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(54) **A LAUNDRY TREATING APPLIANCE HAVING A HEAT PUMP SYSTEM**

WÄSCHEBEHANDLUNGSGERÄT MIT WÄRMEPUMPENSYSTEM

APPAREIL DE TRAITEMENT DE LINGE COMPRENANT UN SYSTÈME DE POMPE À CHALEUR

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- **DOMANSKI P A ET AL: "Performance of a finned-tube evaporator optimized for different refrigerants and its effect on system efficiency", INTERNATIONAL JOURNAL OF REFRIGERATION, ELSEVIER, AMSTERDAM, NL, vol. 28, no. 6, 1 September 2005 (2005-09-01), pages 820 - 827, XP004998949, ISSN: 0140-7007, DOI: 10.1016/J.IJREFRIG.2005.02.003**

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Description

[0001] The present invention refers to a laundry treating appliance, for example a laundry washing machine (called also washing machine), a laundry washer-drier (called also washer-drier), a tumble drier, having a heat pump system.

[0002] Traditional laundry treating appliances, for example washing machines, washer-driers, tumble driers, typically comprise a cabinet containing a rotatable drum wherein the laundry to be treated (i.e. washed and/or dried) can be loaded.

[0003] An operating fluid (e.g., depending on the kind of laundry treating appliance and on the treating process to be applied, water, water mixed with a washing/rinsing additive, air), is circulated through the drum by a circulating system (comprising, for example pumps, valves, fans, etc., depending on the kind of fluid to be circulated).

[0004] In some known laundry treating appliances, the operating fluid is heated and/or cooled/dehumidified by a heat pump system, typically comprising a compressor, an expansion valve, two heat exchangers (one operating as a condenser, and the other as an evaporator), and conduits fluidly connecting such elements in a closed circuit.

[0005] A heat pump system has an improved energy efficiency with respect to traditional heating systems using an electrical heater as heat source.

[0006] Some refrigerant flows through the compressor, the condenser, the expansion valve and the evaporator, and through the conduits connecting these to one another.

[0007] The refrigerant releases heat to the operating fluid by means of the condenser, and extracts heat and humidity from the operating fluid by means of the evaporator. The compressor converts electromechanical power to thermal power by compressing the refrigerant in the refrigerant circuit.

[0008] A known kind of heat exchanger, widely used in heat pump systems of laundry treating appliances, comprises a metallic pipe, made of copper or aluminum, wherein the refrigerant flows, bent to define a coil structure comprising a plurality of straight sections, parallel one another and connected in twos at one end thereof by a plurality of curved sections; this kind of known heat exchanger comprises a plurality of fins, typically made of aluminum and having a rectangular plane, stacked in spaced and parallel planes and comprising a plurality of through-holes, each housing two straight sections of the metallic pipe.

[0009] During the functioning of the heat pump system, the operating fluid flows through the gaps between the fins, exchanging heat with the latter, and therefore with the refrigerant flowing in the metallic pipe, which is thermally connected to the fins. Currently, the refrigerants mainly used in heat pump systems of known laundry treating appliances are hydrofluorocarbon (HFC) refrigerants, in particular the ones known as R134a and R407C. Unfortunately, these refrigerants have a high

Global Warming Potential (GWP), so alternative refrigerants start to be more and more used in different industries.

[0010] Possible alternative refrigerants used for replacing hydrofluorocarbon (HFC) refrigerants in heat pump systems of laundry treating appliances are hydrocarbons refrigerants, such as propane (R290) and propylene (R1270).

[0011] These alternative refrigerants have a negligible impact on GWP and their thermo-physical properties makes them very suitable for the typical working conditions of heat pump systems of laundry treating appliances, in particular tumble driers and washer-driers.

[0012] The downside of these alternative refrigerants is that they are flammable, and therefore, for limiting possible risks, regulations (e.g. the IEC 60335-2-11 standard) limit the amount of refrigerant that can be charged in the heat pump system to 150 g (grams).

[0013] Inside the heat pump system, when the compressor is switched ON, most of the refrigerant can be found inside the condenser, since in this heat exchanger the refrigerant is at high pressure and, for a portion thereof, in liquid state, so with a very high density.

[0014] The evaporator, on the contrary, works at low pressure, and the refrigerant contained therein is mainly a liquid-vapour mixture and a superheated vapour, so its density is quite low. It has been observed that limiting to 150 g the refrigerant charge could negatively affect the performances of the heat pump system, in particular its energy efficiency.

[0015] There is the need, therefore, to reduce the volume of the components of the heat exchangers wherein the refrigerant flows, so as to limit the refrigerant charge required by the system. On the other hand, it's important not reducing too much the external surface area, so as to keep a good heat exchange performance.

[0016] In particular, in order to reduce the overall volume of the single duct of the heat exchanger wherein the refrigerant flows, there could be the possibility to reduce the number of stacked fins, and therefore the overall length of the metallic pipe; unfortunately, reducing the number of fins reduces also the overall thermal exchange surface of the heat exchanger, which reduces the energy efficiency of the heat pump system. EP3066406A1 discloses a household appliance, in particular a laundry treatment appliance, provided with a heat pump comprising a rotary compressor, a condenser, a restrictor, and an evaporator, wherein the condenser is of an expanded tube-and-fin type, with the tubes having an outer diameter of less than 7 mm and wherein the roller has a height-to-radius ratio of 1.4 to 1.2.

[0017] EP3617393A1 discloses a laundry dryer including a heat pump system having a refrigerant circuit in which a refrigerant can flow, said refrigerant circuit including a first heat exchanger where the refrigerant is heated up, a second heat exchanger where the refrigerant is cooled off, a compressor to pressurize and circulate the refrigerant through the refrigerant circuit, and a pres-

sure-lowering device; the first and/or second heat exchanger are apt to perform heat exchange between the refrigerant flowing in the refrigerant circuit and the process air. The refrigerant is a flammable refrigerant. Each of the first and second heat exchanger is a finned tube heat exchanger comprising a tube having multiple sections one above the other and a plurality of fins; it is divided in three portions: a central portion wherein the multiple sections of the tube are in contact with the plurality of fins, and a first and second end portions where the tube is not in contact with the plurality of fins. The value of the ratio between a thickness of the central portion of the second heat exchanger and a thickness of the central portion of the first heat exchanger is lower than 1.

[0018] The scientific article by DOMANSKI P A ET AL, titled "Performance of a finned-tube evaporator optimized for different refrigerants and its effect on system efficiency", published on the INTERNATIONAL JOURNAL OF REFRIGERATION, ELSEVIER, AMSTERDAM, NL, (20050901), vol. 28, no. 6, vol. 1, September 2005, pages 820-827, XP004998949, ISSN 0140-7007, DOI:10.1016/J.IJREFRIG.2005.02.003, presents a comparable evaluation of R600a (isobutane), R290 (propane), R134a, R22, R410A, and R32 in an optimized finned-tube evaporator, and analyses the impact of evaporator effects on the system coefficient of performance (COP).

[0019] The aim of the present invention is therefore obtaining a laundry treating appliance using a heat pump system having a reduced Global Warming Potential (GWP) and an improved efficiency.

[0020] Within this aim, a further object of the invention is obtaining a laundry treating appliance fulfilling the safety regulations related to the refrigerants of the heat pump systems, without reducing the overall energy efficiency. Applicant has found that, by selecting, for specific ranges of external diameters of the metallic pipe of a finned heat exchanger which stacked fins have a plurality of through-holes, each housing two mutually parallel straight sections of the metallic pipe, the straight sections being distributed in such a way that, in a cross section whose cutting plane is perpendicular to the straight sections, their centers are aligned along a plurality of mutually parallel straight lines, specific ranges for the distances of the straight lines of adjoining straight lines, and corresponding specific ranges for the distances between the centers of couples of adjoining straight sections aligned along a same straight line, it is possible to reduce the overall internal volume of the metallic pipe of the heat exchanger wherein the refrigerant flows without reducing the length of the metallic pipe nor the number of fins, and therefore without reducing the overall thermal exchange surface.

[0021] This inventive solution allows using in the heat pump system of a laundry appliance a flammable refrigerant, like for example propane (R290) or propylene (R1270), which have a very low Global Warming Poten-

tial (GWP), but that needs to be used in small quantities, and therefore requires a reduced volume of the metallic pipe of the heat exchanger wherein the refrigerant flows.

[0022] In particular, above aim is solved by a laundry treating appliance comprising:

- a cabinet;
- a drum, rotatably housed within the cabinet, in which laundry can be loaded;
- a heat pump system, using one or more flammable refrigerants, configured for exchanging heat with an operating fluid;
- a circulating system configured for circulating the operating fluid through the drum;

wherein the heat pump system comprises a heat exchanger comprising:

- a metallic pipe, wherein the flammable refrigerant flows, bent to define a coil structure comprising a plurality of straight sections, parallel one another and connected in twos at one end thereof by a plurality of curved sections;
- a plurality of fins, stacked spaced and parallel to one another, each provided with a plurality of through-holes, each through-hole housing two of the straight sections, wherein the external diameter of said metallic pipe is comprised between 5 and 9 mm,

the plurality of straight sections being distributed in such a way that, in a cross section whose cutting plane is perpendicular to the straight sections, their centers are aligned along a plurality of mutually parallel straight lines, wherein,

- the distance between the centers of two adjoining straight sections aligned along a same straight line among the mutually parallel straight lines is comprised between 30 and 40 mm, and the distance between two adjoining straight lines among the mutually parallel straight lines is comprised between 12 and 50 mm, or
- the distance between the centers of two adjoining straight sections aligned along a same straight line among the mutually parallel straight lines is comprised between 40 and 70 mm, and the distance between two adjoining straight lines among the mutually parallel straight lines is comprised between 8 and 50 mm.

[0023] It is underlined that stating that two straight lines are *adjoining* (or in other words contiguous, or neighboring, or adjacent) means that there aren't other straight lines positioned between such two straight lines.

[0024] It is underlined that stating that two straight sections are *adjoining* (or in other words contiguous, or neighboring, or adjacent) means that there aren't other

straight sections positioned between such two straight sections.

[0025] Using the specific inventive ranges of distances between straight lines/straight sections, in combination with the specific inventive ranges of the external diameter of the metallic pipe, allows keeping reduced the internal volume of heat exchanger wherein the flammable refrigerant flows, without significantly affecting the overall dimensions of the stacked fins, and therefore without significantly affecting the heat exchange performances.

[0026] In addition, the specific combinations of inventive ranges allow obtaining a uniform heat distribution along the fins, which avoids overheating of some parts of the latter, and also improves the heat exchange.

[0027] In an advantageous embodiment, the distance between the centers of two adjoining straight sections aligned along a same straight line among the mutually parallel straight lines is comprised between 30 and 40 mm, and the distance between two adjoining straight lines among the mutually parallel straight lines is comprised between 12 and 35 mm.

[0028] In a further advantageous embodiment, the distance between the centers of two adjoining straight sections aligned along a same straight line among the mutually parallel straight lines is comprised between 40 and 55 mm, and the distance between two adjoining straight lines among the mutually parallel straight lines is comprised between 8 and 12 mm.

[0029] In a preferred embodiment, the distance between two adjoining straight lines among the mutually parallel straight lines is the same for all the couples of adjoining straight lines among the mutually parallel straight lines.

[0030] Preferably, the distance between the centers of two adjoining straight sections aligned along a same straight line among the mutually parallel straight lines is the same for all the couples of adjoining straight sections aligned along this same straight line. More preferably, the distance between the centers of two adjoining straight sections aligned along a same straight line among the mutually parallel straight lines is the same for all the mutually parallel straight lines.

[0031] In a preferred embodiment, the metallic pipe comprises an inlet portion and an outlet portion protruding both from a same terminal fin of the plurality of stacked fins. Preferably, the flammable refrigerant is or comprises a hydrocarbon. More preferably, the flammable refrigerant is or comprises propane (R290) or propylene (R1270). Advantageously, the plurality of fins is made of, or comprise, aluminum or aluminum alloy, or copper, or copper alloy.

[0032] In an advantageous embodiment, the perimeter edges of the stacked fins define as a whole an envelope surface comprising at least a plane portion), and the mutually parallel straight lines are perpendicular to the at least a plane portion. Preferably, fins of the plurality of metallic fins have a width comprised between 65 mm and 145 mm, and a height comprised between 110 mm and

185 mm.

[0033] More preferably, fins of the plurality of metallic fins have a width comprised between 95 mm and 125 mm, and a height comprised between 145 mm and 165 mm.

[0034] Preferably, the overall length of the stacked fins is comprised between 330 mm and 370 mm.

[0035] More preferably, the overall length of the stacked fins is comprised between 200 mm and 250 mm.

[0036] Preferably, the metallic pipe is made of, or comprises, aluminum or aluminum alloy, or copper or copper alloy.

[0037] In an advantageous embodiment, the laundry treating appliance is a tumble drier or a washer-drier, and the operating fluid is air.

[0038] In a further advantageous embodiment, the laundry treating appliance is a laundry washing machine, and the operating fluid is water, or water mixed with a washing/rinsing agent. Other advantages and features of a laundry treating appliance according to the present invention will be clear from the following detailed description, provided only as a not limitative example, in which:

Fig 1 is a schematic lateral cross section of a laundry treating appliance, in particular a tumble drier, according to the invention;

Fig. 2 is a schematic lateral view of a heat exchanger of a laundry treating appliance according to the invention;

Fig. 3 is a schematic a cross section operated according to plane Cp-Cp Fig. 2;

Fig. 4 is a rear view of the heat exchanger of Fig. 2; Fig. 5 is a schematic front view of a fin of the heat exchanger of the previous figures;

Fig. 6 is a schematic lateral view of the metallic pipe of the heat exchanger of the previous figures;

Fig. 7 is a lateral schematic view of the stacked fins of a heat exchanger according to the invention;

Fig. 8 is a further schematic a cross section operated according to plane Cp-Cp Fig. 2.

[0039] In the figures, same parts are indicated with the same reference numbers.

[0040] Advantageously, the laundry treating appliance 10 illustrated in figure 1 is a tumble drier of the "horizontal axis type"; it is however clear that the invention can be applied, without any substantial modification, also to tumble driers of the vertical axis" type, and to washing machines and washer driers, both of the "horizontal axis" and of the "vertical axis" type.

[0041] The laundry treating appliance (being it a tumble drier 10, or a washing machine or washer-drier, not illustrated) comprises a cabinet 20, or housing, preferably parallelepiped, configured to be positioned on a horizontal surface 2, for example the floor of a building, preferably by suitable feet 21, one or more of which can have, advantageously, an adjustable height, so as to adapt to a possible not perfect planarity of the horizontal

surface 2.

[0042] Advantageously, in the frontal wall 20a of the cabinet 20 an access opening, not illustrated, is preferably obtained, advantageously selectively closable by a loading/unloading door 4, preferably hinged to the frontal wall 20a.

[0043] The laundry treating appliance (being it a tumble drier 10, or a washing machine or washer-drier) comprises a drum 30 rotatably housed within the cabinet 20, in which the laundry, not illustrated, can be loaded.

[0044] If the laundry treating appliance is a washing machine or a washer-drier, both not illustrated, the cabinet 20 also houses a washing tub, not illustrated, preferably suspended to the cabinet through springs and dumpers, also not illustrated, in which the drum 30 is rotatably contained.

[0045] The laundry treating appliance 10 comprises a circulating system 60 configured for circulating an operating fluid through the drum 3.

[0046] It is underlined that the circulating system 60 can define a closed circuit for the operating fluid (i.e. the operating fluid remains within the closed circuit during the laundry treating process, and the same fluid, opportunely treated, passed repeatedly through the drum 30), or it can define an opened circuit for the operating fluid (i.e. the operating fluid is loaded within the laundry treating appliance 10 at a certain point of the laundry treating process, and it is drained from the laundry treating appliance 10 at another point of the laundry treating process).

[0047] In the advantageous embodiment in which the laundry treating appliance 10 is a tumble drier, like the advantageous example of figure 1, or a washer drier, not illustrated, the operating fluid is or comprises air (represented by arrows 50), and the circulating system preferably comprises an air circuit 61 and one or more fans 62 configured for circulating such air 50 through the drum 3 and the air circuit 61.

[0048] If the laundry treating appliance is a tumble drier 10, it can also advantageously comprise a lint filter 63, arranged in the air circuit 61 for trapping lint or fluff released from the laundry.

[0049] If the laundry treating appliance is a washing machine or a washer drier, both not illustrated, the operating fluid is or comprises water, or water mixed with a washing/rinsing additive, and the circulating system preferably comprises a water inlet circuit, not illustrated, adapted to feed water into the tub, also not illustrated, and a drain circuit, also not illustrated, adapted for draining washing/rinsing liquid from the machine.

[0050] The laundry treating appliance 10 advantageously comprises a heat pump system 40, configured for heating the operating fluid, for example, in case of a tumble drier, the air 50. Advantageously, the heat pump system 40 can also be configured for cooling and dehumidifying the operating fluid.

[0051] Preferably, the heat pump system 40 comprises a compressor, not illustrated, an expansion valve, also not illustrated, two heat exchangers 70a, 70b (one oper-

ating as a condenser, and the other as an evaporator), and conduits, not illustrated, fluidly connecting such elements in a closed circuit.

[0052] A flammable refrigerant flows through the compressor, the condenser 70a, the expansion valve and the evaporator 70b, and through the conduits connecting these to one another.

[0053] The flammable refrigerant releases heat to the operating fluid by means of the condenser 70a and extracts heat and humidity from the operating fluid by means of the evaporator 70b. The compressor converts electromechanical power to thermal power by compressing the flammable refrigerant in the refrigerant circuit.

[0054] The flammable refrigerant is or comprises a hydrocarbon, preferably propane (R290) or propylene (R1270).

[0055] The heat exchangers, for example the condenser 70a and/or the evaporator 70b, comprise a metallic pipe 80, wherein the flammable refrigerant flows, bent to define a coil structure comprising a plurality of straight sections 81, parallel one another and connected in twos at one end thereof by a plurality of curved sections 82.

[0056] Advantageously, the metallic pipe 80 is made of, or comprise, aluminum or aluminum alloy, or copper or copper alloy.

[0057] The straight sections 81 are distributed in such a way that, in a cross section which cutting plane Cp (illustrated in Fig. 2) is perpendicular to the straight sections 81, their centers Ce are aligned along a plurality of mutually parallel straight lines 110.

[0058] The heat exchangers, for example the condenser 70a and/or the evaporator 70b, comprise a plurality of fins 90, stacked spaced and parallel to one another, each provided with a plurality of through-holes 100, each through-hole 100 housing two of the straight sections 81 of the metallic pipe 80. Advantageously, the fins 90 are made of, or comprise, aluminum or aluminum alloy, or copper, or copper alloy. Advantageously, the through-holes 100 of any fin 90 are respectively aligned with the through-holes 100 of the rest of the stacked fins 90.

[0059] Advantageously, the straight sections 81 are fitted, with their lateral surface into close contact with the border of the respective through-holes 100, so as to obtain an effective heat-exchange between them.

[0060] Advantageously, the metallic pipe 80 comprises an inlet portion 84 and an outlet portion 85, configured for allowing the flammable refrigerant respectively to enter/exit the metallic pipe 80; advantageously, the inlet portion 84 and the outlet portion 85 are fluidly connected or connectable to the other elements of the heat pump system 40, so as to allow circulation of the flammable refrigerant through the respective heat exchanger 70a or 70b.

[0061] Advantageously, like in the examples of attached figures, the inlet portion 84 and an outlet portion 85 protrude both from a same terminal fin 91 of the plurality of stacked fins 90, which simplifies the connection of the single duct 83 to the other conduits of the heat

pump system 40.

[0062] Advantageously, the perimeter edges 99 of the stacked fins 90 define as a whole an envelope surface, illustrated in figures 7 and 8 with a dotted line numbered 92, comprising at least a plane portion 93.

[0063] Preferably, the fins 90 have a rectangular or square plan, in which case the envelope surface 92 comprises four plane portions, corresponding to the four sides of the rectangle or square.

[0064] In advantageous embodiments, like for example the ones illustrated in attached figures, in which the fins 90 have a rectangular or square plan, and the envelope surface 92 comprises four plane portions corresponding to the four sides of the rectangle or square, above defined straight lines 110 are advantageously parallel to two sides of such rectangle or square.

[0065] Preferably, the width "w" of the fins 90 is comprised between 65 mm and 145 mm, more preferably between 95 mm and 125 mm. Preferably, the height "h" of the fins 90 is comprised between 110 mm and 185 mm, more preferably between 145 mm and 165 mm. Preferably, the overall length of the stacked fins 90 is comprised between 330 mm and 370 mm, more preferably between 200 mm and 250 mm.

[0066] According to the invention, the external diameter d_e of the metallic pipe 80, and in particular of its straight portions 81 is comprised between 5 and 9 mm, wherein:

- the distance T_p between the centers C_e of two adjoining straight sections 81 aligned along one of the mutually parallel straight lines 110 is comprised between 30 and 40 mm, and the distance R_p between two adjoining straight lines 110 among the mutually parallel straight lines 110 is comprised between 12 and 50 mm, or
- the distance T_p between the centers C_e of two adjoining straight sections 81 aligned along one of the mutually parallel straight lines 110 is comprised between 40 and 70 mm, and the distance R_p between two adjoining straight lines 110 among the mutually parallel straight lines 110 is comprised between 8 and 50 mm.

[0067] In an advantageous embodiment, if the external diameter d_e of the plurality of straight sections 81 of the metallic pipe 80 is comprised between 5 and 9 mm, then the distance T_p between the centers C_e of two adjoining straight sections 81 aligned along one of the mutually parallel straight lines 110 is comprised between 30 and 40 mm, and the distance R_p between two adjoining straight lines 110 among the mutually parallel straight lines 110 is comprised between 12 and 35 mm.

[0068] In a further advantageous embodiment, if the external diameter d_e of the plurality of straight sections 81 of the metallic pipe 80 is comprised between 5 and 9 mm, then the distance T_p between the centers C_e of two adjoining straight sections 81 aligned along one of the

mutually parallel straight lines 110 is comprised between 40 and 55 mm, and the distance R_p between two adjoining straight lines 110 among the mutually parallel straight lines 110 is comprised between 8 and 12 mm.

[0069] In another advantageous embodiment, the distance R_p between two adjoining straight lines 110 among the mutually parallel straight lines 110 is the same for all the couples of adjoining straight lines 110 among the mutually parallel straight lines 110.

[0070] Preferably, the distance T_p between the centers C_e of two adjoining straight sections 81 aligned along one of the mutually parallel straight lines 110 is the same for all the couples of adjoining straight sections 81 aligned along a same straight line 110.

[0071] More preferably, the distance T_p between the centers C_e of two adjoining straight sections 81 aligned along a same straight line 110 is the same for all the straight line 110.

[0072] It is seen therefore how the invention achieves the proposed aim and objects, since it allows obtaining an evaporator for the heat pump system of a laundry treating appliance having a relatively small volume of the metallic pipe wherein the refrigerant flows, and a high overall thermal exchange surface; this evaporator allows using in the heat pump system a flammable refrigerant, like for example propane (R290) or propylene (R1270), which have a very low Global Warming Potential (GWP), fulfilling the regulation requirements related to flammable refrigerant charge, and keeping at the same time a high energetic efficiency.

Claims

1. A laundry treating appliance (10) comprising:

- a cabinet (20);
- a drum (30), rotatably housed within said cabinet (20), in which laundry can be loaded;
- a heat pump system (40), using one or more flammable refrigerants, configured for exchanging heat with an operating fluid (50);
- a circulating system (60) configured for circulating said operating fluid (50) through said drum (30);

wherein said heat pump system (40) comprises a heat exchanger (70a, 70b) comprising:

- a metallic pipe (80), wherein said flammable refrigerant flows, bent to define a coil structure comprising a plurality of straight sections (81), parallel one another and connected in twos at one end thereof by a plurality of curved sections (82), wherein the external diameter (d_e) of said metallic pipe (80) is comprised between 5 and 9 mm;
- a plurality of fins (90), stacked, spaced and parallel to one another, each provided with a

plurality of through-holes (100), each through-hole (100) housing two of said straight sections (81),

said plurality of straight sections (81) being distributed in such a way that, in a cross section whose cutting plane (Cp) is perpendicular to said straight sections (81), their centers (Ce) are aligned along a plurality of mutually parallel straight lines (110),

characterized in that

- the distance (Tp) between the centers (Ce) of two adjoining straight sections (81) aligned along a same straight line (110) among said mutually parallel straight lines (110) is comprised between 30 and 40 mm, and the distance (Rp) between two adjoining straight lines (110) among said mutually parallel straight lines (110) is comprised between 12 and 50 mm,

or

- the distance (Tp) between the centers (Ce) of two adjoining straight sections (81) aligned along a same straight line (110) among said mutually parallel straight lines (110) is comprised between 40 and 70 mm, and the distance (Rp) between two adjoining straight lines (110) among said mutually parallel straight lines (110) is comprised between 8 and 50 mm.

2. A laundry treating appliance (10), according to claim 1, wherein said distance (Tp) between the centers (Ce) of two adjoining straight sections (81) aligned along a same straight line (110) among said mutually parallel straight lines (110) is comprised between 30 and 40 mm, and said distance (Rp) between two adjoining straight lines (110) among said mutually parallel straight lines (110) is comprised between 12 and 35 mm.

3. A laundry treating appliance (10), according to claim 1, wherein said distance (Tp) between the centers (Ce) of two adjoining straight sections (81) aligned along a same straight line (110) among said mutually parallel straight lines (110) is comprised between 40 and 55 mm, and said distance (Rp) between two adjoining straight lines (110) among said mutually parallel straight lines (110) is comprised between 8 and 12 mm.

4. A laundry treating appliance (10) according to one or more of the previous claims, wherein said distance (Rp) between two adjoining straight lines (110) among said mutually parallel straight lines (110) is the same for all the couples of adjoining straight lines (110) among said mutually parallel straight lines

(110).

5. A laundry treating appliance (10) according to one or more of the previous claims, wherein said distance (Tp) between the centers (Ce) of two adjoining straight sections (81) aligned along a same straight line (110) among said mutually parallel straight lines (110) is the same for all the couples of adjoining straight lines (81) aligned along said same straight line (110).

6. A laundry treating appliance (10) according to claim 5, wherein said distance (Tp) between the centers (Ce) of two adjoining straight sections (81) aligned along a same straight line (110) among said mutually parallel straight lines (110) is the same for all said mutually parallel straight lines (110).

7. A laundry treating appliance (10) according to one or more of the previous claims, wherein said metallic pipe (80) comprises an inlet portion (84) and an outlet portion (85) protruding both from a same terminal fin (91) of said plurality of stacked fins (90).

8. A laundry treating appliance (10) according to one or more of the previous claims, wherein said flammable refrigerant is or comprises a hydrocarbon.

9. A laundry treating appliance (10) according to claim 8, wherein said flammable refrigerant is or comprises propane (R290) or propylene (R1270).

10. A laundry treating appliance (10) according to one or more of the previous claims, wherein said plurality of fins (90) are made of, or comprise, aluminum or aluminum alloy, or copper, or copper alloy.

11. A laundry treating appliance (10) according to one or more of the previous claims, wherein perimeter edges (99) of said stacked fins (90) define as a whole an envelope surface (92) comprising at least one plane portion (93), and wherein said mutually parallel straight lines (110) are perpendicular to said at least one plane portion (93).

12. A laundry treating appliance (10) according to one or more of the previous claims, wherein fins of said plurality of fins (90) have a width (w) comprised between 65 mm and 145 mm, preferably between 95 mm and 125 mm, and a height (h) comprised between 110 mm and 185 mm, preferably between 145 mm and 165 mm.

13. A laundry treating appliance (10) according to one or more of the previous claims, wherein the overall length (L) of said stacked fins (90) is comprised between 330 mm and 370 mm, preferably between 200 mm and 250 mm.

14. A laundry treating appliance (10) according to one or more of the previous claims, wherein said metallic pipe (80) is made of, or comprises, aluminum or aluminum alloy, or copper or copper alloy.

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15. A laundry treating appliance (10) according to one or more of the previous claims, wherein said laundry treating appliance (10) is a tumble drier (11) or a washer-drier, and wherein said operating fluid (50) is air or, wherein said laundry treating appliance (10) is a laundry washing machine, and said operating fluid (50) is water, or water mixed with a washing/rinsing agent.

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Patentansprüche

1. Wäschebehandlungsgerät (10), das Folgendes umfasst:

20

- ein Gehäuse (20);
 - eine innerhalb des Gehäuses (20) drehbar aufgenommene Trommel (30), die mit Wäsche beladen werden kann;
 - ein Wärmepumpensystem (40), das ein oder mehrere zum Austauschen von Wärme mit einem Betriebsfluid (50) vorgesehene brennbare Kältemittel nutzt;
 - ein Umwälzsystem (60), das zum Umwälzen des Betriebsfluids (50) durch die Trommel (30) vorgesehen ist;
- wobei das Wärmepumpensystem (40) einen Wärmeaustauscher (70a, 70b) umfasst, der Folgendes umfasst:

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- ein Metallrohr (80), in dem das brennbare Kältemittel fließt, das gebogen ist, um eine Spulenstruktur zu definieren, die mehrere gerade Abschnitte (81) umfasst, die zueinander parallel und an einem Ende durch mehrere gekrümmte Abschnitte (82) in Paaren verbunden sind, wobei der Außendurchmesser (de) des Metallrohrs (80) zwischen 5 und 9 mm beträgt;
- mehrere übereinander angeordnete, zueinander beabstandete und zueinander parallele Rippen (90), die je mit mehreren Durchgangslöchern (100) versehen sind, wobei in jedem Durchgangsloch (100) zwei der geraden Abschnitte (81) aufgenommen sind,

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wobei die mehreren geraden Abschnitte (81) derart verteilt sind, dass in einem Querschnitt, dessen Schnittebene (Cp) senkrecht zu den geraden Abschnitten (81) verläuft, deren Mittelpunkte (Ce) entlang mehrerer zueinander paralleler gerader Linien (110) ausgerichtet sind,

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dadurch gekennzeichnet, dass

- die Entfernung (Tp) zwischen den Mittelpunkten (Ce) zweier angrenzender gerader Abschnitte (81), die entlang derselben geraden Linie (110) der zueinander parallelen geraden Linien (110) ausgerichtet sind, zwischen 30 und 40 mm beträgt und die Entfernung (Rp) zwischen zwei angrenzenden geraden Linien (110) der mehreren zueinander parallelen geraden Linien (110) zwischen 12 und 50 mm beträgt
- oder
- die Entfernung (Tp) zwischen den Mittelpunkten (Ce) zweier angrenzender gerader Abschnitte (81), die entlang derselben geraden Linie (110) der zueinander parallelen geraden Linien (110) ausgerichtet sind, zwischen 40 und 70 mm beträgt und die Entfernung (Rp) zwischen zwei angrenzenden geraden Linien (110) der mehreren zueinander parallelen geraden Linien (110) zwischen 8 und 50 mm beträgt.

2. Wäschebehandlungsgerät (10) nach Anspruch 1, wobei die Entfernung (Tp) zwischen den Mittelpunkten (Ce) zweier angrenzender gerader Abschnitte (81), die entlang derselben geraden Linie (110) der zueinander parallelen geraden Linien (110) ausgerichtet sind, zwischen 30 und 40 mm beträgt und die Entfernung (Rp) zwischen zwei angrenzenden geraden Linien (110) der mehreren zueinander parallelen geraden Linien (110) zwischen 12 und 35 mm beträgt.

3. Wäschebehandlungsgerät (10) nach Anspruch 1, wobei die Entfernung (Tp) zwischen den Mittelpunkten (Ce) zweier angrenzender gerader Abschnitte (81), die entlang derselben geraden Linie (110) der zueinander parallelen geraden Linien (110) ausgerichtet sind, zwischen 40 und 55 mm beträgt und die Entfernung (Rp) zwischen zwei angrenzenden geraden Linien (110) der mehreren zueinander parallelen geraden Linien (110) zwischen 8 und 12 mm beträgt.

4. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei die Entfernung (Rp) zwischen zwei angrenzenden geraden Linien (110) der mehreren zueinander parallelen geraden Linien (110) bei allen Paaren angrenzender gerader Linien (110) der zueinander parallelen geraden Linien (110) gleich ist.

5. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei die Entfernung (Tp) zwischen den Mittelpunkten (Ce) zweier angrenzender gerader Abschnitte

- (81), die entlang derselben geraden Linie (110) der zueinander parallelen geraden Linien (110) ausgerichtet sind, bei allen Paaren angrenzender gerader Linien (81), die entlang derselben geraden Linie (110) ausgerichtet sind, gleich ist. 5
6. Wäschebehandlungsgerät (10) nach Anspruch 5, wobei die Entfernung (Tp) zwischen den Mittelpunkten (Ce) zweier angrenzender gerader Abschnitte (81), die entlang derselben geraden Linie (110) der zueinander parallelen geraden Linien (110) ausgerichtet sind, bei allen zueinander parallelen geraden Linien (110) gleich ist. 10
7. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei das Metallrohr (80) einen Einlassabschnitt (84) und einen Auslassabschnitt (85), die beide von derselben Abschlussrippe (91) der mehreren übereinander angeordneten Rippen (90) vorstehen, umfasst. 20
8. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei das brennbare Kältemittel Kohlenwasserstoff ist oder umfasst. 25
9. Wäschebehandlungsgerät (10) nach Anspruch 8, wobei das brennbare Kältemittel Propan (R290) oder Propylen (R1270) ist oder umfasst. 30
10. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei die mehreren Rippen (90) aus Aluminium oder einer Aluminiumlegierung oder Kupfer oder einer Kupferlegierung hergestellt sind oder Aluminium oder eine Aluminiumlegierung oder Kupfer oder eine Kupferlegierung umfassen. 35
11. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei Umfangskanten (99) der übereinander angeordneten Rippen (90) im Ganzen eine Hüllfläche (92), die mindestens einen Ebenenabschnitt (93) umfasst, definieren, und wobei die zueinander parallelen geraden Linien (110) senkrecht zu dem mindestens einen Ebenenabschnitt (93) sind. 40 45
12. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei die Rippen der mehreren Rippen (90) eine Breite (w), die zwischen 65 mm und 145 mm, vorzugsweise zwischen 95 mm und 125 mm, beträgt, und eine Höhe (h), die zwischen 110 mm und 185 mm, vorzugsweise zwischen 145 mm und 165 mm beträgt, aufweisen. 50 55
13. Wäschebehandlungsgerät (10) nach einem oder

mehreren der vorhergehenden Ansprüche, wobei die Gesamtlänge (L) der übereinander angeordneten Rippen (90) zwischen 330 mm und 370 mm, vorzugsweise zwischen 200 mm und 250 mm, beträgt.

14. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei das Metallrohr (80) aus Aluminium oder einer Aluminiumlegierung oder Kupfer oder einer Kupferlegierung hergestellt ist oder Aluminium oder eine Aluminiumlegierung oder Kupfer oder eine Kupferlegierung umfasst.

15. Wäschebehandlungsgerät (10) nach einem oder mehreren der vorhergehenden Ansprüche, wobei das Wäschebehandlungsgerät (10) ein Wäschetrockner (11) oder ein Waschautomat mit Trockner ist und wobei das Betriebsfluid (50) Luft ist oder wobei das Wäschebehandlungsgerät (10) eine Wäschewaschmaschine ist und das Betriebsfluid (50) Wasser oder mit einem Wasch-/Spülmittel gemischtes Wasser ist.

Revendications

1. Appareil de traitement de linge (10), comprenant :
- une carrosserie (20) ;
 - un tambour (30), logé de façon rotative à l'intérieur de ladite carrosserie (20), dans lequel du linge peut être chargé ;
 - un système de pompe à chaleur (40), utilisant un ou plusieurs réfrigérants inflammables, configuré pour échanger de la chaleur avec un fluide de fonctionnement (50) ;
 - un système de circulation (60) configuré pour faire circuler ledit fluide de fonctionnement (50) à travers ledit tambour (30) ;
- dans lequel ledit système de pompe à chaleur (40) comprend un échangeur de chaleur (70a, 70b) comprenant :
- un tuyau métallique (80), dans lequel ledit réfrigérant inflammable s'écoule, cintré pour définir une structure de serpentin comprenant une pluralité de sections droites (81), parallèles les unes aux autres et raccordées par deux à une extrémité de celles-ci par une pluralité de sections courbées (82), dans lequel le diamètre externe (de) dudit tuyau métallique (80) est compris entre 5 et 9 mm ;
 - une pluralité d'ailettes (90), empilées, espacées, et parallèles les unes aux autres, chacune pourvue d'une pluralité de trous de passage (100), chaque trou de passage

(100) logeant deux desdites sections droites (81),

ladite pluralité de sections droites (81) étant distribuée de manière telle que, en section transversale dont le plan de coupe (Cp) est perpendiculaire auxdites sections droites (81), leurs centres (Ce) sont alignés le long d'une pluralité de lignes droites mutuellement parallèles (110),

caractérisé en ce que

- la distance (Tp) entre les centres (Ce) de deux sections droites contiguës (81) alignées le long d'une même ligne droite (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 30 et 40 mm, et la distance (Rp) entre deux lignes droites contiguës (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 12 et 50 mm,

ou
- la distance (Tp) entre les centres (Ce) de deux sections droites contiguës (81) alignées le long d'une même ligne droite (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 40 et 70 mm, et la distance (Rp) entre deux lignes droites contiguës (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 8 et 50 mm.

2. Appareil de traitement de linge (10), selon la revendication 1, dans lequel ladite distance (Tp) entre les centres (Ce) de deux sections droites contiguës (81) alignées le long d'une même ligne droite (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 30 et 40 mm, et ladite distance (Rp) entre deux lignes droites contiguës (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 12 et 35 mm.
3. Appareil de traitement de linge (10), selon la revendication 1, dans lequel ladite distance (Tp) entre les centres (Ce) de deux sections droites contiguës (81) alignées le long d'une même ligne droite (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 40 et 55 mm, et ladite distance (Rp) entre deux lignes droites contiguës (110) parmi lesdites lignes droites mutuellement parallèles (110) est comprise entre 8 et 12 mm.
4. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel ladite distance (Rp) entre deux lignes droites contiguës (110) parmi lesdites lignes droites mutuellement parallèles (110) est la même pour toutes les paires de lignes droites contiguës (110) parmi lesdi-

tes lignes droites mutuellement parallèles (110).

5. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel ladite distance (Tp) entre les centres (Ce) de deux sections droites contiguës (81) alignées le long d'une même ligne droite (110) parmi lesdites lignes droites mutuellement parallèles (110) est la même pour toutes les paires de lignes droites contiguës (81) alignées le long de ladite même ligne droite (110).
6. Appareil de traitement de linge (10) selon la revendication 5, dans lequel ladite distance (Tp) entre les centres (Ce) de deux sections droites contiguës (81) alignées le long d'une même ligne droite (110) parmi lesdites lignes droites mutuellement parallèles (110) est la même pour toutes lesdites lignes droites mutuellement parallèles (110).
7. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel ledit tuyau métallique (80) comprend une partie d'entrée (84) et une partie de sortie (85) faisant toutes les deux saillie à partir d'une même ailette terminale (91) de ladite pluralité d'ailettes empilées (90).
8. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel ledit réfrigérant inflammable est ou comprend un hydrocarbure.
9. Appareil de traitement de linge (10) selon la revendication 8, dans lequel ledit réfrigérant inflammable est ou comprend du propane (R290) ou du propylène (R1270).
10. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel ladite pluralité d'ailettes (90) sont faites d'aluminium, ou d'un alliage d'aluminium, ou de cuivre, ou d'un alliage de cuivre, ou comprennent celui-ci.
11. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel des bords périmétriques (99) desdites ailettes empilées (90) définissent dans l'ensemble une surface d'enveloppe (92) comprenant au moins une partie plane (93), et dans lequel lesdites lignes droites mutuellement parallèles (110) sont perpendiculaires à ladite au moins une partie plane (93).
12. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel des ailettes de ladite pluralité d'ailettes (90) ont une largeur (w) comprise entre 65 mm et 145 mm, de préférence entre 95 mm et 125 mm, et une hauteur

(h) comprise entre 110 mm et 185 mm, de préférence entre 145 mm et 165 mm.

13. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel la longueur totale (L) desdites ailettes empilées (90) est comprise entre 330 mm et 370 mm, de préférence entre 200 mm et 250 mm. 5
14. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel ledit tuyau métallique (80) est fait d'aluminium, ou d'un alliage d'aluminium, ou de cuivre, ou d'un alliage de cuivre, ou comprend celui-ci. 10
15. Appareil de traitement de linge (10) selon une ou plusieurs des revendications précédentes, dans lequel ledit appareil de traitement de linge (10) est un sèche-linge (11) ou un lave-linge séchant, et dans lequel ledit fluide de fonctionnement (50) est de l'air ou, dans lequel ledit appareil de traitement de linge (10) est une machine à laver le linge, et ledit fluide de fonctionnement (50) est de l'eau, ou de l'eau mélangée avec un agent de lavage/de rinçage. 15

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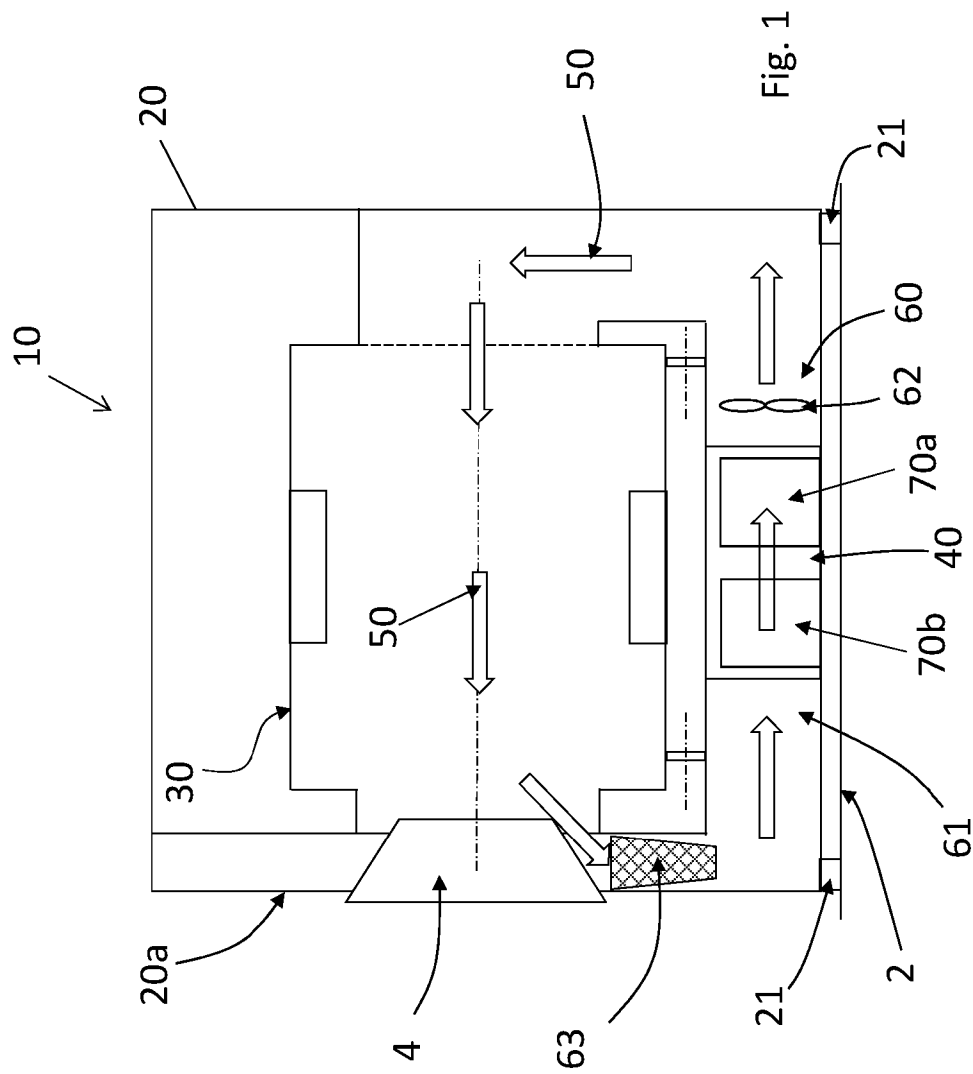
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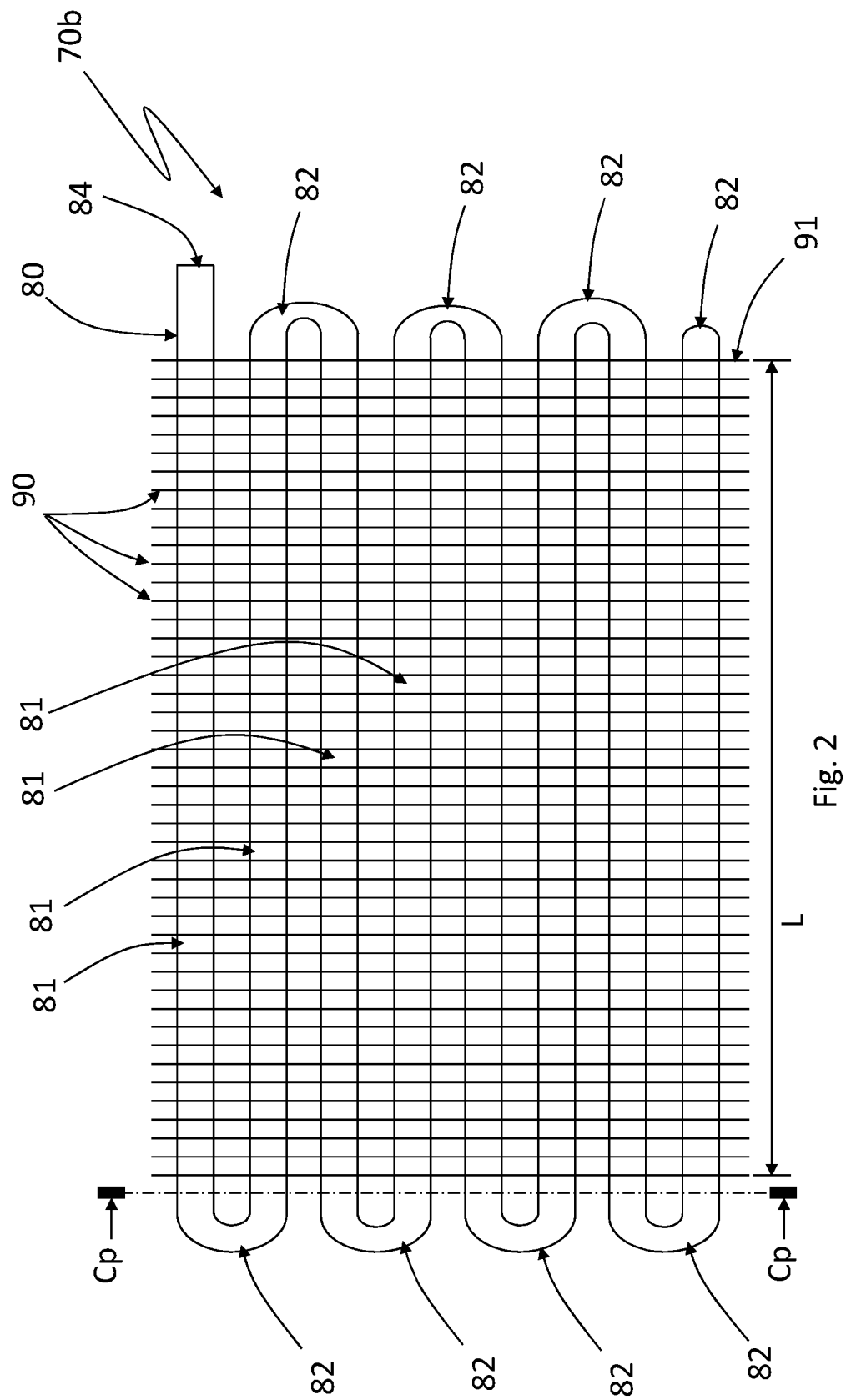
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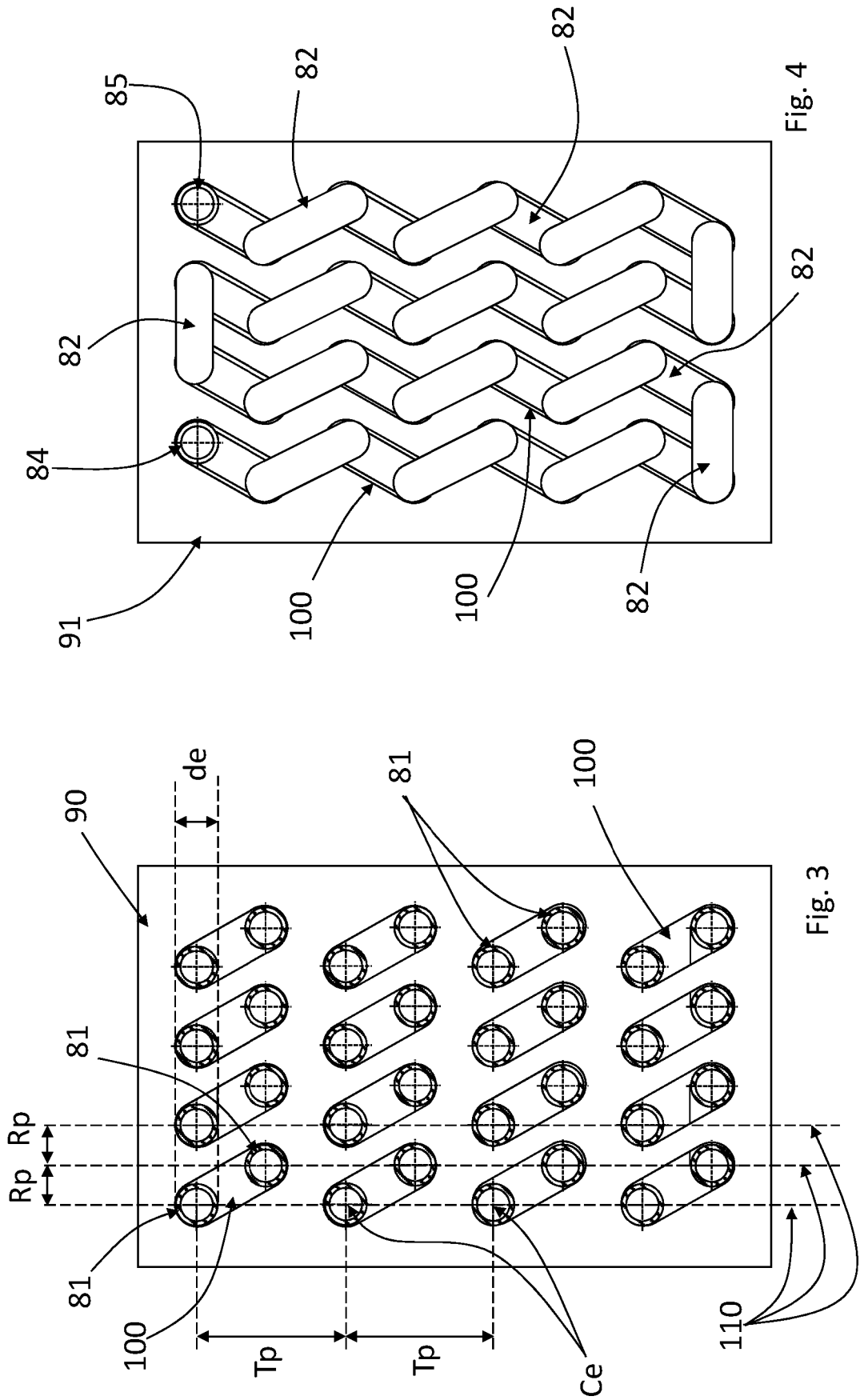
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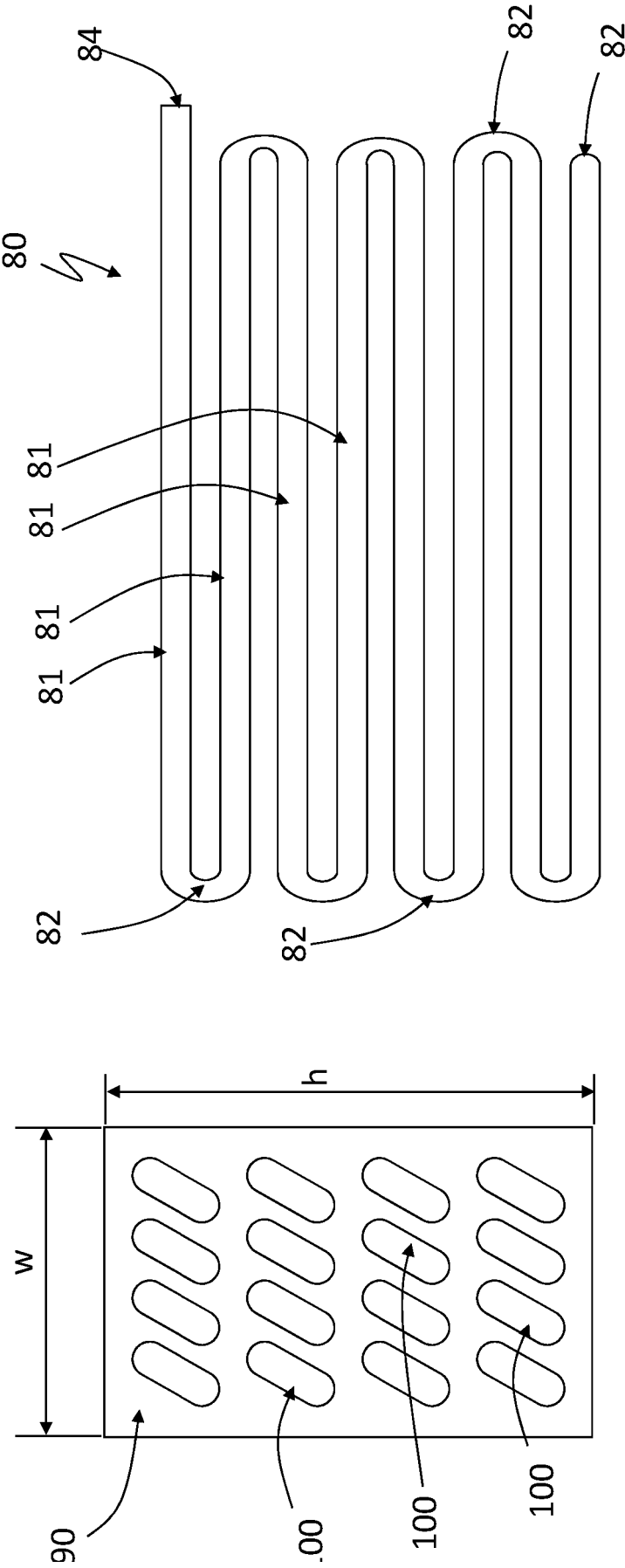
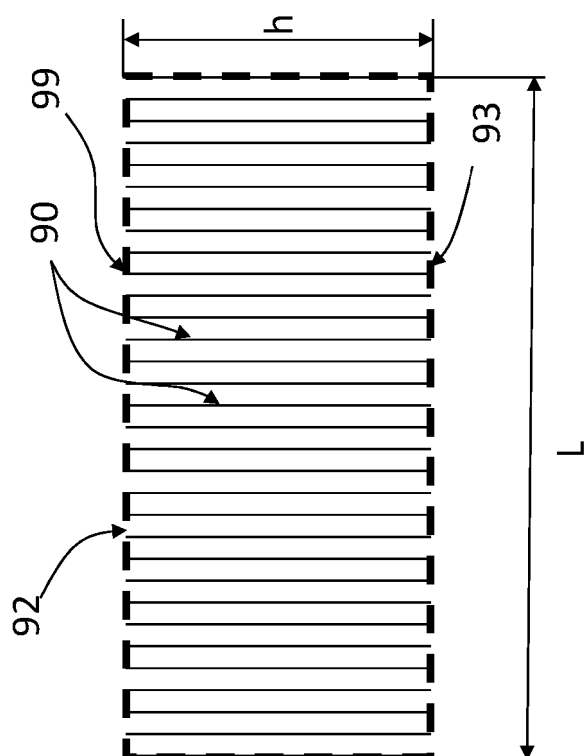
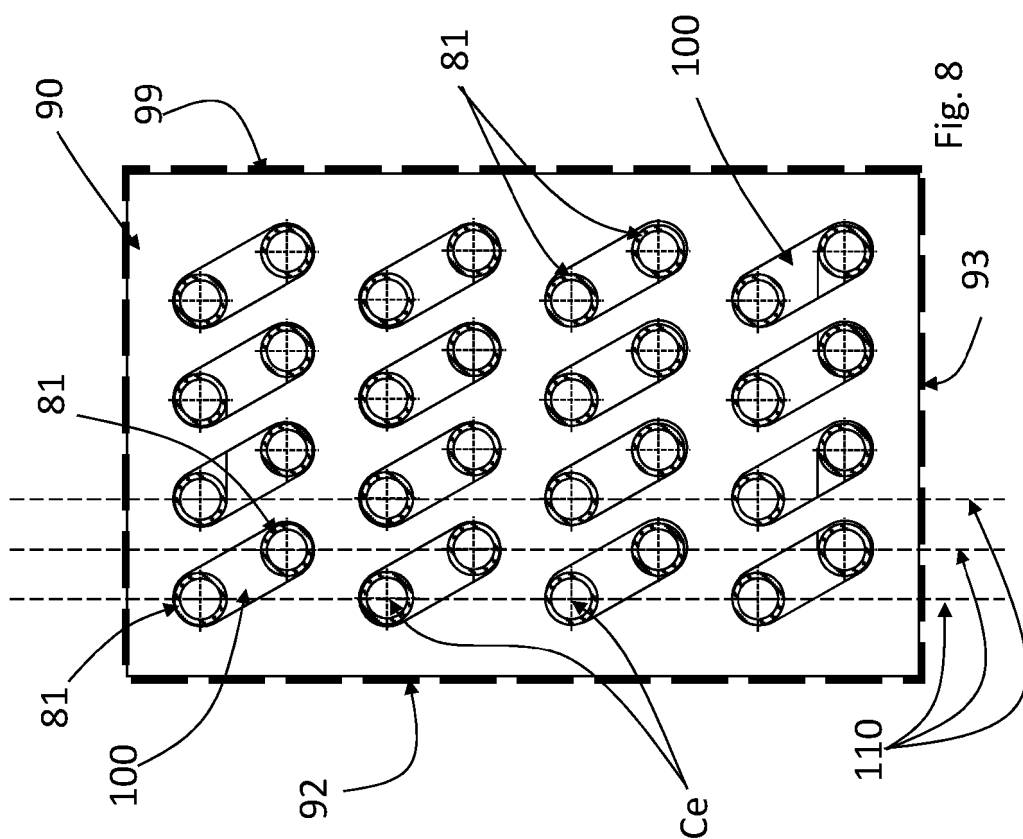


Fig. 5

Fig. 6



REFERENCES CITED IN THE DESCRIPTION

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