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(54) HOUSEHOLD WASHER-DRYER

(57) A household washer-dryer (1A, 1B, 1C, 1D, 1E, 1F), comprising a drum (6) for receiving laundry (5), an air inlet (13) for taking in cool dry air (15) from a surroundings (16) of the household washer-dryer (1A, 1B, 1C, 1D, 1E, 1F) during a drying cycle, wherein the air inlet (13) comprises a heating device (18) for converting the cool dry air (15) into hot dry air (19) which is discharged into the drum (6) by means of the air inlet (13), and a water inlet/air outlet (24) for taking in hot moist air (25) from the drum (6) during the drying cycle, wherein the water inlet/air outlet (24) comprises a dehumidifying device (27) for converting the hot moist air (25) into cool dry air (28) which is discharged into the surroundings (16) by means of the water inlet/air outlet (24).

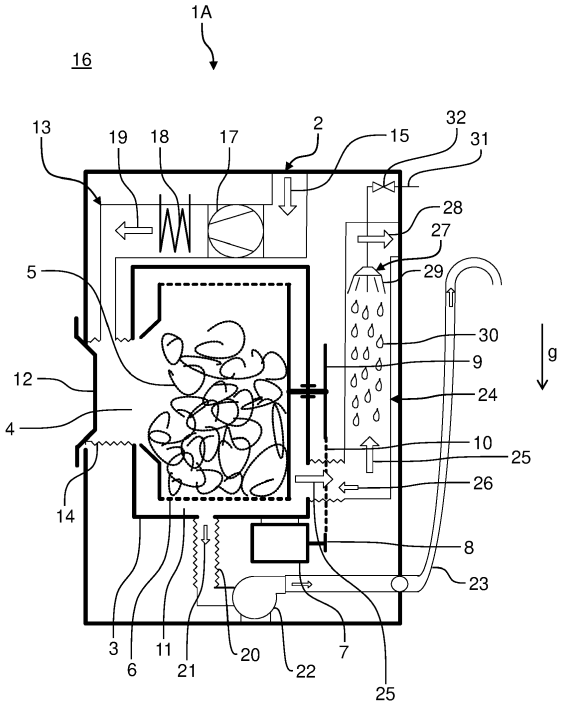

Fig. 1

EP 3 812 500 A1

Description

[0001] The present invention relates to a household washer-dryer.

[0002] For combined washing and drying of laundry, a so-called washer dryer can be used. A washer-dryer is an appliance that is capable of subsequently washing and drying laundry. For drying laundry with conventional dryers, several drying methods are known to the applicant from his in-house experience. Vented dryers work by evacuating hot wet air to the room or outdoors. In this case, drying of the wet laundry takes place by applying an air current blown by a fan and which, when flowing through the laundry, provokes the extraction of humidity contained in said laundry. The air applied to the laundry can be heated, for example, by means of an electrical resistor, and being loaded with the evaporated humidity. Then, the humid air can be discharged to the outside.

[0003] Air condensation dryers dry by recirculating process air and condensing the contained water in it. The humidity in the air can be condensed, turning the air carrying it into dry air that can be recirculated in a closed circuit. Humidity from the humid air being thereby recovered in liquid state. Depending on the dehumidification means, three different processes can be defined. Firstly, the dehumidification can be done with fresh air. In this case, dehumidification of humid air can be carried out by means of an air-air heat exchanger in which one of the exchanging fluids is cold air from the ambient, which flows without direct contact but thermal through this heat exchanger, cooling down the humid air flow and quitting its humidity. This refrigeration air is extracted from the ambient being heated up and expelled again to the ambient after flowing through the exchanger, being propelled by an additional fan.

[0004] Secondly, the dehumidification can be done with fresh water. In this case, dehumidification of humid air can also take place by cooling with refrigeration water taken from the water supply, directly in counter flow contact with the humid air. Thirdly, the dehumidification can be done via an air to refrigerant heat exchanger. In this case, dehumidification is done by heat pump technology comprising a heat pump circuit with a compressor, a condenser and an evaporator. In these home appliances, the air current applied to the laundry to be dried is usually heated by means of the heat pump condenser and propelled by a fan. The dehumidification is achieved by cooling the humid air by passing it through the cold surfaces of the heat pump evaporator. The temperature difference between condenser and evaporator is produced due to compressing a refrigerant media in superheated gas state, which is able to condense by being cooled down by the dried air, then expanded and evaporated again by the humid air coming out of the drum.

[0005] It is one object of the present invention to provide an improved household washer-dryer.

[0006] Accordingly, a household washer-dryer is provided. The household washer-dryer comprises a drum for receiving laundry, an air inlet for taking in cool dry air from a surroundings of the household washer-dryer during a drying cycle, wherein the air inlet comprises a heating device for converting the cool dry air into hot dry air which is discharged into the drum by means of the air inlet, and a water inlet/air outlet for taking in hot moist air from the drum during the drying cycle, wherein the water inlet/air outlet comprises a dehumidifying device for converting the hot moist air into cool dry air which is discharged into the surroundings by means of the water inlet/air outlet.

[0007] Due to the fact that the household washer-dryer uses an open cycle, that means that the air is taken in from and discharged into the surroundings instead of being circulated, the space required for the elements that are need for the drying cycle is smaller compared to a washer-dryer with a closed cycle. In this way, either the size of the drum can be increased or the size of the household washer-dryer can be reduced.

[0008] The household washer-dryer is an open cycle household washer-dryer. "Open cycle" in this context means that the air that is used for drying the laundry does not circulate like in a closed cycle washer-dryer. In other words, the air is taken from the surroundings and is discharged back into the surroundings. The drum is rotatable supported in a tub. Preferably, the air inlet and the water inlet/air outlet are connected to the tub. The washer-dryer can perform a washing cycle and a subsequent drying cycle. This means that the term "household washer-dryer" has to be understand as a household appliance that is capable of both, washing and drying laundry. In particular, the drying cycle is an open drying cycle. The heating device is preferably arranged inside the air inlet. The air inlet can be a duct that connects the surroundings to the tub.

[0009] The dehumidifying device is capable of removing water or moisture from the hot moist air leaving the drum. The hot dry air takes up moisture from the laundry and leaves the drum as hot moist air. The dehumidification process is done by cooling down the hot moist air. In this way, the moisture condenses when cooling down the hot moist air coming from the laundry. The dehumidification device is preferably arranged inside the water inlet/air outlet. The water inlet/air outlet can be a duct that connects the tub to the surroundings. The term "water inlet/air outlet" in this context means that there is provided a double function. During the washing cycle, water is discharged from the water inlet/air outlet into the tub. During the drying cycle, air is discharged from the tub into the water inlet/air outlet.

[0010] According to an embodiment, the air inlet comprises a fan which forces the cool dry air through or over the heating device during the drying cycle.

[0011] The fan can be arranged upstream the heating device. Alternatively, the fan can be arranged downstream the heating device. The fan can be a ventilator.

[0012] According to a further embodiment, the heating device is an electrical resistor that is placed inside the

air inlet.

[0013] A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The electrical resistor can be a wire coil.

[0014] According to a further embodiment, the dehumidifying device comprises a sprinkler that generates a drizzle of fresh water that is in counterflow with the hot moist air leaving the drum during the drying cycle.

[0015] "Counterflow" in this context means that a flow direction of the drizzle and a flow direction of the hot moist air are contrary.

[0016] According to a further embodiment, the water inlet/air outlet comprises an additional heating device for converting the cool dry air into warm dry air which is discharged into the surroundings by means of the water inlet/air outlet.

[0017] In this way, the cool dry air can be heated up before being discharged into the surroundings. The additional heating device can be an additional resistor that is arranged inside the water inlet/air outlet.

[0018] According to a further embodiment, the additional heating device is arranged downstream the dehumidifying device.

[0019] "Downstream" in this context means that seen in a flow direction of the air, the additional heating device is arranged behind the dehumidifying device.

[0020] According to a further embodiment, the household washer-dryer further comprises a heat pump.

[0021] A "heat pump" comprises a condenser, an evaporator, an expansion valve and a compressor.

[0022] According to a further embodiment, the heating device is a condenser of the heat pump, wherein the heating device is placed inside the air inlet.

[0023] Thus, the term "heating device" can be replaced by the term "condenser". In particular, the condenser is a heat exchanger.

[0024] According to a further embodiment, the dehumidifying device is an evaporator of the heat pump, wherein the dehumidifying device is placed inside the water inlet/air outlet.

[0025] Thus, the term " dehumidifying device" can be replaced by the term "evaporator". In particular, the evaporator is a heat exchanger. During the drying cycle, the compressor compresses a refrigerant which is heated up during compressing it. In the heating element the refrigerant condenses and transfers heat to the cool dry air sucked in from the surroundings. The condensed refrigerant is supplied to the expansion valve where the liquid refrigerant is expanded and cooled down. The cool refrigerant is supplied to the dehumidifying device where it evaporates and takes up heat from the hot moist air leaving the tub. The hot moist air cools down and the moisture condenses so that only cool dry air is discharged into the surroundings.

[0026] According to a further embodiment, the heat pump comprises a heat exchanger for converting the cool dry air into warm dry air which is discharged into the surroundings by means of the water inlet/air outlet.

[0027] In this case, the heat pump has three heat exchangers, namely the evaporator, the condenser and the afore-mentioned heat exchanger.

[0028] According to a further embodiment, the heat exchanger is arranged downstream the dehumidifying device.

[0029] By means of the heat exchanger, the cool dry air can be heated up before being discharged into the surroundings.

[0030] According to a further embodiment, the heat exchanger is arranged inside the water inlet/air outlet.

[0031] This reduces space requirements. The household washer-dryer can so be designed more compact.

[0032] According to a further embodiment, the heat pump comprises an evaporator for cooling down fresh water that is delivered to the dehumidifying device.

[0033] In this case, the evaporator is not used to cool down the hot moist air coming from the laundry. In contrast, the evaporator is used to cool down the water that is delivered to the dehumidifying device. In this case, the dehumidifying device is not an evaporator but a sprinkler as mentioned before.

[0034] According to a further embodiment, the heat pump comprises a heat exchanger for converting the cool dry air into warm dry air which is discharged into the surroundings by means of the water inlet/air outlet.

[0035] In this case, the dehumidification device is a sprinkler. The heat pump comprises a condenser in form of the heating device, the condenser for cooling the water for the dehumidification device and the heat exchanger.

[0036] According to a further embodiment, the heat exchanger is arranged downstream the dehumidifying device.

[0037] Contact of water with the heat exchanger can be omitted in this way.

[0038] Further possible implementations or alternative solutions of the invention also encompass combinations - that are not explicitly mentioned herein - of features described above or below with regard to the embodiments. The person skilled in the art may also add individual or isolated aspects and features to the most basic form of the invention.

[0039] Further embodiments, features and advantages of the present invention will become apparent from the subsequent description and dependent claims, taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows one embodiment of a household washer-dryer;

Fig. 2 shows another embodiment of a household washer-dryer;

Fig. 3 shows another embodiment of a household washer-dryer;

Fig. 4 shows another embodiment of a household washer-dryer;

Fig. 5 shows another embodiment of a household washer-dryer; and

Fig. 6 shows another embodiment of a household washer-dryer.

[0040] In the Figures, like reference numerals designate like or functionally equivalent elements, unless otherwise indicated.

[0041] Fig. 1 shows one embodiment of a washer-dryer 1A. The washer-dryer 1A is a household appliance and can therefore be named household washer-dryer. A "washer-dryer" in this context is to be understood as an appliance that is capable of subsequently washing and drying laundry. As will be explained later, the washer-dryer 1A is an open-cycle washer dryer. For this reason, the washer-dryer 1A can be named open-cycle washer-dryer.

[0042] The washer-dryer 1A has a housing 2 which encloses a tub 3. The tub 3 has a load opening 4 through which laundry 5 can be placed in a rotatable drum 6. The drum 6 is rotatable supported in the tub 3. A motor 7 is provided for rotating the drum 6. The motor 7 has a pinion 8 whereas the drum 6 has a gear 9 which engages with the pinion 8 by means of a chain 10. The motor 7 can be connected to the tub 3. Between the drum 6 and the tub 3 is provided a gap 11.

[0043] The load opening 4 can be opened and closed by means of a door 12. The door 12 is hinged to the housing 2. The tub 3 has an air inlet 13. The air inlet 13 can be a duct that discharges into a bellows 14 that connects the tub 3 to the housing 2. The air inlet 13 is capable of sucking in fresh or cool dry air 15 from a surroundings 16 of the washer-dryer 1A. For this purpose, the air inlet 13 has a fan 17. The air inlet 13 further has a heating device 18 for heating the cool dry air 15. The heating device 18 is an electrical resistor. The heating device 18 turns the cool dry air 15 into hot dry air 19.

[0044] The tub 3 has a water outlet 20 for discharging process water 21 from the tub 3. "Process water" in this context means fresh water that comprises a detergent and/or dirt that is separated from the laundry 5. The water outlet 20 can be a bellows that is attached to the tub 3. Seen along a direction of gravity g, the water outlet 20 is provided at a lowest point of the tub 3. The water outlet 20 is connected to a pump 22. The pump 22 discharges the process water 21 into an outlet tube 23. The outlet tube 23 can be connected to a sewer (not shown) or the like.

[0045] Furthermore, the tub 3 comprises a combined water inlet/air outlet 24. By means of the water inlet/air outlet 24 hot moist air 25 can be discharged from the tub 3 and fresh water 26 can be discharged into the tub 3. The water inlet/air outlet 24 has a dehumidifying device 27 for dehumidifying the hot moist air 25. The dehumidifying device 27 is suitable for cooling down and dehumidifying the hot moist air 25. In this way, the dehumidifying device 27 can process the hot moist air 25 into cool dry air 28 that is discharged into the surroundings 16. The dehumidifying device 27 can comprise a spray or sprinkler 29 that sprays the fresh water 26 and thus creates a drizzle 30 of fresh water 26. The dehumidifying device 27 further comprises a feeding tube 31 for supplying the fresh water 26 and a valve 32.

[0046] The function of the washer-dryer 1A is as follows. The laundry 5 that has to be cleaned is placed in the drum 6 and the door 12 is closed. Then a combined washing-drying cycle is started. The washing-drying cycle comprises a washing cycle and a subsequent drying cycle. At the start of the washing cycle, fresh water 26 is discharged into the tub 3 through the water inlet/air outlet 24. This can be done by means of the dehumidifying device 27. Otherwise, the fresh water 26 can be discharged into the water inlet/air outlet 24 in any other way. For example, a water supplying tube (not shown) can discharge the fresh water 26 into the tub 3 and/or the water inlet/air outlet 24.

[0047] The fresh water 26 dissolves a detergent that is placed in the laundry 5 or in a dispenser (not shown). The motor 7 rotates the drum 6 and the process water 21 can be circulated by means of the pump 22. By the end of the washing circle, the clean laundry 5 is centrifuged by means of the motor 7 and the process water 21 is discharged into the outlet tube 23.

[0048] After the washing cycle is finished, the drying cycle is started. The air inlet 13 sucks in cool dry air 15 from the surroundings 16 by means of the fan 17. The cool dry air 15 is processed into hot dry air 19 by means of the heating device 18. The hot dry air 19 is discharged into the rotating drum 6. The hot dry air 19 absorbs moisture from the wet laundry 5 and is discharged through the water inlet/air outlet 24 as hot moist air 25. The hot moist air 25 is in counterflow with the drizzle 30 of fresh water 26.

[0049] The dehumidifying device 27 cools the hot moist air 25 down, whereupon the moisture in the hot moist air 25 condenses and flows back into the tub 3 together with the fresh water 26. From the tub 3, the moisture and the fresh water 26 used to produce the drizzle 30 are discharged as process water 21 into the outlet tube 23 by means of the pump 22. In this way, the hot moist air 25 is processed into cool dry air 28 that is discharged into the surroundings 16. The drying cycle is performed till the laundry 5 has the desired dryness. The desired dryness can be detected by means of a sensor (not shown). The drying cycle is stopped and the laundry 5 can be removed from the drum 6.

[0050] As explained before, during the drying cycle, the washer-dryer 1A sucks in cool dry air 15 from the surroundings 16 and discharges cool dry air 28 into the surroundings 16. In other words, the air does not circulate in a closed circuit. The washer-dryer 1A can therefore be named as open cycle washer-dryer.

[0051] Fig. 2 shows another embodiment of a washer-dryer 1B. The washer-dryer 1B differs from the washer-dryer 1A only in that the water inlet/air outlet 24 comprises

an additional heating device 33 for heating up the cool dry air 28 downstream the dehumidifying device 27. For example, the heating device 33 heats the cool dry air 28 up to room temperature. The heating device 33 turns the cool dry air 28 into warm dry air 34 that is discharged into the surroundings 16.

[0052] Fig. 3 shows another embodiment of a washer-dryer 1C. The washer-dryer 1C differs from the washer-dryer 1A only in that the heating device 18 of the air inlet 13 is a condenser of a heat pump 35 and in that the dehumidifying device 27 of the water inlet/air outlet 24 is an evaporator of the heat pump 35. Apart from the heating device 18 and the dehumidifying device 27, the heat pump 35 comprises an expansion valve 36 and a compressor 37. The heating device 18 is connected to the dehumidifying device 27 by means of a first duct 38. The first duct 38 has the expansion valve 36. The dehumidifying device 27 is connected to the heating device 18 by means of a second duct 39. The second duct 39 has the compressor 37.

[0053] During the drying cycle, the compressor 37 compresses a refrigerant which is heated up during compressing it. In the heating device 18, the refrigerant condenses and transfers heat to the cool dry air 15 sucked in from the surroundings 16. The condensed refrigerant is supplied to the expansion valve 36 where the liquid refrigerant is expanded and cooled down. The cool refrigerant is supplied to the dehumidifying device 27 where it evaporates and takes up heat from the hot moist air 25 leaving the tub 3. The hot moist air 25 cools down and the moisture condenses so that only cool dry air 28 is discharged into the surroundings 16.

[0054] Fig. 4 shows another embodiment of a washer-dryer 1D. The washer-dryer 1D differs from the washer-dryer 1C only in that the heat pump 35 comprises an additional heat exchanger 40. The dehumidifying device 27 is connected to the heating device 18 by means of the second duct 39 which comprises the compressor 37. The heat exchanger 40 is connected to the dehumidifying device 27 by means of a third duct 41 which comprises the expansion valve 36. The heating device 18 is connected to the heat exchanger 40 by means of a fourth duct 42. During the drying cycle, the heat exchanger 40 is used to heat up the cool dry air 28 before being discharged into the surroundings 16. In this way, the heat exchanger 40 processes the cool dry air 28 into warm dry air 34 leaving the washer-dryer 1D.

[0055] Fig. 5 shows another embodiment of a washer-dryer 1E. The washer-dryer 1E differs from the washer-dryer 1A only in that the heating device 18 of the air inlet 13 is a condenser of a heat pump 35. Apart from the heating device 18 the heat pump 35 comprises an evaporator 43. The heating device 18 is connected to the evaporator 43 by means of the first duct 38 which has the expansion valve 36. The evaporator 43 is connected to the heating device 18 by means of the second duct 39 which comprises the compressor 37. During the drying cycle, the evaporator 43 is used to cool down the fresh water 26 before it gets sprayed by means of the dehumidifying device 27. Furthermore, the process water 21 produced during the drying cycle can be delivered to the evaporator 43 by means of the outlet tube 23 and cooled down again before being sprayed by the sprinkler 29. A water circulation can be established. In this way, the consumption of fresh water 26 can be reduced.

[0056] Fig. 6 shows another embodiment of a washer-dryer 1F. The washer-dryer 1F differs from the washer-dryer 1E only in that the heat pump 35 comprises an additional heat exchanger 40. The evaporator 43 is connected to the heating device 18 by means of the second duct 39 which comprises the compressor 37. The heat exchanger 40 is connected to the evaporator 43 by means of the third duct 41 which comprises the expansion valve 36. The heating device 18 is connected to the heat exchanger 40 by means of the fourth duct 42. During the drying cycle, the heat exchanger 40 is used to heat up the cool dry air 28 before being discharged into the surroundings 16. In this way, the heat exchanger 40 processes the cool dry air 28 into warm dry air 34 leaving the washer-dryer 1F.

[0057] The afore-mentioned embodiments of the washer-dryer 1A, 1B, 1C, 1D, 1E, 1F can have the following advantages. Due to the fact that an open cycle is provided, it is possible to provide a fast-drying function in a washer-dryer 1A, 1B, 1C, 1D, 1E, 1F with standard dimensions. A high simplicity for integrating the system in an existing washer-dryer configuration can be achieved. It is possible to reutilize water. This implies lower fresh water consumption during the washing cycle. It is possible to recover heat from water used in the dehumidifying process. Flexibility and adaptability of the design can be provided. Different washing and drying speed and efficiency can be devised.

[0058] Although the present invention has been described in accordance with preferred embodiments, it is obvious for the person skilled in the art that modifications are possible in all embodiments.

Reference Numerals:

[0059]

1A	washer-dryer
1B	washer-dryer
1C	washer-dryer
1D	washer-dryer
1E	washer-dryer
1F	washer-dryer
2	housing
3	tub
4	load opening
5	laundry
6	drum
7	motor
8	pinion
9	gear

10 chain
11 gap
12 door
13 air inlet
14 bellows
15 air
16 surroundings
17 fan
18 heating device
19 air
20 water outlet
21 water
22 pump
23 outlet tube
24 water inlet/air outlet
25 air
26 water
27 dehumidifying device
28 air
29 sprinkler
30 drizzle
31 feeding tube
32 valve
33 heating device
34 air
35 heat pump
36 expansion valve
37 compressor
38 duct
39 duct
40 heat exchanger
41 duct
42 duct
43 evaporator

g direction of gravity

Claims

1. A household washer-dryer (1A, 1B, 1C, 1D, 1E, 1F), comprising a drum (6) for receiving laundry (5), an air inlet (13) for taking in cool dry air (15) from a surroundings (16) of the household washer-dryer (1A, 1B, 1C, 1D, 1E, 1F) during a drying cycle, wherein the air inlet (13) comprises a heating device (18) for converting the cool dry air (15) into hot dry air (19) which is discharged into the drum (6) by means of the air inlet (13), and a water inlet/air outlet (24) for taking in hot moist air (25) from the drum (6) during the drying cycle, wherein the water inlet/air outlet (24) comprises a dehumidifying device (27) for converting the hot moist air (25) into cool dry air (28) which is discharged into the surroundings (16) by means of the water inlet/air outlet (24).

2. The household washer-dryer according to claim 1, wherein the air inlet (13) comprises a fan (17) which forces the cool dry air (15) through or over the heating device (18) during the drying cycle.

3. The household washer-dryer according to claim 1 or 2, wherein the heating device (18) is an electrical resistor that is placed inside the air inlet (13).

4. The household washer-dryer according to one of claims 1 - 3, wherein the dehumidifying device (27) comprises a sprinkler (29) that generates a drizzle (30) of fresh water (26) that is in counterflow with the hot moist air (25) leaving the drum (6) during the drying cycle.

5. The household washer-dryer according to one of claims 1 - 4, wherein the water inlet/air outlet (24) comprises an additional heating device (33) for converting the cool dry air (28) into warm dry air (34) which is discharged into the surroundings (16) by means of the water inlet/air outlet (24).

6. The household washer-dryer according to claim 5, wherein the additional heating device (33) is arranged downstream the dehumidifying device (27).

7. The household washer-dryer according to one of claims 1 - 6, further comprising a heat pump (35).

8. The household washer-dryer according to claim 7, wherein the heating device (18) is a condenser of the heat pump (35), and wherein the heating device (18) is placed inside the air inlet (13).

9. The household washer-dryer according to claim 7 or 8, wherein the dehumidifying device (27) is an evaporator of the heat pump (35), and wherein the dehumidifying device (27) is placed inside the water inlet/air outlet (24).

10. The household washer-dryer according to one of claims 7 - 9, wherein the heat pump (35) comprises a heat exchanger (40) for converting the cool dry air (28) into warm dry air (34) which is discharged into the surroundings (16) by means of the water inlet/air outlet (24).

11. The household washer-dryer according to claim 10, wherein the heat exchanger (40) is arranged downstream the dehumidifying device (27).

12. The household washer-dryer according to claim 10 or 11, wherein the heat exchanger (40) is arranged inside the water inlet/air outlet (24).

13. The household washer-dryer according to one of claims 7 - 12, wherein the heat pump (35) comprises an evaporator (43) for cooling down fresh water (26) that is delivered to the dehumidifying device (27).

14. The household washer-dryer according to claim 13, wherein the heat pump (35) comprises a heat exchanger (40) for converting the cool dry air (28) into warm dry air (34) which is discharged into the surroundings (16) by means of the water inlet/air outlet (24).

15. The household washer-dryer according to claim 14, wherein the heat exchanger (40) is arranged downstream the dehumidifying device (27).

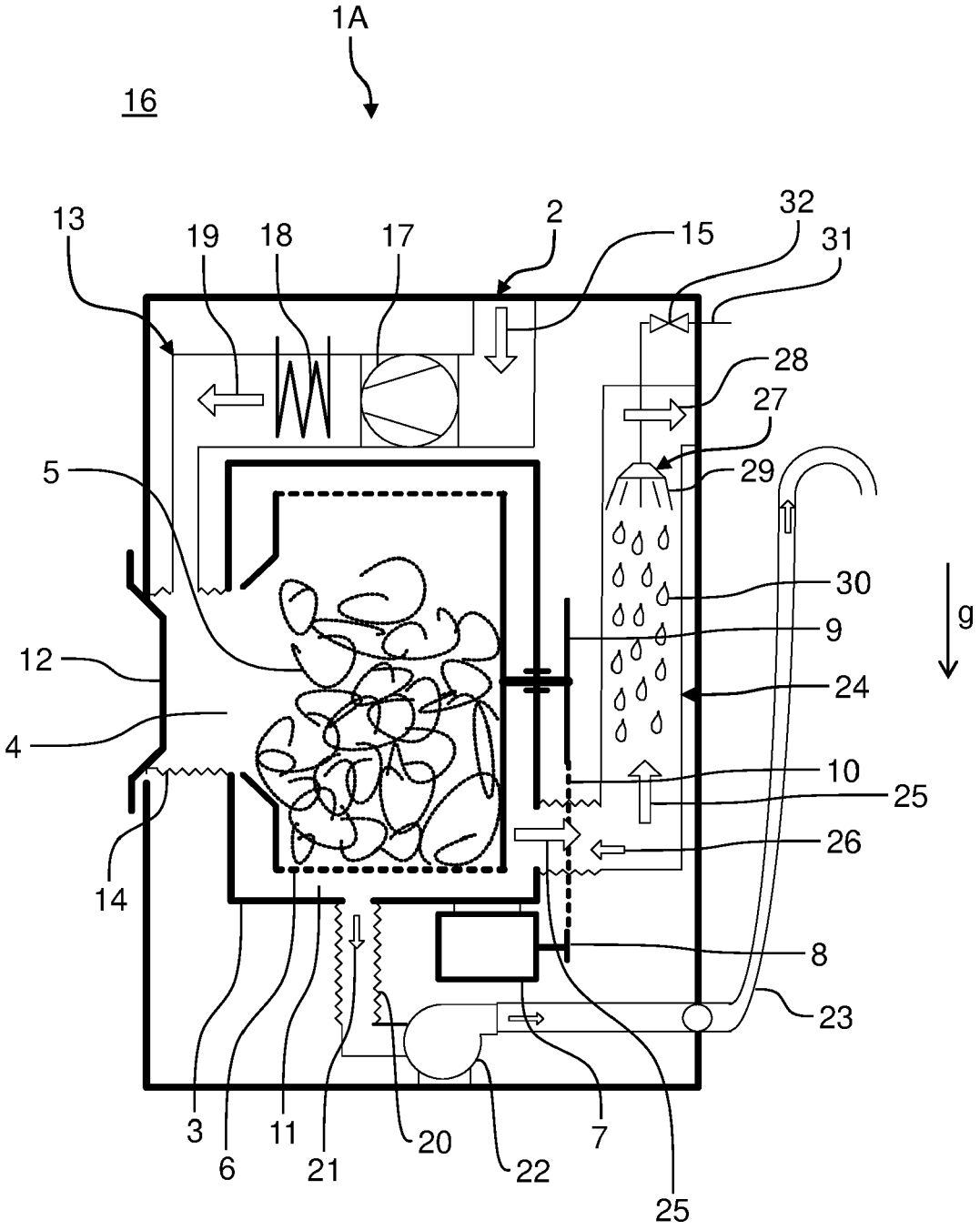
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Fig. 1

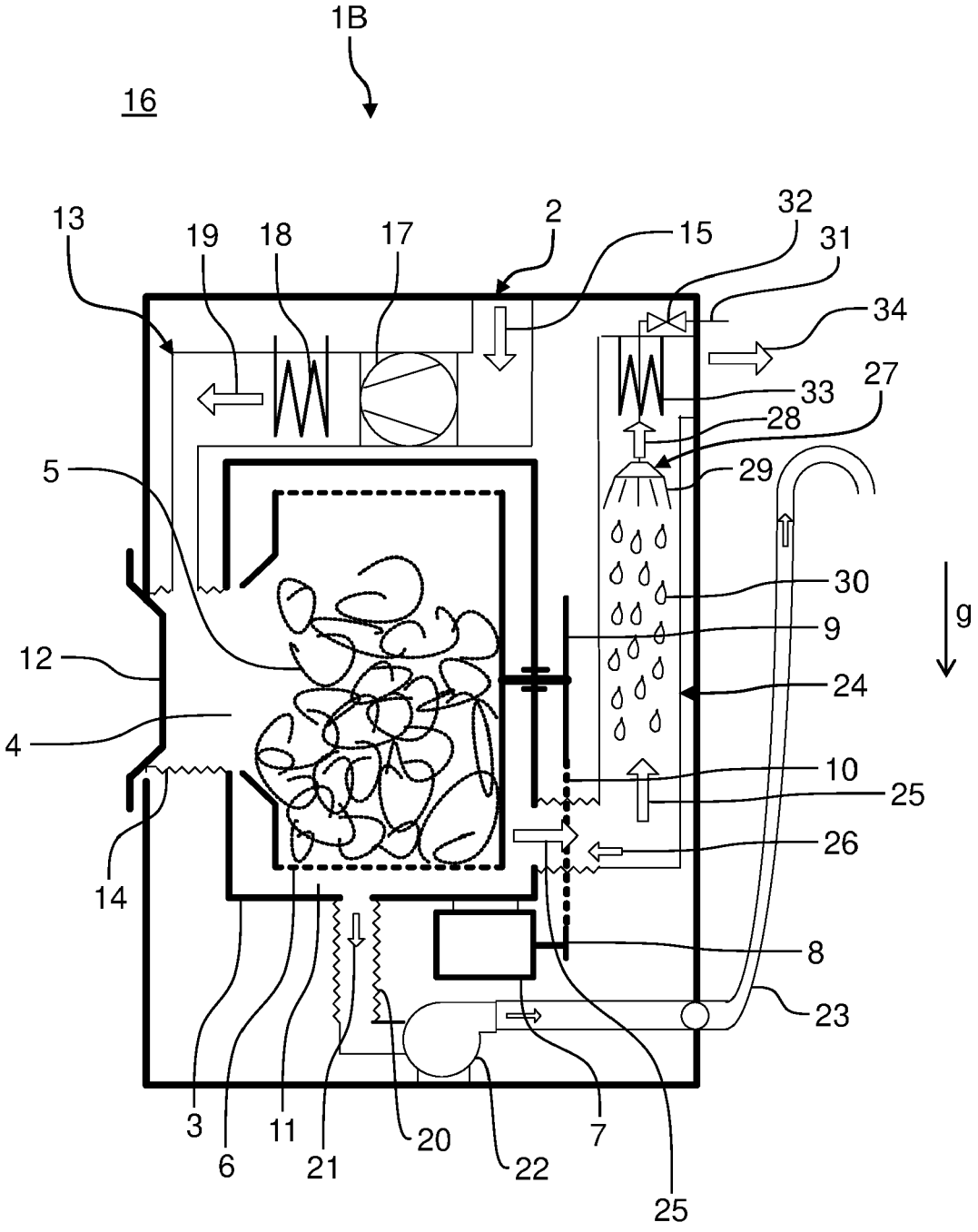
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Fig. 2

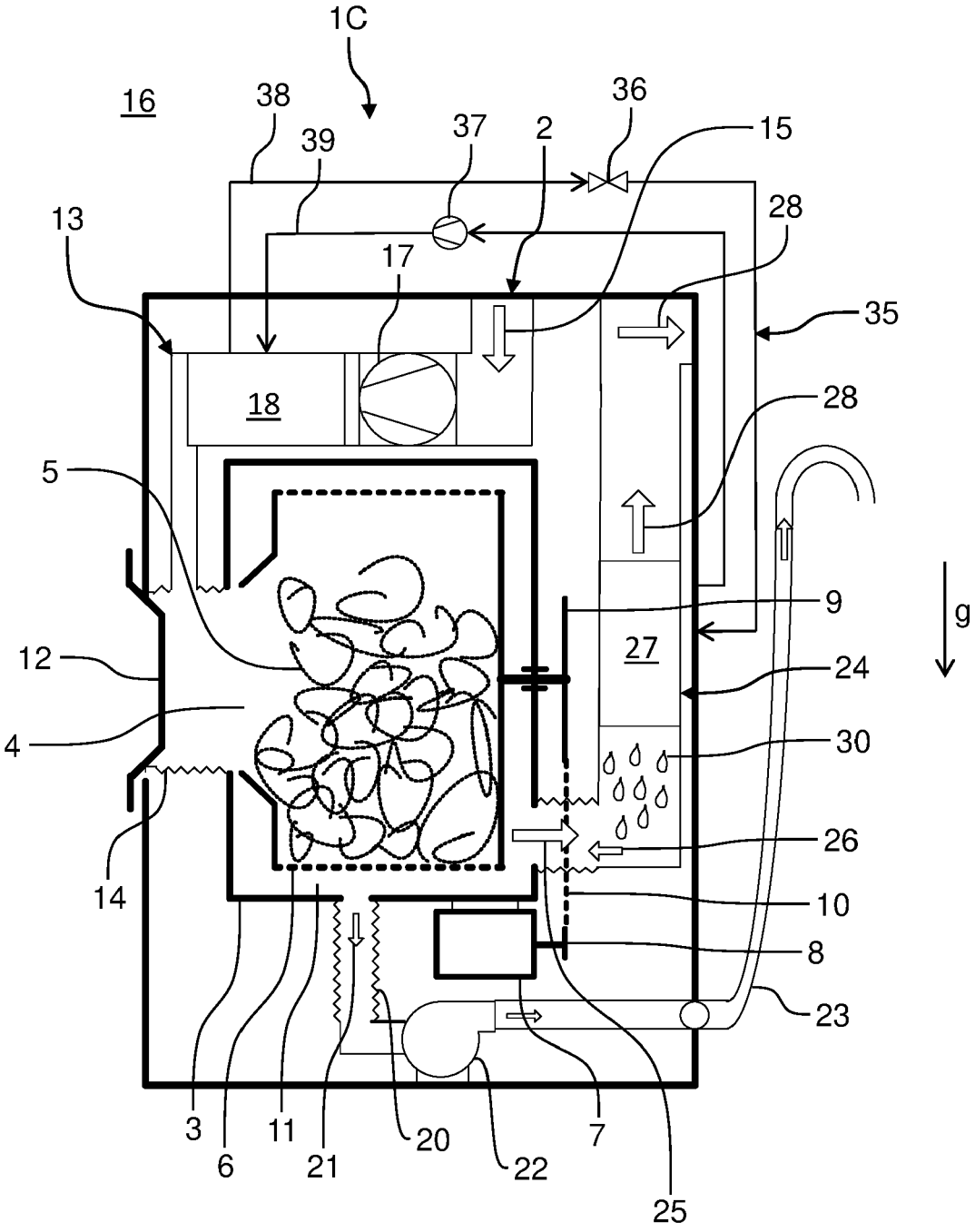
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Fig. 3

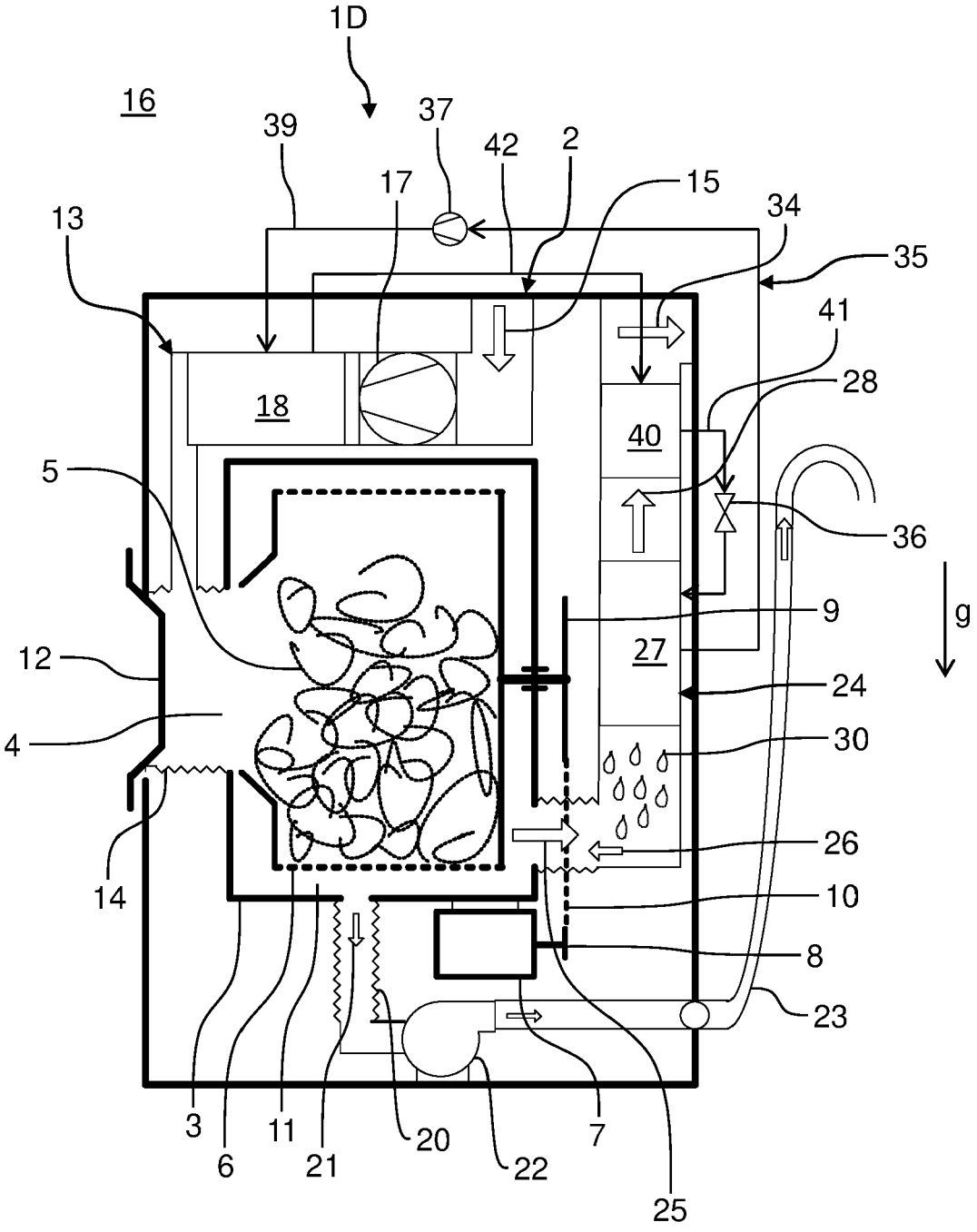
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Fig. 4

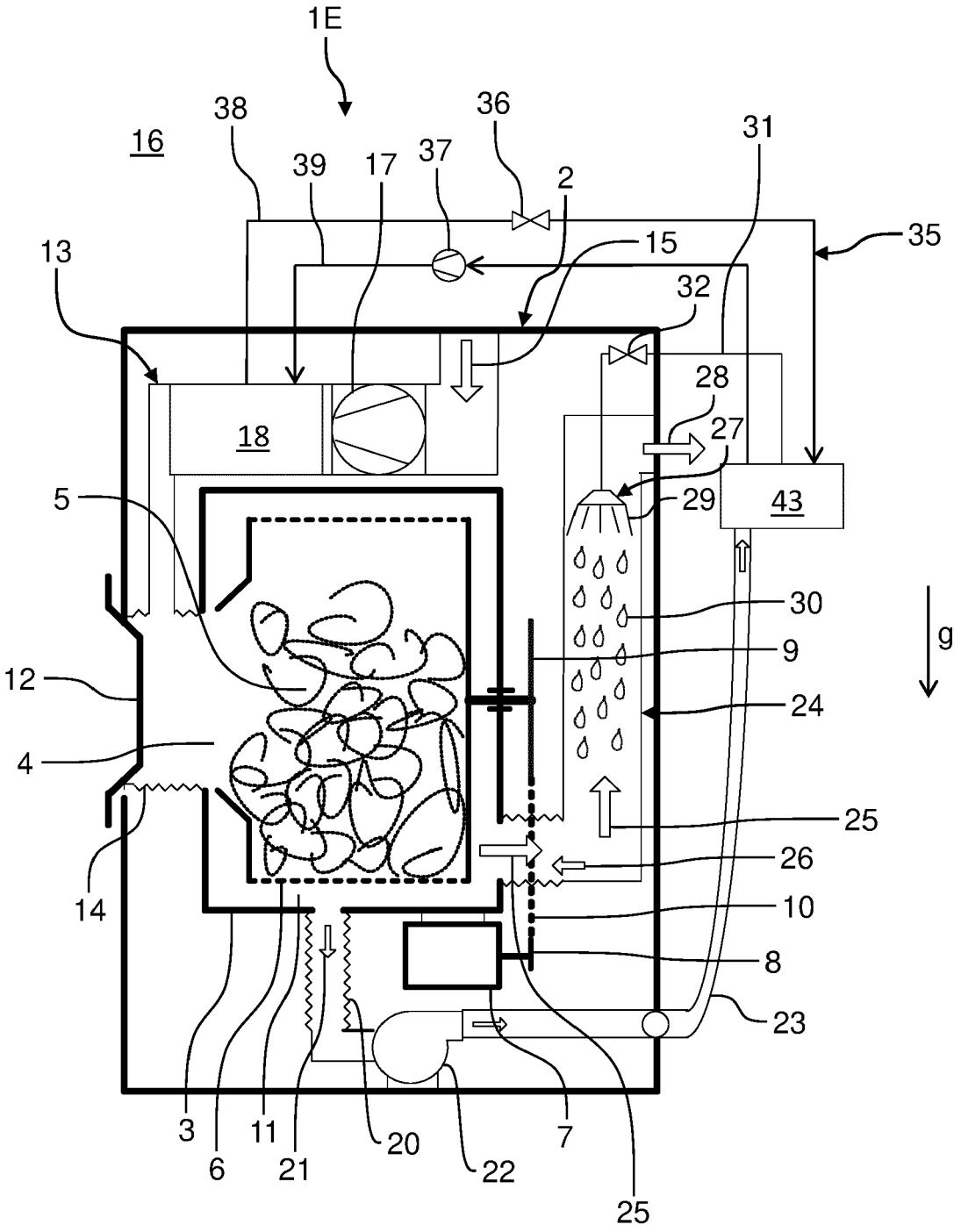
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Fig. 5

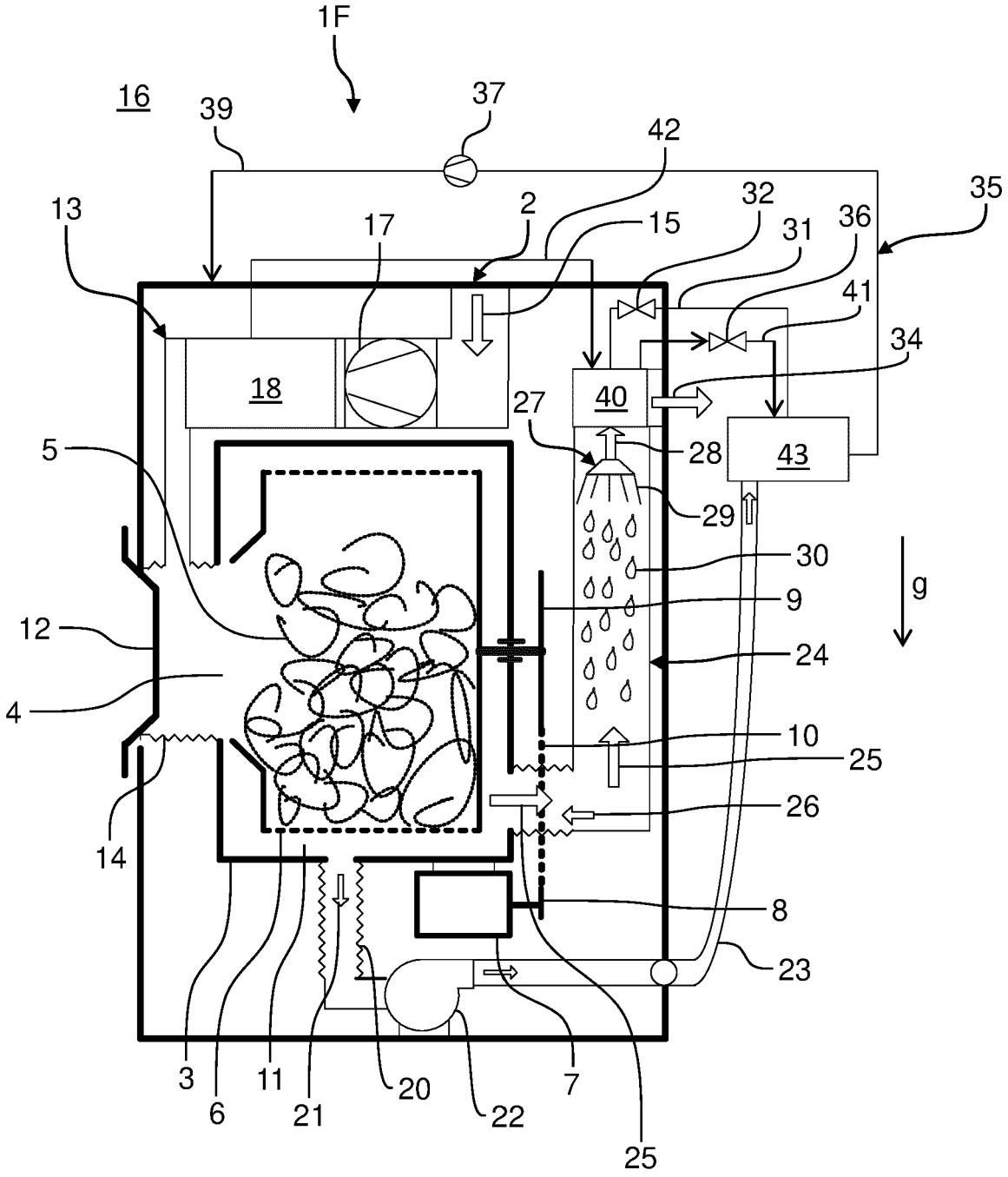
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Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 20 19 9820

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D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 March 2021	Bermejo, Marco

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