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(54) HEAT EXCHANGE APPARATUS AND LAUNDRY DRYING APPLIANCE HAVING HEAT EXCHANGE APPARATUS

(57) A heat exchange apparatus is provided, including a flat body (14,140,240), the body having a tiled fluid passage (11,110,210), the fluid passage having an outlet (13,112,212) and an inlet (12,111) adapted to receive a cooling medium that enters the fluid passage from the inlet and leaves the fluid passage from the outlet, where the body is at least partially made of metal or a material whose thermal conductivity is not inferior to that of metal, and the body includes a through hole (15,1500), the fluid passages being distributed around the through hole. A laundry drying appliance, including a heat exchange apparatus mounted between a rear wall (22) of a tub (2) and a rear wall (43) of a drum (4), a drive shaft (44) passing through a through hole (15,1500) of the heat exchange apparatus.

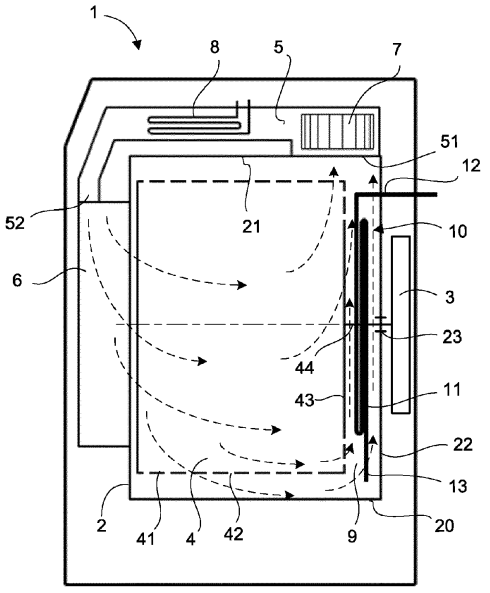

FIG. 1

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Description

[0001] The present invention belongs to the technical field of household appliances, and relates to a laundry drying appliance and a heat exchange apparatus thereof.

[0002] Chinese Patent Application Publication No. CN105463804A discloses a laundry dryer having a laundry processing barrel assembly located inside a cabinet, the barrel assembly including a drum that may be driven by a motor to rotate and a tub sleeved outside the drum. The tub is connected to a condensing passage and space of the tub is in communication with space of the condensing passage. The condensing passage is then connected to a fan and an air heating passage successively. The other end of the air heating passage is then in communication with the space of the tub. Therefore, an air circulation path is formed among the tub, the condensing passage, the fan, and the air heating passage. In a drying procedure, a heater in the air heating passage heats drying air flowing through the air heating passage. Heated high-temperature drying air enters the laundry processing barrel assembly under action of the fan, to heat wet laundry in the drum, thereby evaporating moisture in the laundry. The drying air carrying the evaporated moisture then enters the condensing passage, in which the moisture in the drying air is condensed to become liquid again and be separated from the drying air. The drying air then becomes cooled and dried again, and enters the heating passage again under driving of the fan, to start a new cycle of circulation, and so on, so that the laundry in the drum are eventually dried. A cooling water inlet pipe is connected to the condensing passage. In the drying procedure, cooling water flows into the condensing passage from the inlet pipe, so that heat is exchanged with the drying air entering the condensing passage, thereby condensing the moisture in the drying air.

[0003] U.S. Patent No. US6279357B1 discloses a washer-dryer. The washer-dryer has a roller that is mounted in a tub using a tripod. A rear wall of the tub has a groove. Water flows to the rear wall of the tub from a water inlet apparatus. In a drying mode, the roller rotates, and wet air leaves the roller and is stirred under rotation of the roller. Flowing water contacts the wet air, so that an effect of condensing the air is improved before the air is heated and returns to the roller along a circulation passage.

[0004] The present invention is intended to provide a heat exchange apparatus applicable to a laundry drying appliance. According to an aspect of the present invention, a heat exchange apparatus is provided, including a flat body, the body having a tiled fluid passage, the fluid passage having an outlet and an inlet adapted to receive a cooling medium that enters the fluid passage from the inlet and leaves the fluid passage from the outlet, where the body is at least partially made of metal or a material whose thermal conductivity is not inferior to that of metal, and the body includes a through hole, the fluid passages being distributed around the through hole.

[0005] The body may be implemented as an annular structure, and the through hole is rounded.

[0006] According to an embodiment of the present invention, the body includes a first sheet and a second sheet that are attached to each other, the fluid passage being formed therebetween.

[0007] According to another embodiment of the present invention, the body includes a tiled pipe in which a fluid passage is formed.

[0008] The pipe may be fixedly connected to the third sheet in a thermally conductive manner.

[0009] The pipe may also be fixed using a connecting bracket.

[0010] In addition, the pipe may include several sections that are in communication and close to each other, walls of the sections being fixed to each other.

[0011] According to an embodiment of the present invention, there is at least one fluid passage on each side of the through hole. A cooling medium may pass both sides of the through hole through various fluid passages.

[0012] According to an embodiment of the present invention, the fluid passage is folded and bent, and an acute angle is formed between each two adjacent bent sections.

[0013] According to an embodiment of the present invention, the fluid passage is folded and bent, and mutually bent sections are parallel to each other.

[0014] According to an embodiment of the present invention, the fluid passage is folded and bent, and has several mutually bent sections, the flat body being vertically or obliquely mounted relative to a horizontal plane, and when the inlet of the fluid passage is higher than other portions of the fluid passage, at least partial sections of the fluid passage being inclined downward relative to the horizontal plane along a direction in which a fluid flows.

[0015] The present invention is further intended to provide a laundry drying appliance.

[0016] According to an aspect of the present invention, a laundry drying appliance is provided, including a drum horizontally or obliquely disposed, the drum being rotatably located in a tub, and a wall of the drum having several densely-distributed holes to allow circulation of process air used in drying flows between the drum and the tub, a rear wall of the drum being connected to a drive shaft that drives the drum to rotate, and the drive shaft passing through a bearing located on a rear wall of the tub, the heat exchange apparatus constructed in the foregoing manner being mounted between the rear wall of the tub and the rear wall of the drum, and the drive shaft passing through a through hole of the heat exchange apparatus.

[0017] According to an embodiment of the present invention, the tub is connected to a process air passage, the process air passage being provided with a fan therein, where an air inlet of the process air passage is located on the rear wall of the tub or near the rear wall of the tub.

[0018] An air outlet of a process air passage may be close to a front end of the tub. Air circulation is then

formed between the process air passage and the tub.

[0019] According to an embodiment of the present invention, a body of the heat exchange apparatus is disposed substantially coaxially with the drum.

[0020] According to an embodiment of the present invention, the body of the heat exchange apparatus is fixed to the rear wall of the tub.

[0021] According to an embodiment of the present invention, an outer edge of the body of the heat exchange apparatus is close to an edge of the rear wall of the tub.

[0022] According to an embodiment of the present invention, an outlet of a fluid passage is close to a guiding apparatus provided on the rear wall of the tub, the guiding apparatus extending toward a bottom of the tub.

[0023] Specific implementations of the present invention are described using examples below with reference to the accompanying drawings.

FIG. 1 is a simple schematic diagram of a laundry drying appliance;

FIG. 2 is a schematic exploded view of partial components of a laundry drying appliance;

FIG. 3 is a front view of a heat exchange apparatus according to a first implementation;

FIG. 4 is a schematic view of components of a heat exchange apparatus shown in FIG. 3;

FIG. 5 is a front view of a heat exchange apparatus and a rear part of a tub according to a second implementation; and

FIG. 6 is a three-dimensional view of a heat exchange apparatus according to a third implementation.

[0024] As shown in FIG. 1, a laundry drying appliance 1 includes a tub 2 and a drum 4 that is located in the tub 2 and that may be driven by a motor 3 to rotate, the tub and the drum constituting a main drying chamber. A wall 41 of the drum 4 has dense holes 42, so that air circulation is suitable between an interior of the drum 4 and the tub 2. A rear wall 43 of the drum is connected to a drive shaft 44 that drives the drum to rotate. The drive shaft 44 is connected to the motor 3 in a driving manner after passing through a bearing 23 located on the rear wall 22 of the tub. The drum 4 is horizontally disposed. In other implementations, the drum may also be obliquely disposed in an oblique tub. A central axis of the drum 4 being horizontal or oblique is used as a reference for terms "horizontally" and "obliquely".

[0025] The tub 2 is connected to a process air passage 5. An air inlet 51 of the process air passage 5 is connected to a side wall 21 of the tub 2, and is close to the rear wall 22 of the tub 2. An air outlet 52 of the process air passage 5 is connected to a washer 6 mounted on a front side of the tub 2. Space of the process air passage 5 and space of the tub 2 are in communication. In other implementations, the inlet of the process air passage 5 may also be connected to the rear wall 22 of the tub 2.

[0026] A fan 7 and a heating apparatus 8 are provided inside the process air passage 5. After the fan 7 is started, air can be driven to enter the process air passage 5 from the air inlet 51 of the process air passage 5, and passes through the heating apparatus 8, and is blown out through the air outlet 52 to enter a front portion of the tub 2, so as to enter the drum 4 to fully contact laundry and then passes through the hole 42 on the wall 41 of the drum. Relatively much airflow passes through the hole 42 and then enter a gap 9 that is between the rear wall 22 of the tub and the rear wall 43 of the drum and whose pressure is relatively low, and then aim at the air inlet 51 of the process air passage 5 along the gap 9, and finally enter the process air passages 5, thereby completing a cyclic flow.

[0027] It can be learned that, during flowing of the process air to the air inlet 51 of the process air passage 5, relatively dense process air passes through the gap 9 between the rear wall 22 of the tub and the rear wall 43 of the drum. A heat exchange apparatus 10 is disposed in the gap 9 between the rear wall 22 of the tub and the rear wall 43 of the drum. Therefore, when wet hot process air passes through the gap 9, heat is exchanged with the heat exchange apparatus 10, so that a temperature decreases, and moisture in the wet hot process air is condensed. The process air subsequently enters the process air passage 5 from the air inlet 51 under action of the fan 7. Subsequently, due to heating of the heating apparatus 8, the temperature of the process air rises again, and then the process air enters the tub 2 and the drum 4 again to contact with laundry therein, thereby evaporating moisture in the laundry.

[0028] The heat exchange apparatus 10 is mounted in the gap between the rear wall 22 of the tub and the rear wall 43 of the drum, through which relatively dense process air passes, so that the heat exchange apparatus 10 exerts higher heat exchange efficiency. In addition, since a dedicated heat exchange passage is not required, more space is saved, thereby reducing a volume and manufacturing costs of the laundry drying appliance 1.

[0029] The heat exchange apparatus 10 has a flat structure and is fixed to the tub 2, for example, may be fixed to the rear wall 22 of the tub. The heat exchange apparatus 10 includes a fluid passage 11 defined by a material having relatively good thermal conductivity, and the fluid passage 11 having an inlet 12 that passes through a wall 20, for example, the rear wall 22 of the tub 2. An outlet 13 of the fluid passage 11 is located inside the tub 2. In a working process, a cooling medium is supplied to the fluid passage 11 through the inlet 12 of the fluid passage 11. Heat is exchanged between the cooling medium and the process air contacting the heat exchange apparatus 10 using a thermally conductive passage wall, to reduce the temperature of the process air.

The cooling medium with an increased temperature is discharged from a bottom of the tub 2. The cooling medium may be water. The fluid passage 11 can continuously provide a cooling medium to the heat exchange apparatus 10. In addition, the cooling medium flows in the fluid passage 11, and heat can be sufficiently exchanged with the process air through the passage wall, so that the cooling medium is fully utilized. In addition, since the cooling medium flows in the fluid passage 11, no splash enters the drum 4 under blowing of the airflow, and therefore laundry in the drum 4 is prevented from being wet, and the cooling medium is not inhaled into the process air passage 5 by the fan 7. In addition, the heat exchange apparatus 10 with the flat structure in which the fluid passage 11 is arranged may be designed to have a relatively thin thickness as required, so that a requirement on a width of the gap 9 between the rear wall 22 and the rear wall 43 of the drum is relatively low, thereby more helping air pass through the gap.

[0030] In the embodiment shown in FIG. 2, the heat exchange apparatus 10 includes a flat body 14. The body 14 has a substantially annular structure, and has a rounded through hole 15. The body 14 is fixed to the rear wall 22 of the tub 2 in various feasible manners, for example, welding, gluing, screwing, or injection molding. The body 14 is coaxial with the bearing 23 on the rear wall 22 of the tub 2, and thus is also disposed substantially coaxially with the drum 4. The drive shaft 44 passes through the through hole 15 of the heat exchange apparatus 10. The heat exchange apparatus 10 is disposed in such way that a size of the rear wall 22 of the tub can be fully utilized to spread the heat exchange apparatus, so that a heat exchange area is maximized, thereby improving heat exchange efficiency. In addition, in this manner, mounting of the tub 2 and the drum 4 and a drive system are not affected. More advantageously, more wet hot process air approaches the rear wall 22 of the tub along edges of the tub 2 and the drum 4. Therefore, through the design of the through hole 15, the fluid passage 11 can be more collectively distributed in an area with more dense process air. An outer edge 142 of the body 14 of the heat exchange apparatus can extend to a position near an edge of the rear wall 22 of the tub.

[0031] As shown in FIG. 3 and FIG. 4, in an implementation, a body 140 of a heat exchange apparatus 100 has a tiled fluid passage 110. The fluid passage has an inlet 111 and an inlet outlet 112 adapted to receive a cooling medium that enters the fluid passage 110 from the inlet 111 and leaves the fluid passage 110 from the outlet 112.

[0032] The body 140 includes a first sheet 1401 and a second sheet 1402 that are substantially annular, each being made of metal. The first sheet 1401 is generally flat. The second sheet 1402 has a pre-formed groove 150. The first sheet 1401 and the second sheet 1402 are attached to each other to form the substantially annular body 140. In addition, the fluid passage 110 is formed in space surrounded by the groove 150 and the first sheet 1401. The first sheet 1401 and the second sheet 1402 may be made of other materials having relatively good thermal conductivity, at least not inferior to that of ordinary metal.

[0033] After the inlet 111, the fluid passage 110 is divided into two parts located on both sides of a through hole 1500, and there is one outlet 112 at the end. The cooling medium entering the fluid passage 110 from the inlet 111 then flows from both sides of the through hole 1500 respectively, to fill the entire fluid passage 110. At the same time, heat is uniformly exchanged with process air on both sides of the through hole 1500.

[0034] In the embodiments shown in FIG. 3 and FIG. 4, the fluid passage 110 is folded and bent, and mutually bent sections 1100 are parallel to each other.

[0035] In other embodiments not shown in the accompanying drawings, an acute angle may be implemented between each two adjacent bent sections. After the heat exchange apparatus is mounted on a rear wall of a tub, the flat body is vertically or obliquely mounted relative to a horizontal plane in a manner of in which the tub and a drum are disposed, and the inlet of the fluid passage is higher than other portions of the fluid passage. In this case, at least partial sections of the fluid passage are inclined downward relative to the horizontal plane along a direction in which a fluid flows. Generally, the cooling medium is tap water. The cooling water can generate relatively large potential energy in an inclined bent area, and a relatively large turbulent flow in generated in a bent section. Therefore, precipitation and accumulation of sediments in water in the bending section are reduced, so that a water flow in the fluid passage is smoother, thereby avoiding blockage of the fluid passage.

[0036] As shown in FIG. 5, in an implementation, a body 240 of a heat exchange apparatus 200 includes a tiled pipe 160 in which a fluid passage 210 is formed. The pipe 160 is fixed using a connecting bracket 170. An inlet 161 of the pipe 160 passes through a rear wall 22 of a tub. An outlet 212 of the fluid passage 210 defined by the pipe 160 is close to a guiding apparatus 17 provided on the rear wall 22 of the tub. The guiding apparatus 17 extends toward a bottom of the tub 2. The guiding apparatus 17 may be a protruding rib.

[0037] In addition to being fixed using a bracket 170, in other embodiments not shown, the pipe includes several sections that are in communication and close to each other, walls of the sections being fixed to each other. In other words, the sections of the pipe are close to each other and fixed to each other.

[0038] As shown in FIG. 6, in another implementation, a heat exchange apparatus 300 includes a pipe 260, the pipe 260 being fixedly connected to the third sheet 1403 in a thermally conductive manner. The third sheet 1403 is at least partially made of metal or a material whose thermal conductivity is not inferior to that of metal.

[0039] The specific implementations described above and shown in the accompanying drawings are merely for describing the present invention. Any form of change made by persons of ordinary skill in the art to the present

invention within the scope of the basic technical ideas of the present invention falls within the protection scope of the present invention.

Claims

1. A heat exchange apparatus of a laundry drying appliance, **characterized by** comprising a flat body (14, 140, 240), the body having a tiled fluid passage (11, 110, 210), the fluid passage having an outlet (13, 112, 212) and an inlet (12, 111) adapted to receive a cooling medium that enters the fluid passage from the inlet and leaves the fluid passage from the outlet, wherein the body is at least partially made of metal or a material whose thermal conductivity is not inferior to that of metal, and the body comprises a through hole (15, 1500), the fluid passages being distributed around the through hole.

2. The heat exchange apparatus according to claim 1, **characterized in that** the body has an annular structure, and the through hole is rounded.

3. The heat exchange apparatus according to claim 1, **characterized in that** the body comprises a first sheet (1401) and a second sheet (1402) that are attached to each other, the fluid passage being formed therebetween.

4. The heat exchange apparatus according to claim 1, **characterized in that** the body comprises a tiled pipe (160, 260) in which a fluid passage is formed.

5. The heat exchange apparatus according to claim 4, **characterized in that** the pipe (260) is fixedly connected to the third sheet (1403) in a thermally conductive manner.

6. The heat exchange apparatus according to claim 4, **characterized in that** the pipe is fixed using a connecting bracket (170).

7. The heat exchange apparatus according to claim 4, **characterized in that** the pipe comprises several sections that are in communication with and close to each other, walls of the sections being fixed to each other.

8. The heat exchange apparatus according to claim 1, **characterized in that** there is at least one fluid passage (110) on each side of the through hole.

9. The heat exchange apparatus according to claim 1, **characterized in that** the fluid passage is folded and bent, and an acute angle is formed between every other two adjacent bent sections.

10. The heat exchange apparatus according to claim 1, **characterized in that** the fluid passage is folded and bent, and mutually bent sections (1100) are parallel to each other.

11. The heat exchange apparatus according to claim 1, **characterized in that** the fluid passage is folded and bent, and has several mutually bent sections, the flat body being vertically or obliquely mounted relative to a horizontal plane, and when the inlet of the fluid passage is higher than other portions of the fluid passage, at least partial sections of the fluid passage being inclined downward relative to the horizontal plane along a direction in which a fluid flows.

12. A laundry drying appliance, comprising a drum (4) horizontally or obliquely disposed, the drum being rotatably located in a tub (2), and a wall (41) of the drum having several densely-distributed holes (42) to allow circulation of process air used in drying flows between the drum and the tub, a rear wall of the drum being connected to a drive shaft (44) that drives the drum to rotate, and the drive shaft passing through a bearing (23) located on a rear wall (22) of the tub, **characterized in that** the heat exchange apparatus (10, 100, 200, 300) according to any of the foregoing claims is mounted between the rear wall (22) of the tub and the rear wall (43) of the drum, the drive shaft passing through a through hole (15) of the heat exchange apparatus.

13. The laundry drying appliance according to claim 12, **characterized in that** the tub is connected to a process air passage (5), the process air passage being provided with a fan (7) therein, wherein an air inlet (51) of the process air passage is located on the rear wall (22) of the tub or near the rear wall of the tub.

14. The laundry drying appliance according to claim 13, **characterized in that** an air outlet (52) of the process air passage is close to a front end of the tub.

15. The laundry drying appliance according to claim 12, **characterized in that** a body (14, 140, 240) of the heat exchange apparatus is disposed substantially coaxially with the drum (4).

16. The laundry drying appliance according to claim 12, **characterized in that** the body of the heat exchange apparatus is fixed to the rear wall of the tub.

17. The laundry drying appliance according to claim 12, **characterized in that** an outer edge (142) of the body of the heat exchange apparatus is close to an edge of the rear wall of the tub.

18. The laundry drying appliance according to claim 12, **characterized in that** an outlet (212) of a fluid pas-

sage is close to a guiding apparatus (17) provided on the rear wall of the tub, the guiding apparatus extending toward a bottom of the tub (2).

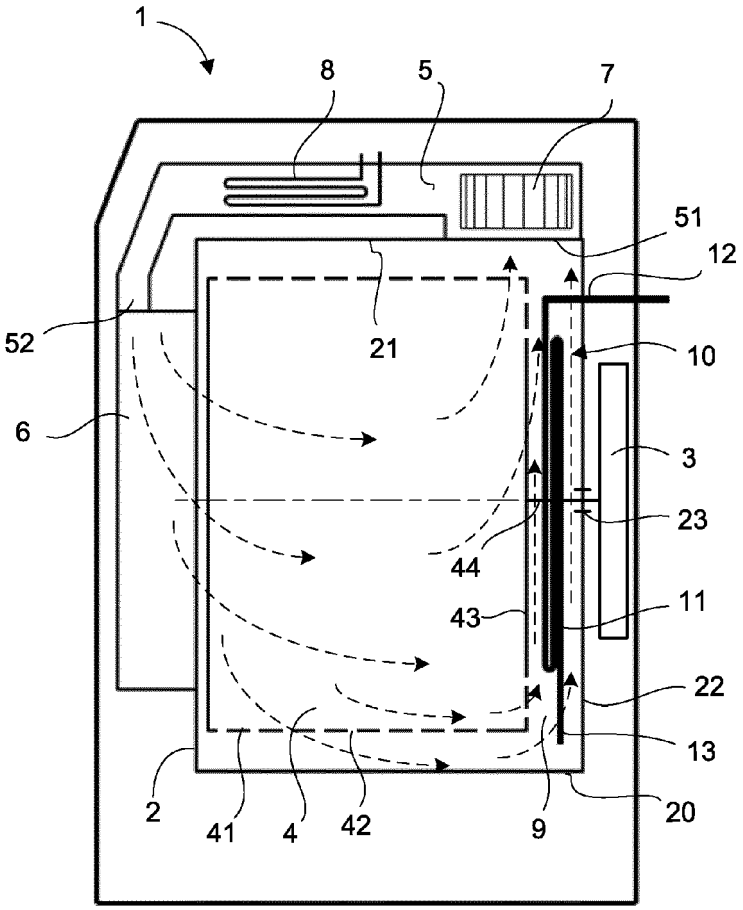

FIG. 1

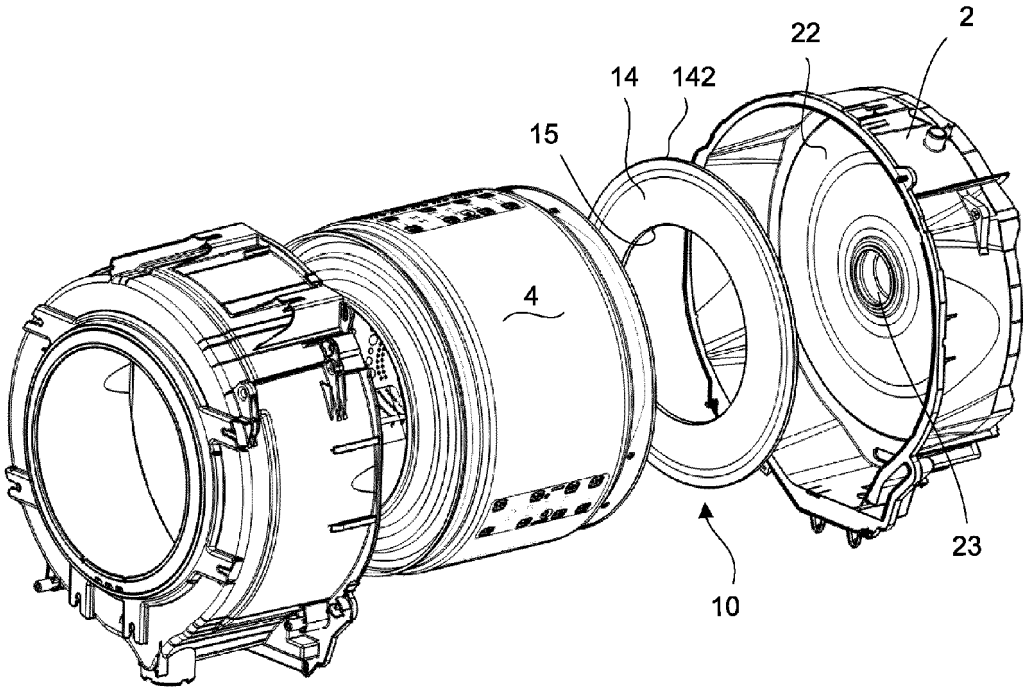

FIG. 2

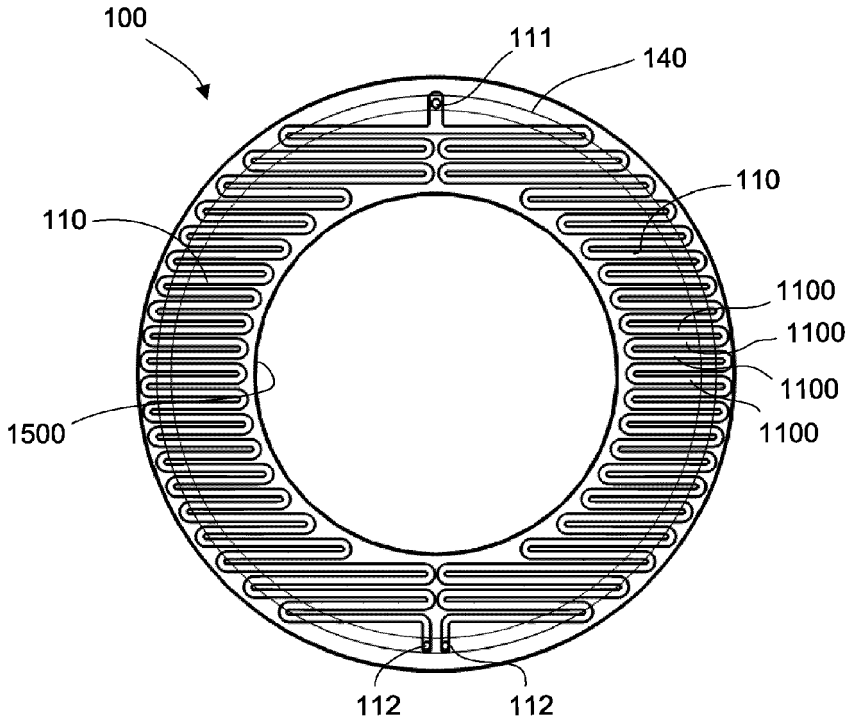
100
111
140
110
110
1100
1100
1100
1100
1500
112
112

FIG. 3

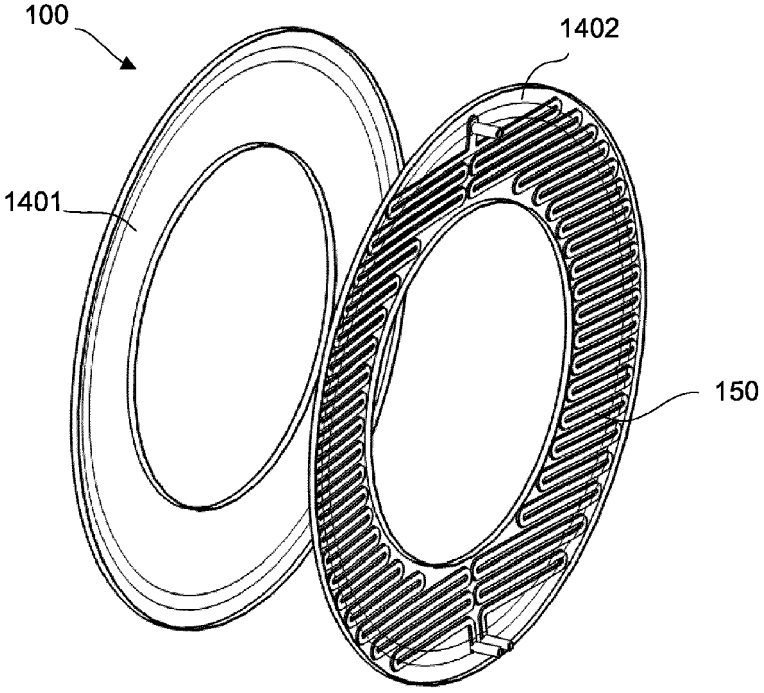
100
1402
1401
150

FIG. 4

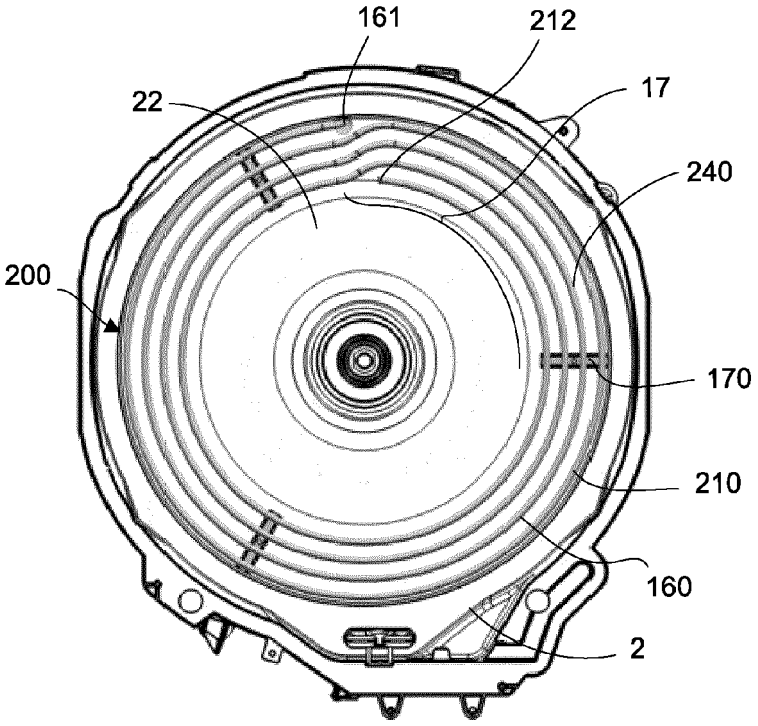

FIG. 5

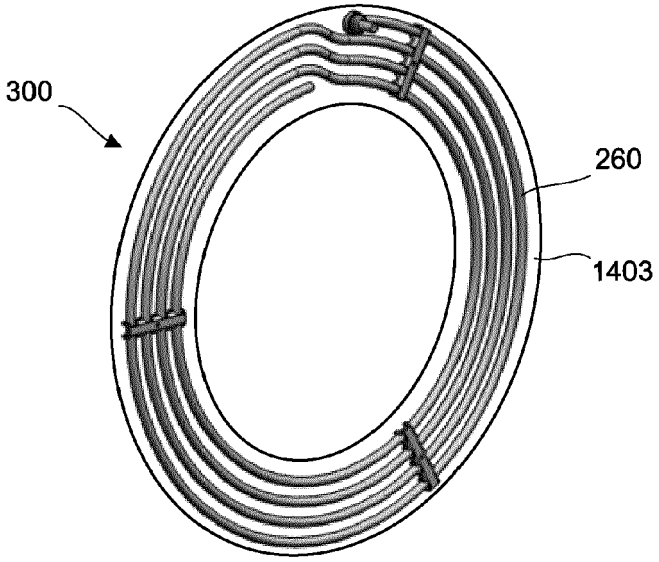

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 19 20 7983

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	CN 105 200 748 A (WUXI LITTLE SWAN CO LTD) 30 December 2015 (2015-12-30) * figure 1 * -----	4	TECHNICAL FIELDS SEARCHED (IPC) D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 January 2020	Kising, Axel

CATEGORY OF CITED DOCUMENTS

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23-01-2020

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

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