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

(57) A laundry treating appliance (10) comprising: - a cabinet (20); - a drum (30); - 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 the operating fluid (50) through the drum (30); wherein the heat pump system (40) comprises a heat exchanger (70a, 70b) comprising: - a plurality of metallic pipes (80); - 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 one of the metallic pipes (80), the plurality of through-holes (100) being distributed on the respective fin (90) to define a plurality of mutually parallel rows (150) of aligned through-holes (100), wherein the centers (Ce) of the through-holes (100) of each row (150) are aligned to each other along a respective straight line (110).

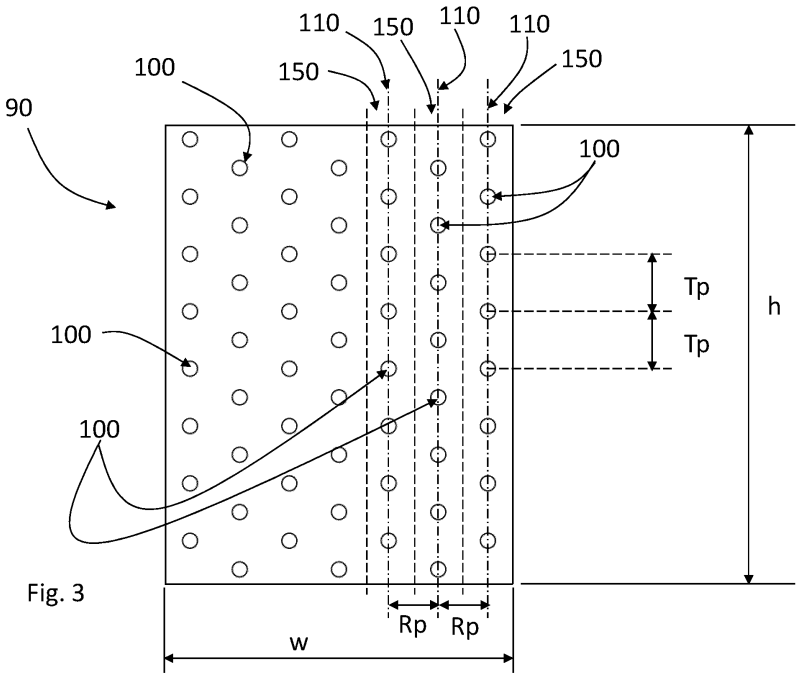


Fig. 3

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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 exchangers, widely used in heat pump systems of laundry treating appliances, comprises a plurality of fins, typically made of aluminum and having a rectangular plane, stacked in spaced and parallel planes; the fins comprise a plurality of through-holes wherein a plurality straight pipes, made of copper or aluminum, parallel one another and perpendicular to the fins, are fitted, with their lateral surface into close contact with the border of the through-holes, so as to obtain an effective heat-exchange.

**[0009]** The straight pipes are connected in twos, at one end, by a curved pipe, to define as a whole a single duct wherein the refrigerant flows; this single duct has an inlet portion and an outlet portion protruding from the stack of fins, and connectable to the rest of the heat pump system circuit. 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 pipes, which are 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 length of the straight pipes composing the single duct; 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.

**[0017]** 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.

**[0018]** 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 pipes of a finned heat exchanger which stacked fins have a plurality of

through-holes distributed to define a plurality of mutually parallel rows of aligned through-holes which centers are aligned to each other along a respective straight line, specific ranges for the distances of the straight lines of adjoining rows, and corresponding specific ranges for the distances between the centers of couples of adjoining through-holes of a same row, it is possible to reduce the overall internal volume of the single duct of the heat exchanger wherein the refrigerant flows without reducing the length of the single pipes composing such a single duct nor the number of fins, and therefore without reducing the overall thermal exchange surface.

**[0019]** 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 Potential (GWP), but that needs to be used in small quantities, and therefore requires a reduced volume of the single duct of the heat exchanger wherein the refrigerant flows.

**[0020]** 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 plurality of metallic pipes wherein the flammable refrigerant flows;
- a plurality of fins, stacked spaced and parallel to one another, each provided with a plurality of through-holes, each through-hole housing one of the metallic pipes,

the plurality of through-holes of the fins being distributed on the respective fin to define a plurality of mutually parallel rows of aligned through-holes, wherein the centers of the through-holes of each row are aligned to each other along a respective straight line,
wherein
if the external diameter of the metallic pipes is comprised between 3 and 6.5 mm, then:

- the distance between the centers of two adjoining through-holes of a same row is comprised between 14 and 22 mm, and the distance between the straight lines of two adjoining rows is comprised between 18 and 50 mm,
  or
- the distance between the centers of two adjoining through-holes of a same row is comprised between 22 and 50 mm, and the distance between the straight lines of two adjoining rows is comprised between 15 and 50 mm,

and in that
if the external diameter of the metallic pipes is comprised between 6.5 and 8 mm, then:

- the distance between the centers of two adjoining through-holes of a same row is comprised between 16 and 26 mm, and the distance between the straight lines of two adjoining rows is comprised between 24 and 50 mm,
  or
- the distance between the centers of two adjoining through-holes of a same row is comprised between 26 and 50 mm, and the distance between the straight lines of two adjoining rows is comprised between 18 and 50 mm.

**[0021]** It is underlined that stating that two rows are *adjoining* (or in other words contiguous, or neighboring, or adjacent) means that there aren't other rows positioned between such two rows. It is underlined that stating that two through-holes are *adjoining* (or in other words contiguous, or neighboring, or adjacent) means that there aren't other through-holes positioned between such two through-holes.

**[0022]** Using the specific inventive ranges of distances between straight lines/through-holes, 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.

**[0023]** In addition, the specific combinations of inventive ranges allow allows obtaining a uniform heat distribution along the fins, which avoids overheating of some parts of the latter, and also improves the heat exchange.

**[0024]** In an advantageous embodiment, if the external diameter of the metallic pipes is comprised between 3 and 6.5 mm, then the distance between the centers of two adjoining through-holes of a same row is comprised between 14 and 22 mm, and the distance between the straight lines of two adjoining rows is comprised between 20 and 35 mm.

**[0025]** In a further advantageous embodiment, if the external diameter of the metallic pipes is comprised between 3 and 6.5 mm, then the distance between the centers of two adjoining through-holes of a same row is comprised between 22 and 35 mm, and the distance between the straight lines of two adjoining rows is comprised between 15 and 18 mm.

**[0026]** In another advantageous embodiment, if the external diameter of the metallic pipes is comprised between 6.5 and 8 mm, then the distance between the centers of two adjoining through-holes of a same row is com-

prised between 16 and 26 mm, and the distance between the straight lines of two adjoining rows is comprised between 26 and 40 mm.

**[0027]** In a further advantageous embodiment, if the external diameter of the metallic pipes is comprised between 6.5 and 8 mm, then the distance between the centers of two adjoining through-holes of a same row is comprised between 30 and 40 mm, and the distance between the straight lines of two adjoining rows is comprised between 18 and 24 mm.

**[0028]** In a preferred embodiment, the distance between the straight lines of two adjoining rows is the same for all the couples of adjoining rows.

**[0029]** Preferably, the distance between the centers of two adjoining through-holes of a same row is the same for all the couples of adjoining through-holes of a same row.

**[0030]** More preferably, the distance between the centers of two adjoining through-holes of a same row is the same for all the rows.

**[0031]** In an advantageous embodiment, the metallic pipes comprise two or more straight pipes, parallel one another and perpendicular to the fins, each one of the two or more straight pipes being housed in one of the plurality of through-holes of each stacked fin), the two or more straight pipes being connected in twos, at one end, by a curved pipe, to define as a whole a single duct wherein the flammable refrigerant flows.

**[0032]** In an advantageous embodiment, the single duct 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, or is or comprises propane (R290) or propylene (R1270) .

**[0033]** Preferably, the plurality of fins and/or the metallic pipes are made of, or comprise, aluminum or aluminum alloy, or copper, or copper alloy.

**[0034]** 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 wherein the plurality of mutually parallel rows are perpendicular to the at least a plane portion.

**[0035]** 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.

**[0036]** 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.

**[0037]** Preferably, the overall length of the stacked fins is comprised between 330 mm and 370 mm.

**[0038]** More preferably, the overall length of the stacked fins is comprised between 200 mm and 250 mm.

**[0039]** Advantageously, the laundry treating appliance is a tumble drier or a washer-drier, and the operating fluid is air or, the laundry treating appliance is a laundry washing machine, and the operating fluid is water, or water mixed with a washing/rinsing agent.

**[0040]** 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 plan view of a heat exchanger of a laundry treating appliance according to the invention:

Fig. 3 is a schematic plan view of a fin of a heat exchanger of a laundry treating appliance according to the invention;

Fig. 4 is a lateral schematic view of the stacked fins of a heat exchanger according to the invention;

Fig. 5 is a schematic plan view of a fin of a heat exchanger of a laundry treating appliance according to the invention.

**[0041]** In the figures, same parts are indicated with the same reference numbers.

**[0042]** 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.

**[0043]** 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.

**[0044]** 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.

**[0045]** 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.

**[0046]** 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.

**[0047]** The laundry treating appliance 10 comprises a circulating system 60 configured for circulating an operating fluid through the drum 3.

**[0048]** 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).

**[0049]** 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.

**[0050]** 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.

**[0051]** 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.

**[0052]** 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.

**[0053]** Preferably, the heat pump system 40 comprises a compressor, not illustrated, an expansion valve, also not illustrated, two heat exchangers 70a, 70b (one operating as a condenser, and the other as an evaporator), and conduits, not illustrated, fluidly connecting such elements in a closed circuit.

**[0054]** 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.

**[0055]** 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.

**[0056]** The flammable refrigerant is or comprises a hydrocarbon, preferably propane (R290) or propylene (R1270). Advantageously, the heat exchangers, for example the condenser 70a and/or the evaporator 70b, comprise a plurality of metallic pipes 80 (called also simply pipes) wherein the flammable refrigerant flows, and a plurality of fins 90 (advantageously metallic), stacked spaced and parallel to one another, each provided with a plurality of through-holes 100) wherein one of the metallic pipes 80 is fitted.

**[0057]** 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.

**[0058]** Advantageously, the perimeter edges 99 of the stacked fins 90 define as a whole an envelope surface, illustrated in figures 4 and 5 with a dotted line numbered 92, comprising at least a plane portion 93.

**[0059]** 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.

**[0060]** 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.

**[0061]** Advantageously, the fins 90 are made of, or comprise, aluminum or aluminum alloy, or copper, or copper alloy.

**[0062]** Advantageously, the metallic pipes 80 are made of, or comprise, aluminum or aluminum alloy, or copper or copper alloy.

**[0063]** Preferably, the metallic pipes 80 comprise two or more straight pipes 81, parallel one another and perpendicular to the fins 90, each straight pipe 81 being housed in one of the through-holes 100 of each stacked fin 90.

**[0064]** Advantageously, the straight pipes 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; this can be obtained by radially expanding such straight pipes 81 by suitable tools, not illustrated.

**[0065]** Advantageously, the two or more straight pipes 81 are connected in twos, at one end thereof, by a curved pipe 82, to define as a whole a single duct 83 wherein the flammable refrigerant flows.

**[0066]** Such a single duct 83 advantageously comprises an inlet portion 831 and an outlet portion 832, configured for allowing the flammable refrigerant respectively to enter/exit the single duct; advantageously, the inlet portion 831 and the outlet portion 832 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.

**[0067]** Advantageously, like in the examples of attached figures, the inlet portion 831 and an outlet portion 832 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.

**[0068]** According to the invention, the through-holes

100 are distributed on the respective fins 90 to define a plurality of mutually parallel rows 150 of aligned through-holes 100, wherein the centers Ce of the through-holes 100 of each row 150 are aligned to each other along a straight line 110. According to the invention, if the external diameter de of the metallic pipes 80 is comprised between 3 and 6.5 mm, then:

- the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 14 and 22 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 18 and 50 mm, or
- the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 22 and 50 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 15 and 50 mm.

**[0069]** According to the invention, if the external diameter de of the metallic pipes 80 is comprised between 6.5 and 8 mm, then:

- the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 16 and 26 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 24 and 50 mm, or
- the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 26 and 50 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 18 and 50 mm. In an advantageous embodiment of the invention, if the external diameter de of the metallic pipes 80 is comprised between 3 and 6.5 mm, the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 14 and 22 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 20 and 35 mm.

**[0070]** In a further advantageous embodiment, if the external diameter de of the metallic pipes 80 is comprised between 3 and 6.5 mm, the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 22 and 35 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 15 and 18 mm. In another advantageous embodiment, if the external diameter de of the metallic pipes 80 is comprised between 6.5 and 8 mm, the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 16 and 26 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 26 and 40 mm. In another advantageous embodiment, if the external diameter de of the metallic pipes 80 is comprised between 6.5 and 8 mm, the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is comprised between 30 and 40 mm, and the distance Rp between the straight lines 110 of two adjoining rows 150 is comprised between 18 and 24 mm. In a preferred embodiment, the distance Rp between the straight lines 110 of two adjoining rows 150 is the same for all the couples of adjoining rows 150.

**[0071]** In a further preferred embodiment, the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is the same for all the couples of adjoining through-holes 100 of a same row 150; more preferably, the distance Tp between the centers Ce of two adjoining through-holes 100 of a same row 150 is the same for all the rows 150.

**[0072]** 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, the straight lines 110 are parallel to two sides of such rectangle or square.

**[0073]** 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 single duct 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 plurality of metallic pipes (80) wherein said flammable refrigerant flows;
- 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 one of said me-

tallic pipes (80),
said plurality of through-holes (100) of said fins (90) being distributed on the respective fin (90) to define a plurality of mutually parallel rows (150) of aligned through-holes (100), wherein the centers (Ce) of the through-holes (100) of each row (150) are aligned to each other along a respective straight line (110),

**characterized in that**
**if** the external diameter (de) of said metallic pipes (80) is comprised between 3 and 6.5 mm, **then:**

- the distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 14 and 22 mm, and the distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 18 and 50 mm,
**or**
- the distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 22 and 50 mm, and the distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 15 and 50 mm,

**and in that**
**if** the external diameter (de) of said metallic pipes (80) is comprised between 6.5 and 8 mm, **then:**

- the distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 16 and 26 mm, and the distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 24 and 50 mm,
or
- the distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 26 and 50 mm, and the distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 18 and 50 mm.

**2.** A laundry treating appliance (10), according to claim 1, wherein,
**if** the external diameter (de) of said metallic pipes (80) is comprised between 3 and 6.5 mm,
**then** said distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 14 and 22 mm, and said distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 20 and 35 mm.

**3.** A laundry treating appliance (10), according to claim 1, wherein,
**if** the external diameter (de) of said metallic pipes (80) is comprised between 3 and 6.5 mm,
**then** said distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 22 and 35 mm, and said distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 15 and 18 mm.

**4.** A laundry treating appliance (10), according to claim 1, wherein,
**if** the external diameter (de) of said metallic pipes (80) is comprised between 6.5 and 8 mm,
**then** said distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 16 and 26 mm, and said distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 26 and 40 mm.

**5.** A laundry treating appliance (10), according to claim 1, wherein,
**if** the external diameter (de) of said metallic pipes (80) is comprised between 6.5 and 8 mm,
**then** said distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is comprised between 30 and 40 mm, and said distance (Rp) between the straight lines (110) of two adjoining rows (150) is comprised between 18 and 24 mm.

**6.** A laundry treating appliance (10) according to one or more of the previous claims, wherein said distance (Rp) between the straight lines (110) of two adjoining rows (150) is the same for all the couples of adjoining rows (150).

**7.** 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 through-holes (100) of a same row (150) is the same for all the couples of adjoining through-holes (100) of a same row (150).

**8.** A laundry treating appliance (10) according to claim 7, wherein said distance (Tp) between the centers (Ce) of two adjoining through-holes (100) of a same row (150) is the same for all said rows (150).

**9.** A laundry treating appliance (10) according to one or more of the previous claims, wherein said metallic pipes (80) comprise two or more straight pipes (81), parallel one another and perpendicular to said fins (90), each one of said two or more straight pipes (81) being housed in one of said plurality of through-holes (100) of each stacked fin (90), said two or more straight pipes (81) being connected in twos, at one

end, by a curved pipe (82), to define as a whole a single duct (83) wherein said flammable refrigerant flows.

**10.** A laundry treating appliance (10) according to claim 9, wherein said single duct (83) comprises an inlet portion (831) and an outlet portion (832) protruding both from a same terminal fin (91) of said plurality of stacked fins (90).

**11.** A laundry treating appliance (10) according to one or more of the previous claims, wherein said flammable refrigerant is or comprises a hydrocarbon, or is or comprises propane (R290) or propylene (R1270).

**12.** A laundry treating appliance (10) according to one or more of the previous claims, wherein said plurality of fins (90) and/or said metallic pipes (80) are made of, or comprise, aluminum or aluminum alloy, or copper, or copper alloy.

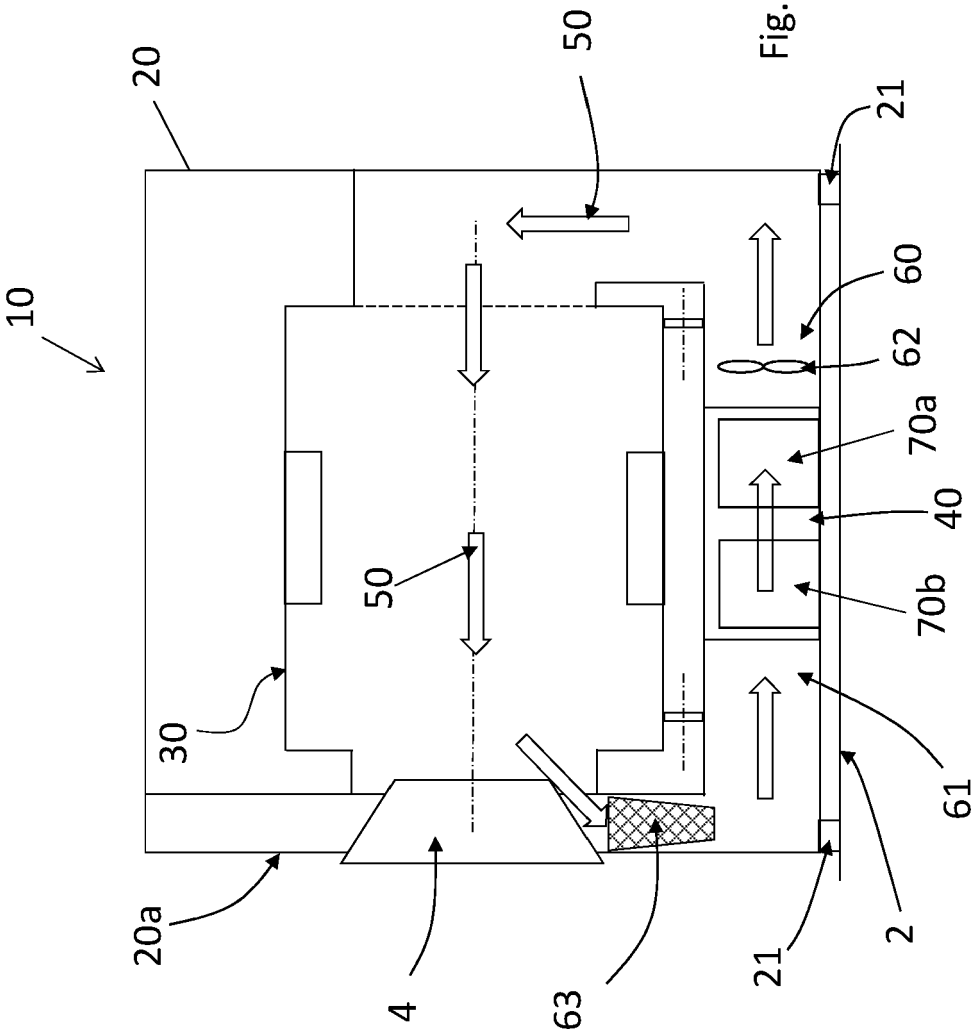
**13.** A laundry treating appliance (10) according to one or more of the previous claims, wherein the perimeter edges (99) of said stacked fins (90) define as a whole an envelope surface (92) comprising at least a plane portion (93), and wherein said plurality of mutually parallel rows (150) are perpendicular to said at least a plane portion (93).

**14.** A laundry treating appliance (10) according to one or more of the previous claims, wherein fins of said plurality of metallic 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.

**15.** 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.

**16.** 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.

Fig. 1



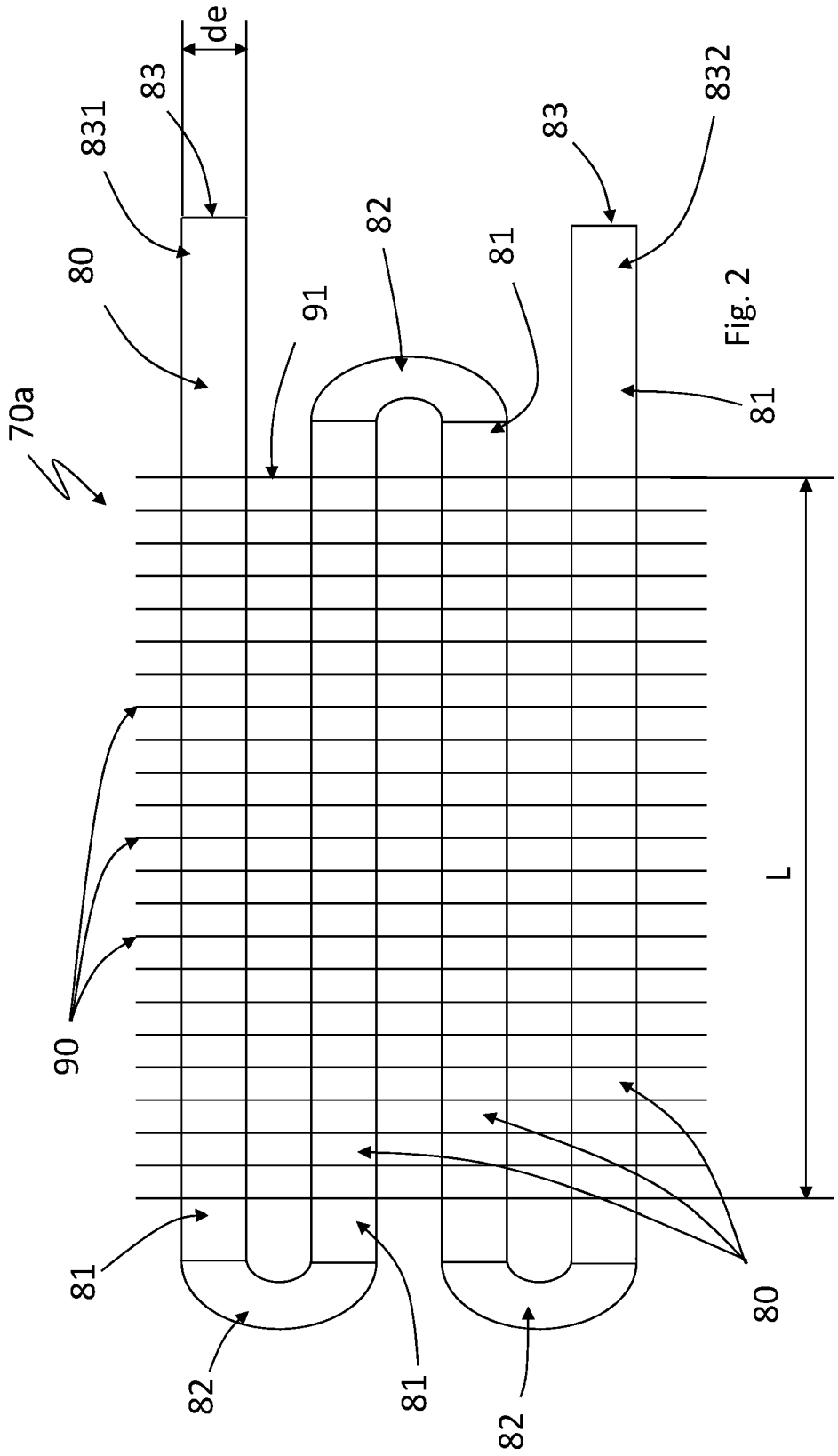



Fig. 2

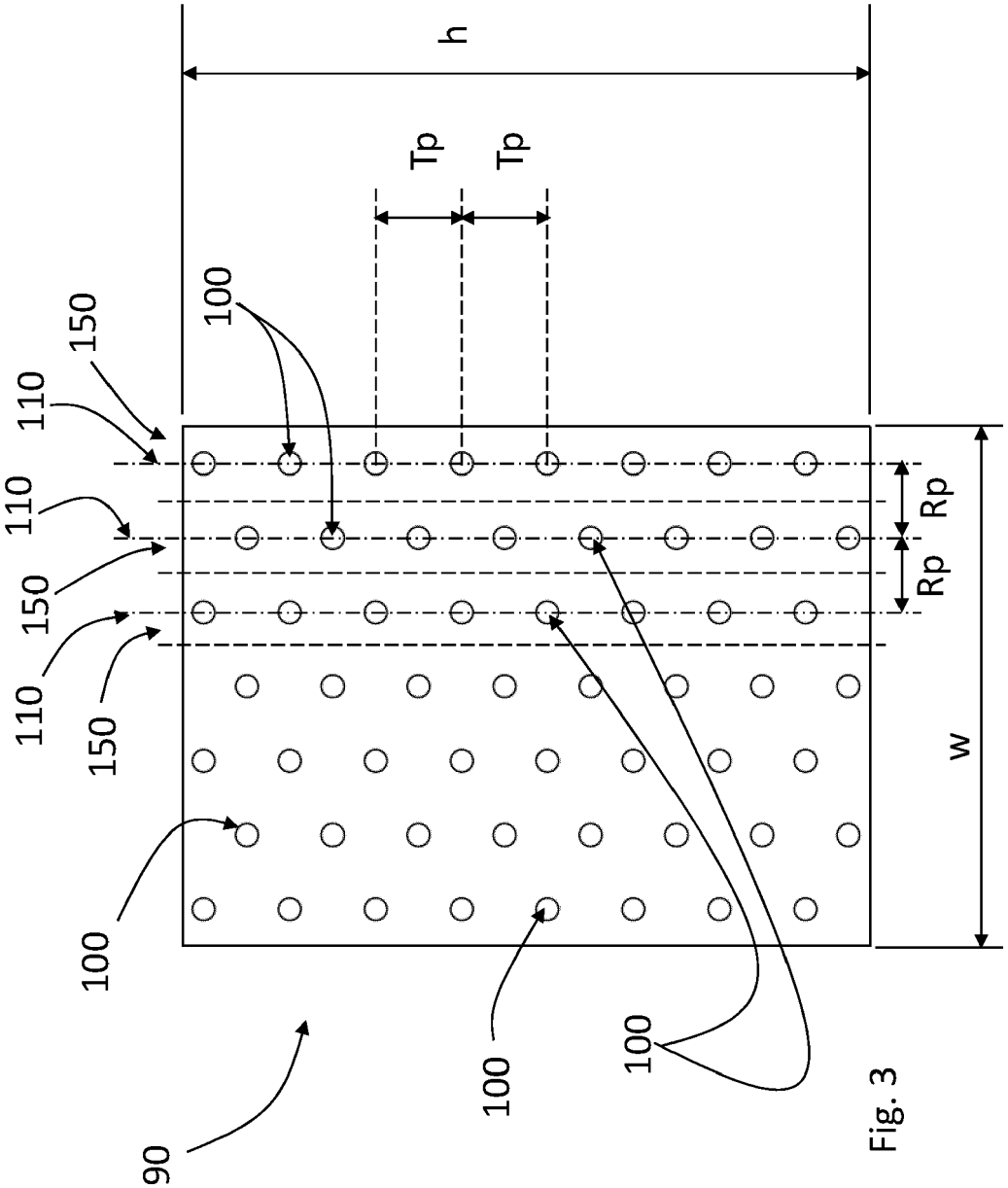



Fig. 3

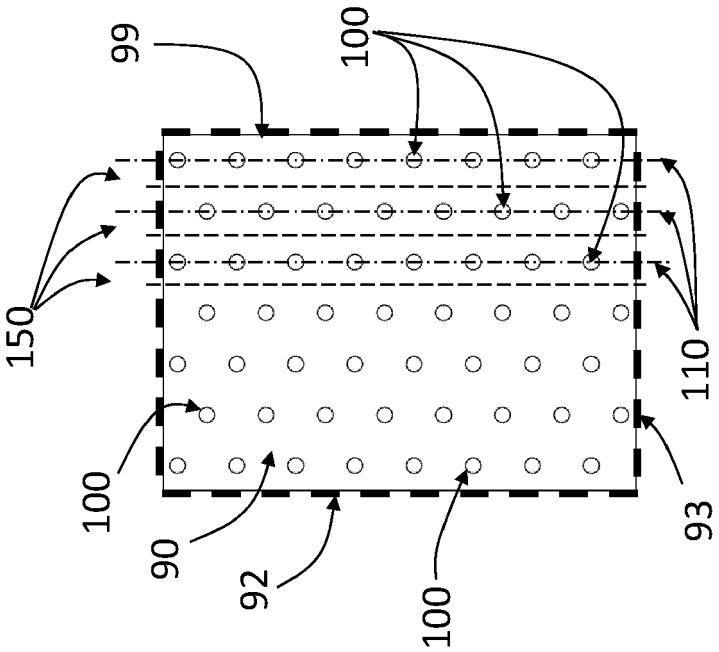



Fig. 5

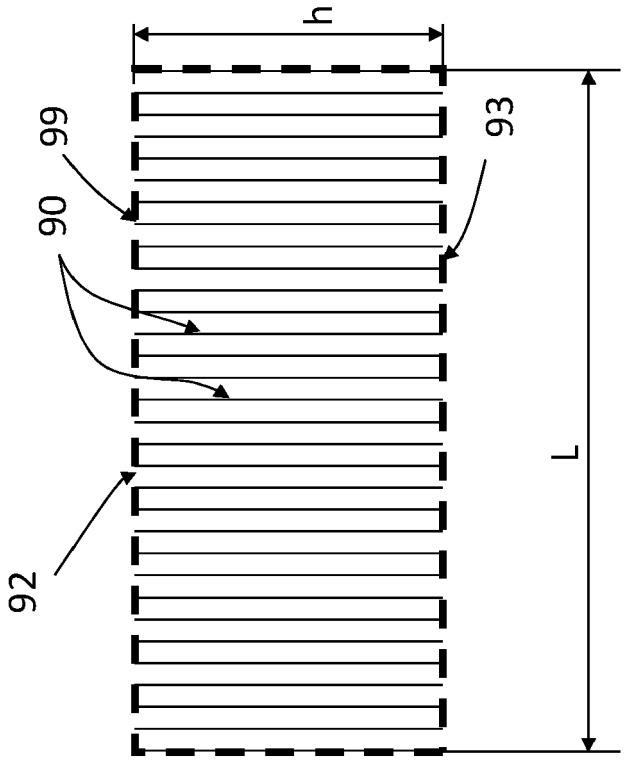



Fig. 4

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 19 August 2020 | Werner, Christopher |

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