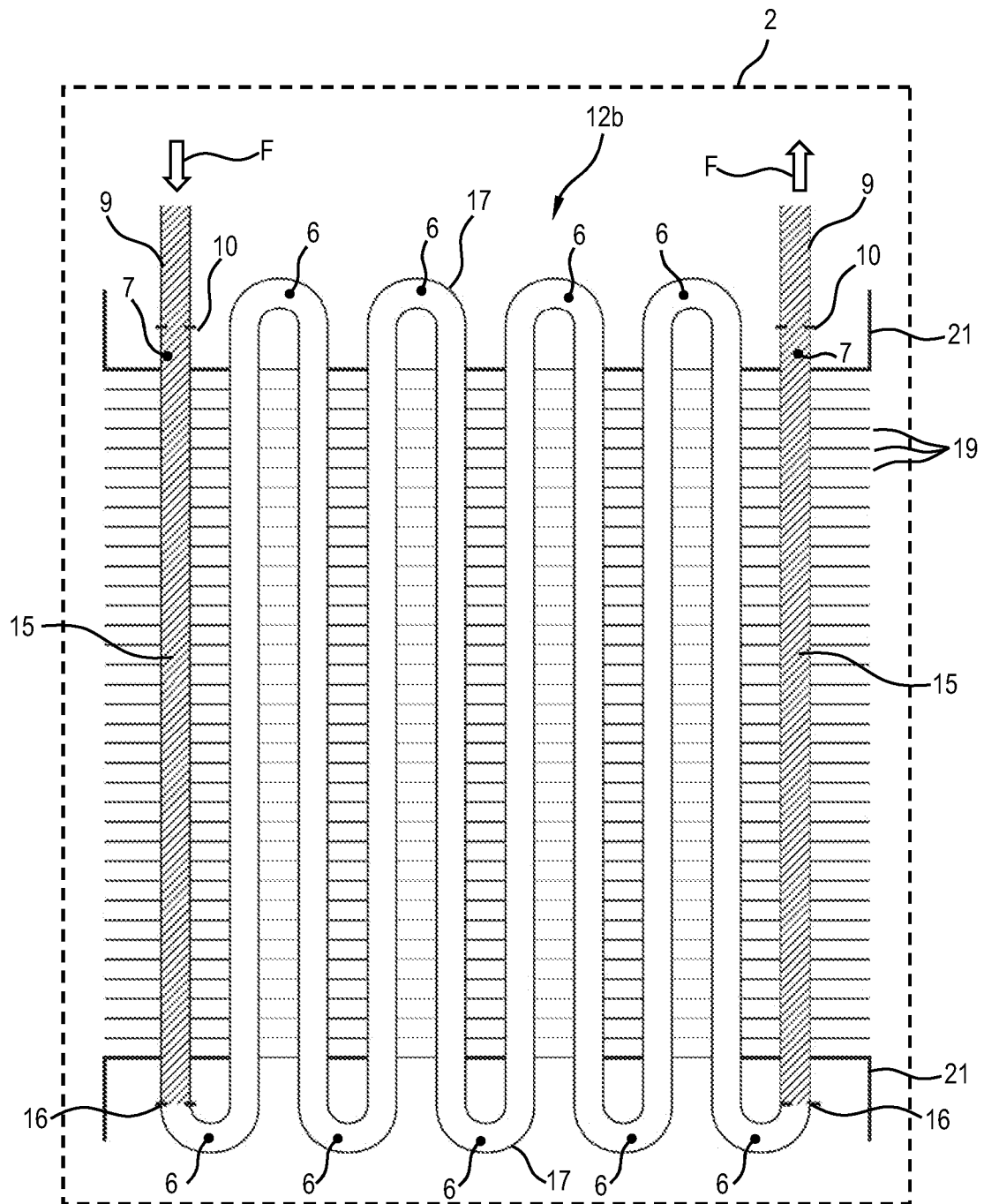


Fig.3

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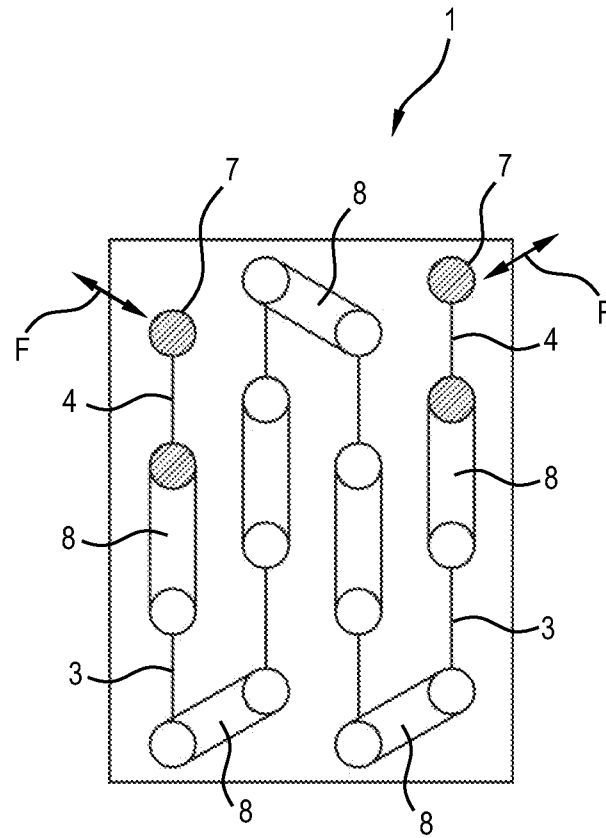


Fig.4a

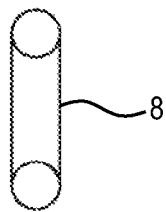


Fig.4b

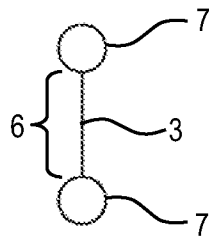


Fig.4c

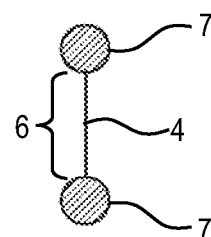


Fig.4d

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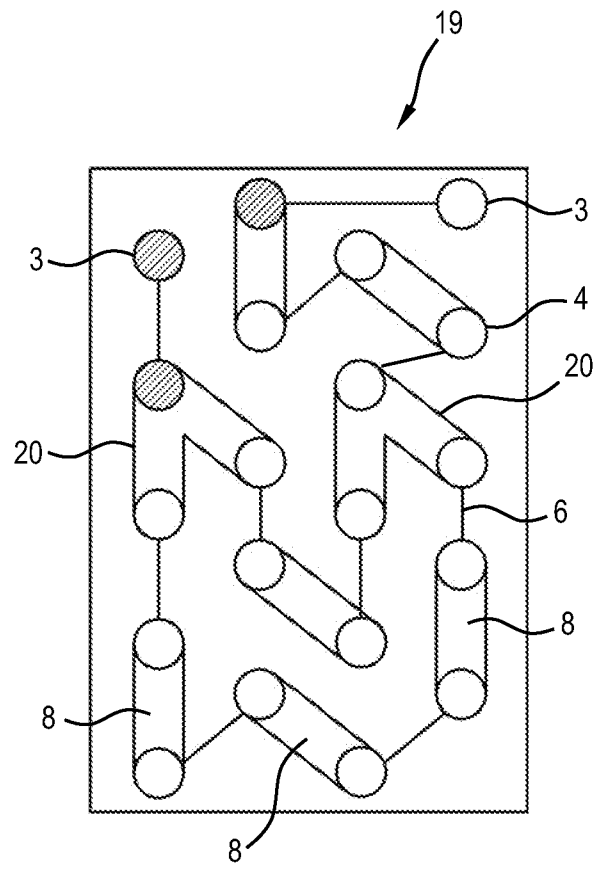


Fig.5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2011/053547

A. CLASSIFICATION OF SUBJECT MATTER
INV. F28D1/047 F28F9/26 F28F21/08
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)
F28D F28F

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	US 3 849 854 A (MATTIOLI H ET AL) 26 November 1974 (1974-11-26) abstract column 4, line 51 - line 57 column 3, line 8 - column 4, line 67 -----	1-14
A	US 5 644 840 A (HISAMORI YOUICHI [JP] ET AL) 8 July 1997 (1997-07-08) column 2, line 31 - line 44 -----	1-14
A	US 1 790 241 A (MURRAY JR THOMAS E ET AL) 27 January 1931 (1931-01-27) the whole document -----	1-14
A	EP 1 550 834 A1 (TRAVASSAROS CONSTANTINE [GR]) 6 July 2005 (2005-07-06) paragraph [0014] -----	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search

27 September 2011

Date of mailing of the international search report

05/10/2011

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2011/053547

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3849854	A	26-11-1974	NONE
US 5644840	A	08-07-1997	NONE
US 1790241	A	27-01-1931	NONE
EP 1550834	A1	06-07-2005	GR 1004729 B1 22-11-2004 US 2005145680 A1 07-07-2005