(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 366 828 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.09.2011 Bulletin 2011/38

(51) Int Cl.:
D06F 58/24 *(2006.01)*

(21) Application number: **10425072.5**

(22) Date of filing: **17.03.2010**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA ME RS

(71) Applicant: **Candy S.p.A.**
20052 Monza (MI) (IT)

(72) Inventor: **Fumagalli, Silvano**
20052 Monza (MI) (IT)

(74) Representative: **Perani, Aurelio et al**
Perani & Partners
Piazza San Babila, 5
20122 Milano (IT)

(54) Laundry dryer machine with improved condenser cooling system

(57) The present invention concerns a laundry dryer (11), comprising:
- a rotary drum (13) with a cavity (41) for receiving the laundry to be dried,
- heating means (14) for heating the drying air,
- a condenser (15) for removing moisture from the drying air,
- conveying means (16) for successively circulating the drying air through the drum (13), the condenser (15) and the heating means (14).
The laundry dryer (11) comprises a hydraulic circuit (43-48) for feeding a cooling liquid to the condenser (15). Said hydraulic circuit (43-48) includes a heat exchanger (32) for cooling the cooling liquid and is hydraulically connected to the condenser (15) to form a closed circuit therewith.

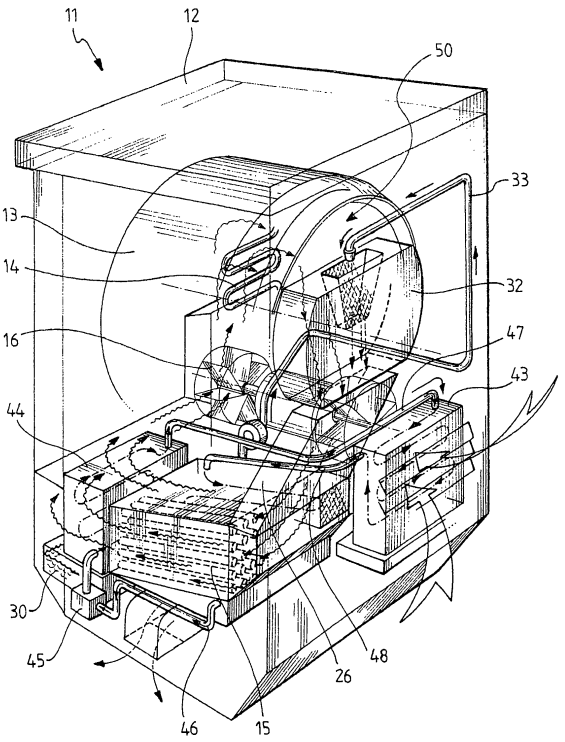

Fig.1

EP 2 366 828 A1

Description

[0001] The present invention relates to a rotary-drum laundry dryer, particularly for household use.

[0002] It is known in the art to provide laundry dryer machines comprising a rotary drum designed to receive the laundry to be dried, means for heating the drying air and a condenser for removing the moisture contained in the drying air at the exit of the rotary drum. These parts are arranged within an outer casing of the household appliance.

[0003] The machine also comprises a special fan which successively circulates the drying air through the drum, the condenser and the heating means (typically an electrical resistor) during operation of the apparatus.

[0004] Prior art machines of this type have a rather high power consumption for each working cycle, due to the power required for driving fans, motors and particularly for the resistor that heats the drying air.

[0005] Furthermore, in prior art machines, the condenser is cooled by air, by means of a special fan that conveys air drawn from the outside environment towards the condenser. This configuration does not always afford a quick and satisfactory condensation of the moisture carried by the drying air at the exit of the drum, and this may involve a relatively slow and inefficient laundry drying process.

[0006] In view of the above state of the art, the object of the present invention is to provide a laundry dryer machine that is capable of affording effective condensation of the moisture contained in the drying air, and of ensuring a quick and efficient laundry drying process.

[0007] A further object of the invention is to provide a laundry dryer machine that affords satisfactory energy savings.

[0008] Another object of the invention is to provide a machine that affords high performances, while maintaining a relatively simple structure and a relatively low cost.

[0009] According to the present invention, this object is fulfilled by a laundry dryer machine comprising:

- a rotary drum with a cavity for receiving the laundry to be dried,
- heating means for heating a drying air,
- a condenser for removing moisture from the drying air,
- conveying means for successively circulating the drying air through the drum, the condenser and the heating means,

characterized in that it comprises a hydraulic circuit which is hydraulically connected to the condenser to form a closed hydraulic circuit in which a condenser cooling liquid circulates during operation, said hydraulic circuit comprising a heat exchanger for cooling the cooling liquid and means for circulating the cooling liquid through the condenser and the heat exchanger.

[0010] The features and advantages of the present invention will appear from the following detailed description of two practical embodiments, which are given by way of example and without limitation with reference to the annexed drawings, in which:

- Figure 1 is a general perspective view of a laundry dryer machine of the invention,
- Figure 2 is a plan view of the machine of Figure 1, with certain parts omitted to show the interior parts,
- Figure 3 is an elevational view of the machine of the preceding figures, with certain parts omitted to show the interior parts,
- Figure 4 is a view of an alternative embodiment of a laundry dryer machine of the invention;
- Figure 5 shows the curve of the temperatures of drying air (t3-t4) and cooling water (T3-T4) in the condenser, in the case of the first embodiment of the invention as described herein;
- Figure 6 shows the curve of the temperatures of drying air (t1-t2) and cooling water (T1-T2) in the heat exchanger downstream from the condenser, in the case of the first embodiment of the invention as described herein.

[0011] Figures 1-3 show a laundry dryer machine 11 having an outer casing 12, with a rotary drum 13, a condenser 15 and drying air heating means 14 arranged therein.

[0012] The rotary drum 13 has a cavity 41 (Fig. 3) for receiving the laundry to be dried, and is rotated, during operation, by known motor means, about a substantially horizontal axis.

[0013] The drum 13 has a front opening 50 (Fig. 1), through which the laundry may be loaded and unloaded into and from the drying cavity 41.

[0014] An opening is formed on the front 54 of the casing 12, for the user to access the interior of the drum 13 therethrough (Fig. 3). The opening 25 can be closed by a door, preferably formed as a window 39 hinged to the casing 12 of the household appliance, with a container 32 for collecting condensed water possibly mounted thereto.

[0015] In operation, the heating means 14 have the task of heating the drying air circulating in the household appliance. Preferably, these means are formed as an electrical resistor 14 disposed on the back of the machine 12, i.e. on the side opposite to the front side 54.

[0016] In operation, the condenser 15 has the task of removing moisture from the drying air at the exit of the drum 13. The condenser 15 is advanatgeously placed under the drum 13.

[0017] The laundry dryer 11 also comprises conveying means 16 for successively circulating the drying air through the rotary drum 13, the condenser 15 and the heating means 14. These conveying means preferably include a fan 16 placed downstream from the condenser 15 and upstream from the heating means 14.

[0018] Advantageously, a filtering conduit 26 is inter-

posed between the drying air outlet of the drum 14 (at the lower end of the opening 50) and the inlet to the condenser 15, for the drying air stream to flow therethrough.

[0019] A collection tank 30 for condensed water is placed downstream from the condenser 15. The water collected in this tank is conveyed towards the collection container 32 via a special pump and a conduit 33 (Fig. 1).

[0020] The laundry dryer machine 11 also comprises a hydraulic circuit 43-48, in which a liquid for cooling the condenser 15, preferably water, circulates.

[0021] The hydraulic circuit 43-48 and the condenser 15 form a closed hydraulic circuit.

[0022] The hydraulic circuit 43-48 comprises an exchanger 43 for cooling the cooling liquid and means 45 for circulating the cooling liquid through the condenser 15 and the exchanger 43.

[0023] The exchanger 43 is preferably cooled with air. A fan 17 is provided for this purpose, which draws air from outside the machine 11 and causes it to flow through the exchanger 43. Advantageously, the air for cooling the exchanger 43 is admitted through an opening 53 formed in the front face 54 of the casing of the machine (Fig. 3). Then, the air for cooling the exchanger 43 is exhausted from the machine through the bottom opening 49 (Fig. 3).

[0024] The fan 17 is advantageously placed downstream from the exchanger 43, with respect to the cooling air stream. Preferably, such fan 17 is rotated by a motor 42 which also has connected thereto the fan 16 for circulating the drying air in the machine (Fig. 2).

[0025] The exchanger 43 may be advantageously formed as a tube bundle, e.g. a serpentine, for the cooling liquid to flow therein.

[0026] The presence of the hydraulic circuit for cooling the condenser 15 affords quick and effective condensation of moisture contained in the drying air.

[0027] In a preferred embodiment of the invention, the hydraulic circuit also comprises a second exchanger 44, located at the drying air outlet of the condenser 15.

[0028] The second condenser 44 is designed to heat the drying air before reintroduction thereof into the drum 13, by utilizing the heat that the cooling water has stored in the condenser 15. This exchanger 44 is fed with the water that comes from the condenser 15 through the conduit 46.

[0029] The conduit 46 is fitted with the hydraulic pump 45, which circulates the cooling liquid in the hydraulic circuit.

[0030] The conduit 47 carries the cooling liquid that comes out of the exchanger 44 to the exchanger 43, where water is cooled with air.

[0031] Then, the conduit 48 carries the cold cooling liquid from the exchanger 43 to the condenser 15.

[0032] The condenser 15 is preferably formed as a tube bundle with the cooling liquid flowing therein. The flow of cooling liquid is directed countercurrent to the drying air stream in the condenser 15.

[0033] Advantageously, the temperature of the cooling liquid that comes out of the condenser 15 is higher than the temperature of the drying air that comes out of the condenser. This allows recovery of part of the heat released to the cooling liquid to pre-heat the drying air, before introduction thereof into the drum 13.

[0034] In Figure 5, numeral 63 designates the curve of temperatures T3-T4 of water in the condenser 15 and numeral 62 designates the curve of temperatures t3-t4 of air in the condenser 15.

[0035] The temperature T3 of water as it enters the condenser 15 preferably ranges from 25°C to 35°C, and is particularly 30°C. The temperature t3 of air as it enters the condenser 15 ranges from 65°C to 75°C, and is advantageously 70°C. Air is relatively hot as it exits the drum, whereas the cooling water is relatively cold as it exits the exchanger 43.

[0036] In the condenser 15, air is cooled, thereby releasing heat to the cooling water, and the moisture contained therein is condensed.

[0037] At the exit of the condenser, the cooling water is heated to a temperature from 60°C to 70°C, preferably about 65°C. On the other hand, the drying air at the exit of the condenser 15 has a temperature from 50°C to 60°C, advantageously about 55°C.

[0038] In Figure 6, numeral 60 designates the curve of temperatures T1-T2 of water in the condenser 44 and numeral 61 designates the curve of temperatures t1-t2 of the drying air in the condenser 44.

[0039] The temperature T1 of water as it enters the exchanger 44 corresponds to its temperature as it exits the condenser, i.e. from 60°C to 70°C. Likewise, the temperature t1 of the drying air as it enters the exchanger 44 is equal to its temperature as it exits the condenser, i.e. from 50°C to 60°C. Thus, the drying air is preheated before being introduced into the drum 13. This provides energy savings, as the resistor 14 is required to add a smaller amount of heat to the drying air to reach the appropriate operating temperature in the drum 13.

[0040] At the exit of the exchanger 44, the drying air has a temperature t2 from 55°C to 65°C, preferably about 60°C. The cooling water at the exit of the exchanger 44 has a temperature from 53°C to 63°C, preferably about 58°C.

[0041] Then, as the cooling liquid flows through the exchanger 43, its temperature is reduced by at least 25°C.

[0042] Preferably, a collection tank 52, as shown in Figure 4, may be located below the exchanger 43, to collect any condensation water formed in the exchanger 43.

[0043] Advantageously, the exchanger 43 is located in the proximity of the front wall 54 of the machine casing 12.

[0044] Preferably, the exchanger 44 is in such position as to substantially cover the whole extension of the drying air outlet of the condenser 15. The drying air stream in the condenser 15 and the exchanger 44 has a substantially horizontal orientation.

[0045] In an alternative embodiment of the invention, the second exchanger 44 might be omitted. Such arrangement is shown in Figure 4, where the parts that correspond to parts of the first embodiment are designated by the same numerals, increased by 100. In this case, the cooling water that comes out of the condenser 115 is directly conveyed through the conduit 147 to the air-cooled exchanger 143.

[0046] The above clearly shows that the objects of the present invention have been fulfilled.

[0047] A laundry dryer machine has been provided, which affords effective condensation of moisture contained in the drying air. The laundry drying cycle is thus particularly quick and efficient.

[0048] Furthermore, due to the countercurrent flows in the condenser, the temperature of the drying air as it exits the condenser may be lower than the temperature of the cooling liquid as it exits from the condenser. This provides heat for heating the drying air before reintroduction thereof into the drum.

[0049] Therefore, the second heat exchanger 44 allows recovery of part of the heat collected from the cooling liquid in the condenser while condensing the moisture contained in the drying air.

[0050] This affords general energy savings in the machine, because the air heating resistor may be allowed to operate at lower power.

[0051] Also, the structure of the machine is relatively simple and cost-effective. The fan that cools the exchanger 43 may be driven by the motor that also rotates the fan for circulating the drying air in the machine.

[0052] Those skilled in the art will obviously appreciate that a number of changes and variants may be made to the arrangements as described hereinbefore to meet incidental and specific needs, without departure from the scope of the invention, as defined in the following claims.

Claims

1. A laundry dryer machine comprising:

- a rotary drum (13) with a cavity (41) for receiving the laundry to be dried,
- heating means (14) for heating a drying air,
- a condenser (15) for removing moisture from the drying air,
- conveying means (16) for successively circulating the drying air through the drum (13), the condenser (15) and the heating means (14),

characterized in that it comprises a hydraulic circuit (43-48) which is hydraulically connected to the condenser (15) to form a closed hydraulic circuit in which a condenser cooling liquid circulates, said hydraulic circuit comprising a heat exchanger (43) for cooling the cooling liquid and means (45) for circulating the cooling liquid through the condenser (15) and the heat exchanger (43).

2. A machine as claimed in claim 1, **characterized in that** within the condenser (15) the flow of cooling liquid is directed countercurrent to the drying air stream.

3. A machine as claimed in one or more of the preceding claims, **characterized in that** the condenser (15) is formed as a tube bundle exchanger, the cooling liquid flowing in the tubes of the tube bundle.

4. A machine as claimed in one or more of the preceding claims, **characterized in that** said heat exchanger (43) is cooled with air, means (17) being provided for causing cooling air to flow in the exchanger (43).

5. A machine as claimed in one or more of the preceding claims, **characterized in that** the temperature of the cooling liquid that comes out of the condenser (15) is higher than the temperature of the drying air that comes out of the condenser (15).

6. A machine as claimed in one or more of the preceding claims, **characterized in that** the hydraulic circuit has a second heat exchanger (44) located in the proximity of the drying air outlet of the condenser (15) for heating the drying air, said second exchanger (44) being connected in said hydraulic circuit downstream from the condenser (15) and upstream from the first heat exchanger (43).

7. A machine as claimed in one or more of the preceding claims, **characterized in that** the temperature of the cooling liquid changes from a value of 25°C - 35°C as it enters the condenser (15) to a value of 60°C - 70°C as it exits the condenser (15).

8. A machine as claimed in one or more of the preceding claims, **characterized in that** the temperature of the drying air changes from a value of 65°C - 75°C as it enters the condenser (15) to a value of 50°C - 60°C as it exits the condenser (15).

9. A machine as claimed in one or more of the preceding claims, **characterized in that**, in the second heat exchanger (44), the drying air is heated so that its temperature increases of 5°C - 15°C.

10. A machine as claimed in one or more of the preceding claims, **characterized in that** the cooling liquid is cooled by at least 25°C through said first exchanger (43).

11. A machine as claimed in one or more of the preceding claims, **characterized in that** it has a first fan (17) for conveying cooling air to the first exchanger

(43) of the hydraulic circuit, and a second fan (16) for circulating the drying air in the machine, said two fans (16, 17) being rotated by the same motor (42).

12. A machine as claimed in one or more of the preceding claims, **characterized in that** said means for circulating the cooling liquid in the hydraulic circuit include a pump.

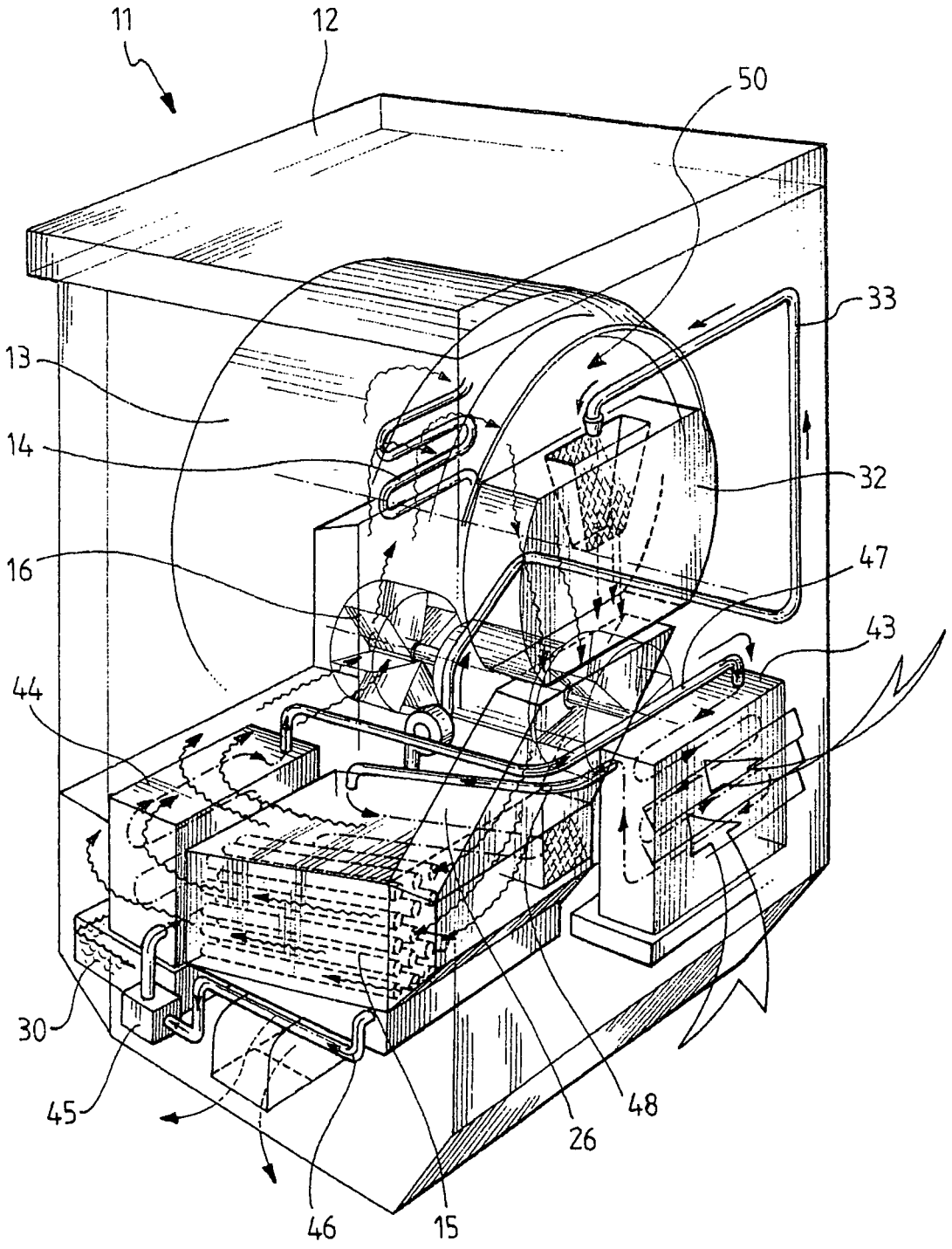

Fig. 1

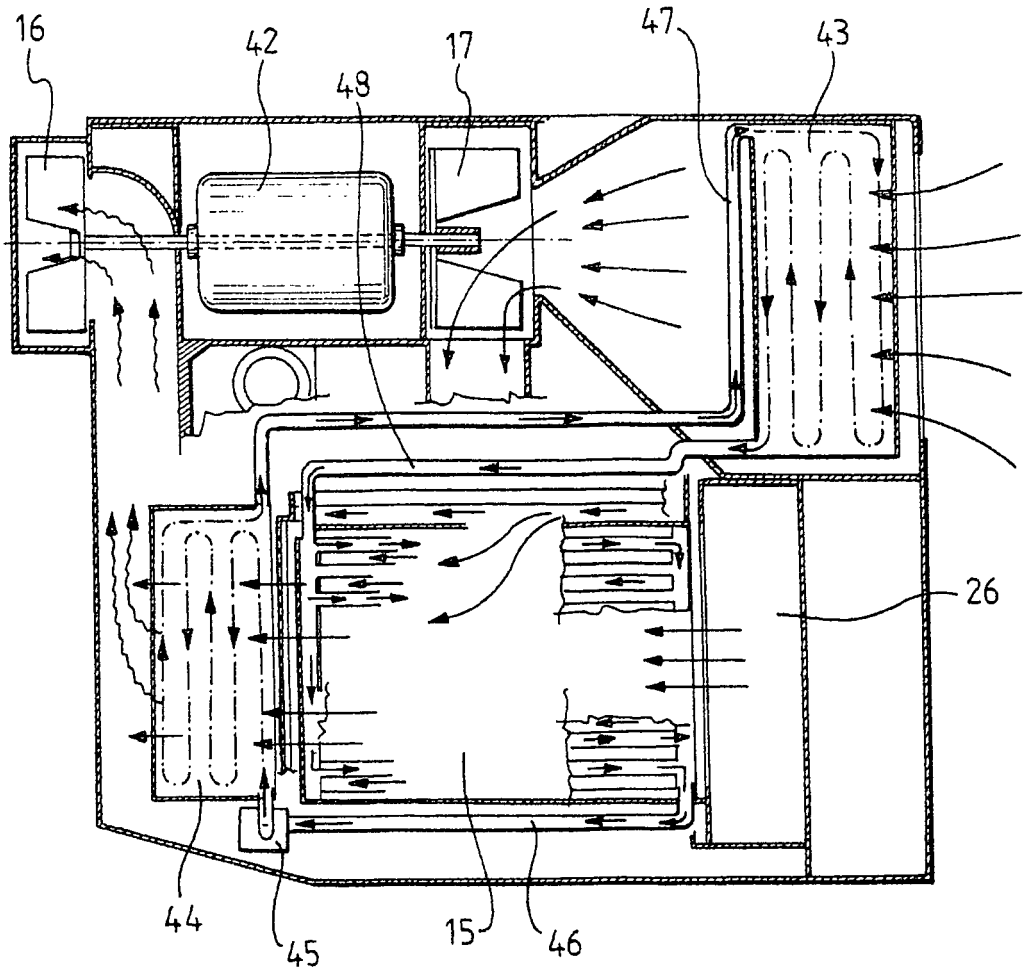

Fig.2

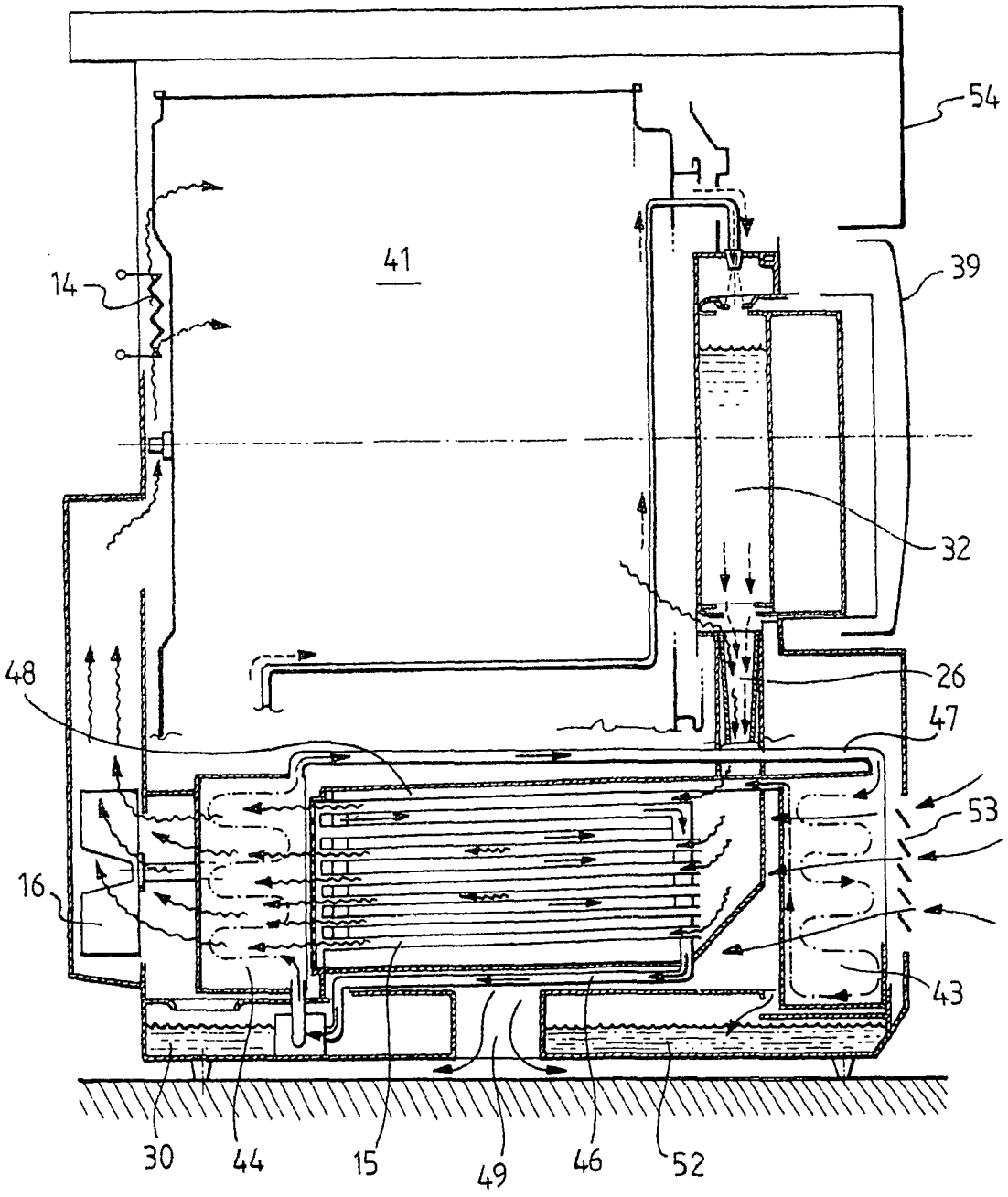

Fig.3

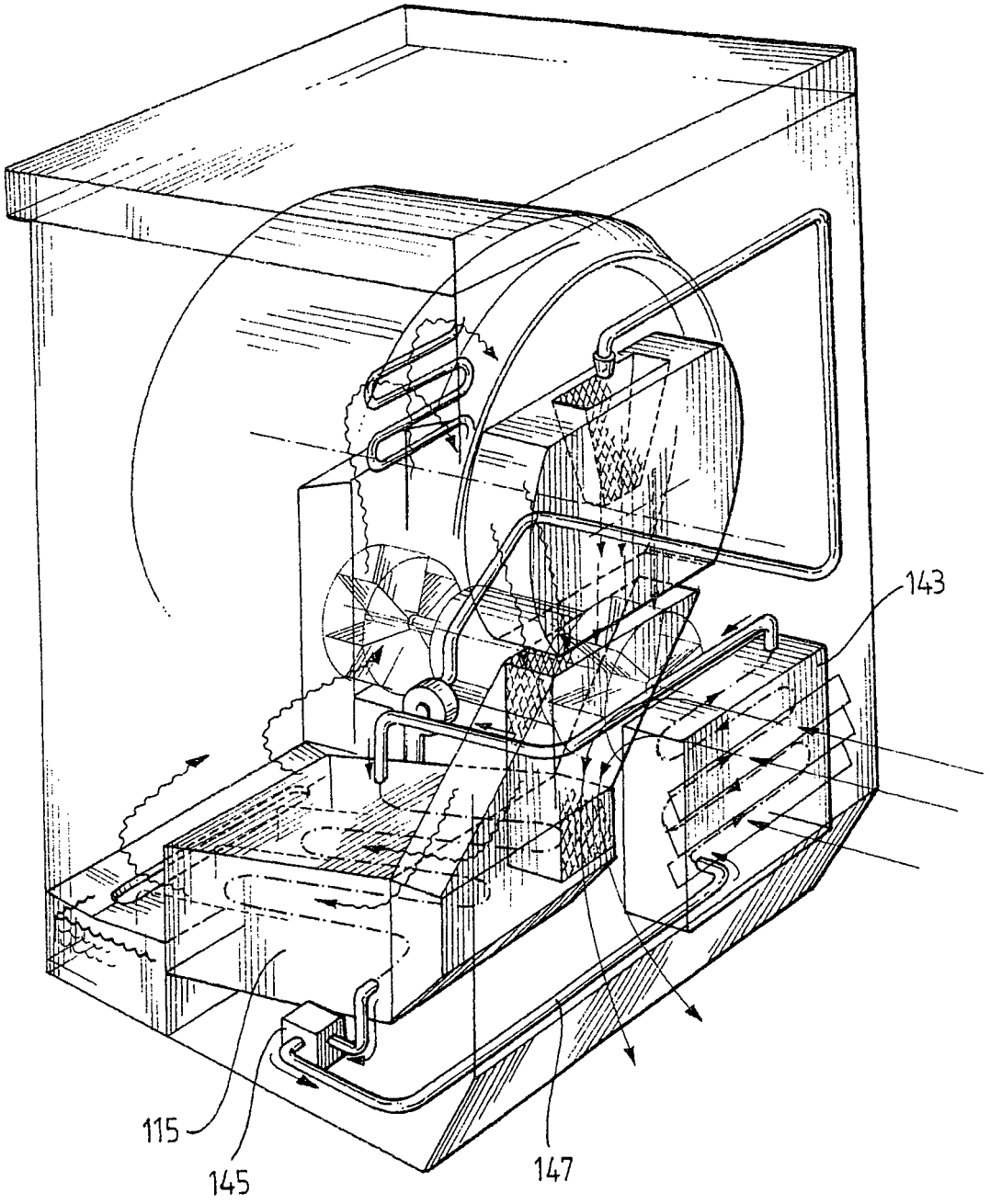

Fig.4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 42 5072

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y A	EP 2 065 510 A1 (CANDY SPA [IT]) 3 June 2009 (2009-06-03) * paragraphs [0001], [0002], [0031] - [0040], [0045], [0075], [0076]; claims; figures * -----	1,2,4,12 3 5-11	INV. D06F58/24
Y A	US 2003/056393 A1 (LEE WON HEE [KR] ET AL) 27 March 2003 (2003-03-27) * paragraphs [0002], [0048] - [0061]; claims; figure 4 * -----	3 1,2,4-12	
A	US 2006/096334 A1 (HABU SATOSHI [JP] ET AL) 11 May 2006 (2006-05-11) * paragraphs [0016] - [0027]; figures * -----	1-12	
			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	14 September 2010	Clivio, Eugenio

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 42 5072

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-09-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2065510 A1	03-06-2009	NONE	
US 2003056393 A1	27-03-2003	JP 4108984 B2	25-06-2008
		JP 2003103087 A	08-04-2003
		KR 20030028656 A	10-04-2003
US 2006096334 A1	11-05-2006	CA 2513169 A1	09-05-2006
		CN 1773005 A	17-05-2006
		CN 2876142 Y	07-03-2007
		HK 1087444 A1	14-05-2010
		JP 4293114 B2	08-07-2009
		JP 2006130198 A	25-05-2006
		KR 20060050301 A	19-05-2006

EPO FORM P0459

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