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(54) Domestic washing machine having a closed drying circuit, air condensation of vapour and self cleaning filter

(57) A domestic laundry washer-dryer machine in which the closed drying circuit comprises an air/air heat exchanger (14), which is readily removable for inspection, and a self-cleaning filter (13) for trapping fluff, which filter is readily removable and is cleaned automatically, in a washing machine programme, with rinsing water in the course of a washing operation or also with the water of condensation itself at the end of a drying operation, with substantial savings in the consumption of water and optional recovery of the drying heat from the surroundings.

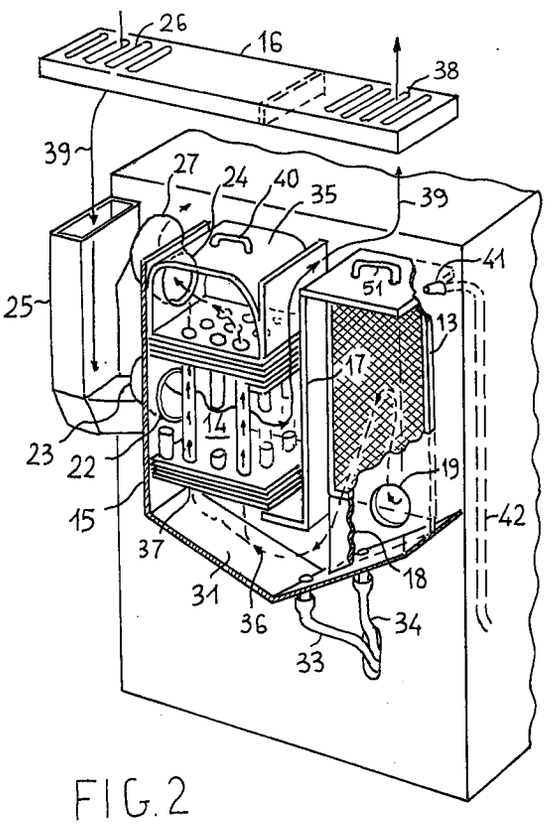

FIG. 2

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Description

The present invention relates to a domestic washing machine incorporating a drying circuit.

Domestic washing machines, referred to as washer-dryers, are known which, in addition to washing the laundry, also dry it by means of a current of heated air induced in a closed drying circuit comprising, in sequence, a washing tank-drum unit, an air/water heat exchanger, a suction unit, and a heating unit having electrical resistors.

The flow of air induced by the suction unit is heated by the electrical resistors and conveyed into the washing drum where, by passing through the wet laundry, it brings about the evaporation of the absorbed water. In the heat exchanger, which is generally of the sprinkler type, the moist air is cooled by a stream of cold water which is taken from the mains and discharged into the back-flow collecting unit. Owing to the cooling effect, the steam condenses and is collected in the washing tank and discharged together with the cooling water.

The dehumidified air is then aspirated by the suction unit and recycled.

In addition to a substantial consumption of electrical energy for heating the current of air in the drying circuit, there is thus also a not inconsiderable consumption of cooling water, of the order of from 40 to 50 litres per drying cycle, which is completely wasted.

This is a serious problem because water is a limited resource which is becoming ever more precious and expensive, to the extent that in some regions it is actually rationed, with periodic supply for filling collection reservoirs of limited capacity.

The thermal power used for drying is also completely wasted with the cooling water.

Laundry drying machines having the sole function of drying laundry are also known which do not have this disadvantage because the condensation of the steam produced by drying takes place in a condensation circuit having an air/air heat exchanger which uses air from the surroundings to cool the moist air and to condense the steam.

It is therefore desirable to use the same technology in washer-dryer machines but this transfer of technology, although conceptually obvious, is not so simple.

In order for the drying circuit to be efficient, it is necessary for the fluff coming off the laundry and transported by the current of moist air leaving the drum containing the laundry to be trapped by a filter which must be cleaned frequently.

This problem, which does not occur in washer-dryer machines because the steam is condensed by sprinkling the moist air, with resultant trapping of the fluff by the cooling liquid, is solved in laundry drying machines to some extent by providing a filter in the drying circuit, the filter being accessible by way of the front loading porthole of the machine.

The filter inevitably has to be small and therefore it easily becomes blocked in the course of the drying operation, involving substantial losses of pressure in the drying circuit with a consequent increase in the power necessary to obtain a predetermined flow rate, a substantial variation in the flow rate in the course of the drying operation and a reduction in efficiency.

In these machines, the drying circuit may extend, as desired, at levels below and above the level of the loading porthole because it is not intended that the drying drum should be filled with liquid but only that a limited volume of condensation water of the overall order of from 2 to 3 litres at most per drying cycle should be condensed in the drying circuit.

This solution is not possible in washer-dryer machines because the washing liquid, even in the case of machines having a minimum volume of washing water, reaches the level of the loading porthole.

It is therefore necessary for the drying circuit, which must not be affected in any way by the washing liquid, to extend at a higher level than that of the porthole and therefore at a level of maximum filling of the washing tank.

This precludes the arrangement of the fluff-trapping filter in a position which is readily accessible through the loading porthole.

For this reason and for other reasons concerning a greater space requirement and difficulties in reconciling the extent of the drying circuit with the various components necessary for washing operations, washer-dryer machines having a drying circuit with an air/air exchanger have not been produced and the problem of producing a machine of this type in a practicable, functional and ergonomic manner, satisfying the requirement of avoiding a substantial waste of water, has still not been solved.

The present invention solves this problem and provides a laundry washer-dryer machine having a drying circuit with an air/air exchanger and a self-cleaning filter for trapping fluff without any necessity for the intervention of the user (such intervention nevertheless always being readily possible).

The filter, which may have large dimensions and which therefore is hardly subject to blockage and is particularly efficient, is cleaned by a limited amount of a stream of sprinkling water.

According to a further aspect of the present invention, the washing cycle is advantageously designed to perform the filter-washing operation using all or some of the rinsing water from a washing cycle, or also the water of condensation resulting from the drying operation.

The characteristics and advantages of the present invention will become clearer from the following description of a preferred embodiment given purely by way of non-limiting example with reference to the appended drawings in which:

- Figure 1 is a diagrammatic section from front to back (on different levels) of a preferred embodiment

of a laundry washer-dryer machine in accordance with the present invention, and

- Figure 2 is a "transparent" perspective view of the rear portion of the machine of Figure 1.

Referring to Figures 1 and 2, a washer-dryer machine according to the present invention comprises a casing 1 of standardised dimensions, for example width 60 cm, depth 50 cm, height 80 cm, which accommodates, in resiliently supported manner, a washing tank 2 containing a rotating drum 3, motor components (not shown), a discharge pump 4 of the self-cleaning type, with its inlet connected to the base of the tank 2 by a flexible tube 5 and with its outlet connected to a discharge pipe 6.

The laundry to be washed is loaded into the drum 3 through a front door/porthole 7.

Devices for heating the washing water, which is supplied from the mains under the control of programming devices of which none is shown and all of which are conventional per se, complete the functional structure of the machine, as a washing machine.

In order for the machine to function as a laundry dryer the structure of the machine is integrated with a motor fan unit 8 having two separate fans 9, 10, an auxiliary recycling filter/pump unit 11, a heating chamber 12 having heating resistors 29 and (Figure 2) a sliding filter 13 for trapping the fluff freed during the drying process, and also a cross-flow air/air heat exchanger 14.

As illustrated in Figure 2, the filter 13 and the heat exchanger 14 are arranged removably in a flattened box-shaped body 15 arranged at the rear of the machine casing, such as a vertical box which has a small thickness of the order of from 7 to 15 cm and which is closed at the top by a removable cover 16 flush with the top of the machine and which is provided internally with diaphragms 17, 18 and ribs for positioning the filter 13 and the heat exchanger 14 which, together with the diaphragms, form two separate flow paths for the air of the drying circuit and for the air for cooling and condensing the steam.

At the bottom, the box-shaped body 15 also forms a tank 31 for collecting condensation and a tank 32 for collecting water for washing the filter 13, the first preferably being connected by way of a pipe 33 to the discharge pipe 5, and the second being connected directly to the discharge pump 4 by way of a pipe 34.

The tanks 31 and 32 are arranged at a level higher than the' maximum filling level of the washing tank 2 in order to avoid back-ups of washing liquid in the course of washing operations.

The box 15 is provided with a first air-inlet opening 19 which communicates, by way of a bellows-form resilient pipe 20, with the washing tank 2 and which opens into the tank 32 for collecting the filter-washing water, with a second opening 22 for introducing cooling air into the exchanger 14, which opening 22 is connected by a pipe 23 to the outlet of the fan 10, and with an outlet opening 24 for the drying air from the heat exchanger 14, which opening 24 is connected by a pipe 27 to the inlet of the fan 9.

A suction pipe 25 is formed integrally with the box 15 or also separately therefrom and is open to the surrounding atmosphere by way of a grille 26 of the removable covering in order to convey air from the surrounding atmosphere to the inlet of the fan 10.

The outlet of the fan 9 (Figure 1) conveys the air received through the pipe 27, by means of a bellows-form resilient connection 28, into the heating chamber 12 where heating resistors 29 heat the air stream.

The heated air, at a temperature of the order of from 120 to 150C, is conveyed by a pipe 30 and introduced, through the opening for loading the drum 3, into the drum itself which it passes through (the drum is expediently perforated) to flow through the bellows-form pipe 20 and the opening 19 into the box 15.

By passing through the drum 3, which, in the drying stage, is rotated at a suitable speed in order to mix and agitate the laundry placed therein, the current of hot air causes the water absorbed in the laundry to be evaporated.

The steam, together with the fluff released from the laundry, is transported by the current of air into the box 15 where it passes through the filter 13 for trapping fluff in order to flow with the air thus filtered into the tank 31 and to pass through the heat exchanger 14 where it partially condenses.

The dehumidified air collects in a collector 35 of the heat exchanger 14 and is then aspirated and recycled by the fan 9 through the opening 24 and the pipe 27.

The oriented broken line marked by the numeral 36 indicates the path of the drying air.

The ambient air necessary to cool and condense the steam contained in the drying air is sucked by the fan 10 through the grille 26 and the pipe 25 and conveyed into the pipe 23. It flows through the opening 22 into the heat exchanger, brushing along radiating fins 37 of the exchanger, is channelled into a space formed between the radiator 14 and the diaphragm 17 and flows into the surrounding atmosphere through a grille 38 in the cover 16.

The continuous line 39 with arrows represents the path of the cooling air.

The condensation liquid which forms in the condenser columns, through which moist drying air passes, falls into the tank 31 and is conveyed via the pipe 33 and the pipe 5 to the discharge pump 4 (Figure 1) which, when actuated, expels it to the back-flow collecting unit.

The heat exchanger 14 which has the general form of a rectangular parallelepiped is removably arranged in the box-shaped body 15 and can be extracted from the top by means of a handle 40, with simple removal of the cover 16, for easy periodic inspection by the user.

Analogously, the filter 13, which is formed by a fine-meshed net supported by a rectangular frame which is provided, at the top, with a cap/cover with a handle 51,

is removably arranged in a sliding manner in the box-shaped body 15 and can be readily removed from the top, with simple removal of the cover 16, for easy periodic inspection by the user and for any cleaning required.

According to one aspect of the present invention, in order to dispense with these periodic inspection and cleaning operations by the user, means are provided which automatically ensure cleaning, by washing the filter, either at the end of each drying operation or at the end of each washing operation carried out by the machine, especially in the course of a rinsing stage.

To that extent, the filter can be defined as being self-cleaning.

These means, which are extremely simple, consist basically in a sprinkler nozzle 41 connected via a pipe 42 to the outlet of the auxiliary recycling pump 11.

The inlet of the pump 11 is connected by way of a pipe 43 to the discharge pipe 5 of the tank 2.

As is known, a washing operation of a washing machine comprises various stages: washing (optionally preceded by a pre-wash), rinsing and spinning.

In a washer-dryer machine, these stages are followed, automatically or by controlling the programme manually, by a drying stage.

A rinsing stage consists in filling the tank 2, with clean water taken from the mains, up to a predetermined level (for example level 21), then rotating the drum 3 (optionally intermittently or in alternate directions) for a predetermined period and, finally, actuating the discharge pump in order to empty the tank.

More rinsing operations may also be possible.

According to the invention, by actuating the discharge pump 4 in conjunction with the auxiliary pump 11, a substantial proportion of the rinsing water (or of the last lot of rinsing water if more than one rinsing operation) which may even be 50% of the rinsing water, and thus of the order of a few litres, is conveyed to the sprinkler nozzle 41 which sprays the surface of the filter 13 on which the fluff has been deposited, thus causing it to become detached, to fall into the tank 32 and to be transported, with the sprinkling liquid and through the pipe 34, to the pump 4 which expels the liquid and the fluff.

Alternatively or in addition to this automatic operation for cleaning the filter 13 with the rinsing water, it is possible to provide for an automatic cleaning operation with the condensation water at the end of a drying stage.

In the course of a drying operation, during which the drum 3 is rotated at a suitable speed and the motor fan 8 is actuated for a period of the order of a few tens of minutes, a mass of steam of, as mentioned, approximately from 2 to 2.5 litres of water, is condensed and collects in the tank 31, and from there it flows through the pipe 33 and the pipe 5 to the discharge pump.

In known washer-dryer machines, the water is discharged continuously, as it is formed, by the pump 4 which is operated continuously or intermittently.

According to the present invention, the pump 4 can be maintained inactive for almost all of the duration of the drying cycle so that the condensation water accumulates in the tank 2.

This accumulation does not prejudice the drying operation because the accumulated water does not fill the tank 2 to a level sufficient to touch the rotating drum 3.

At the end of the drying operation, the joint actuation of the pump 4 and the pump 11 brings about the expulsion of the condensation water, a substantial proportion of which, of the order of at least one litre, supplies the nozzle 41 for sprinkling and cleaning the filter 13 before being discharged.

There is therefore no need to clean the filter 13 manually and therefore, above all, no water additional to that necessary for normal washing operations is required.

Both when using the rinsing water and when using the condensation liquid to clean the filter 13, the joint actuation of the discharge pump 4 and the auxiliary pump 11 is not strictly necessary (the actuation of the pump 4 could follow the actuation of the pump 11) but it is preferable because it enables the fluff trapped by the liquid for washing the filter to be expelled using the pump 4, without liquid or fluff returning to the auxiliary pump 11, which can of course be provided with a filter for trapping fluff but this filter, which is superfluous if the pumps are actuated simultaneously, would require manual cleaning intervention, although this would be easy.

The above description relates only to a preferred embodiment of the invention but it will be appreciated that many variants can be introduced.

In particular, if the auxiliary pump 11 has the sole function of recycling the condensation or rinsing water to the nozzle 41 and is actuated in conjunction with the discharge pump, it is not absolutely necessary, as already stated, for the pump 11 also to comprise a filter.

In general, however, it may be advantageous to use the pump 11 to ensure the recycling of washing water and, optionally, rinsing water to the drum 3 in the course of the respective stages.

In that case, as shown in Figure 1, it is possible also to provide a flow diverter 44 controlled by the machine programming device in order to divert the flow delivered by the pump 11 to the nozzle 41 or to the drum 3, depending on the required operation.

As a further variant, which, however, requires a certain additional consumption of water, although much less than that required by conventional washer-dryer machines having an air/water heat exchanger, the nozzle 41 may be supplied directly from the mains, by means of the solenoid valve for charging the machine, which is always present, and a flow-diverter device controlled by the programming components.

Finally, in addition to the nozzle 41 which sprinkles one face of the filter 13, which may be either that on

which the fluff is deposited or the opposite face, it is possible to provide a second nozzle, also supplied on command with rinsing water, condensation water or mains water, in order to sprinkle the two opposite faces of the filter simultaneously.

Claims

1. A domestic laundry washer-dryer machine having a front wall provided with a loading door (7), a rear wall and a discharge pump (4), of the type in which a current of air heated by heating elements (29) is induced, through a washer/dryer drum (3) arranged in a washing tank (2), by a suction motor fan (8) having a first fan (9), in order to bring about the evaporation of the liquid absorbed in the laundry placed in the washing drum, characterised in that it comprises:

   - a second fan (10) actuated by the motor fan (8),
   - a box-shaped body (15), provided with internal diaphragms (17, 18), which is open at the top and is juxtaposed on the rear wall,
   - a filter (13) arranged removably, with extraction from the top, in the box-shaped body (15), and
   - an air/air heat exchanger (14) arranged removably, with extraction from the top, in the box-shaped body (15), the box-shaped body forming with the exchanger a first, closed path for the air current, through the filter and the exchanger, with an inlet opening (19) open at the washing tank and an outlet opening (24) connected to the inlet of the first fan (9), and a second, open path for a current of cooling air, with an inlet opening (22) connected to the outlet of the second fan (10), the first path comprising a tank (31) which collects condensation liquid and which is connected to tubing (33, 5) for conveying condensation liquid to the discharge pump (4).

2. A laundry washer-dryer machine according to Claim 1, comprising a nozzle (41) for sprinkling and washing the filter (13), means (11) for supplying the nozzle with a stream of water and means (34) for conveying the water to the discharge pump (4).

3. A laundry washer-dryer machine according to Claim 2, wherein the means for supplying the nozzle comprise an auxiliary pump (11) having its inlet connected to a discharge pipe (5) of the washing tank (2) and its outlet connected to the nozzle (41).

4. A laundry washer-dryer machine according to Claim 3, comprising programming means for actuating the auxiliary pump (11) at the end of a rinsing operation and thus conveying at least a portion of the rinsing water contained in the tank (2) to the filter (13), through the nozzle (41).

5. A laundry washer-dryer machine according to Claim 3 or 4, comprising programming means for permitting the recovery of the condensation liquid from the washing tank (2) in the course of a drying operation and for actuating the auxiliary pump (11) at the end of the drying operation and thus conveying at least a portion of the condensation liquid, recovered from the washing tank (2), to the nozzle (41).

6. A laundry washer-dryer machine according to Claim 3, 4 or 5, comprising programming means for actuating the discharge pump (4) in conjunction with the auxiliary pump (11).

7. A laundry washer-dryer machine according to Claim 2, 3, 4, 5 or 6, comprising a pair of nozzles for sprinkling the two opposite faces of the filter (13).

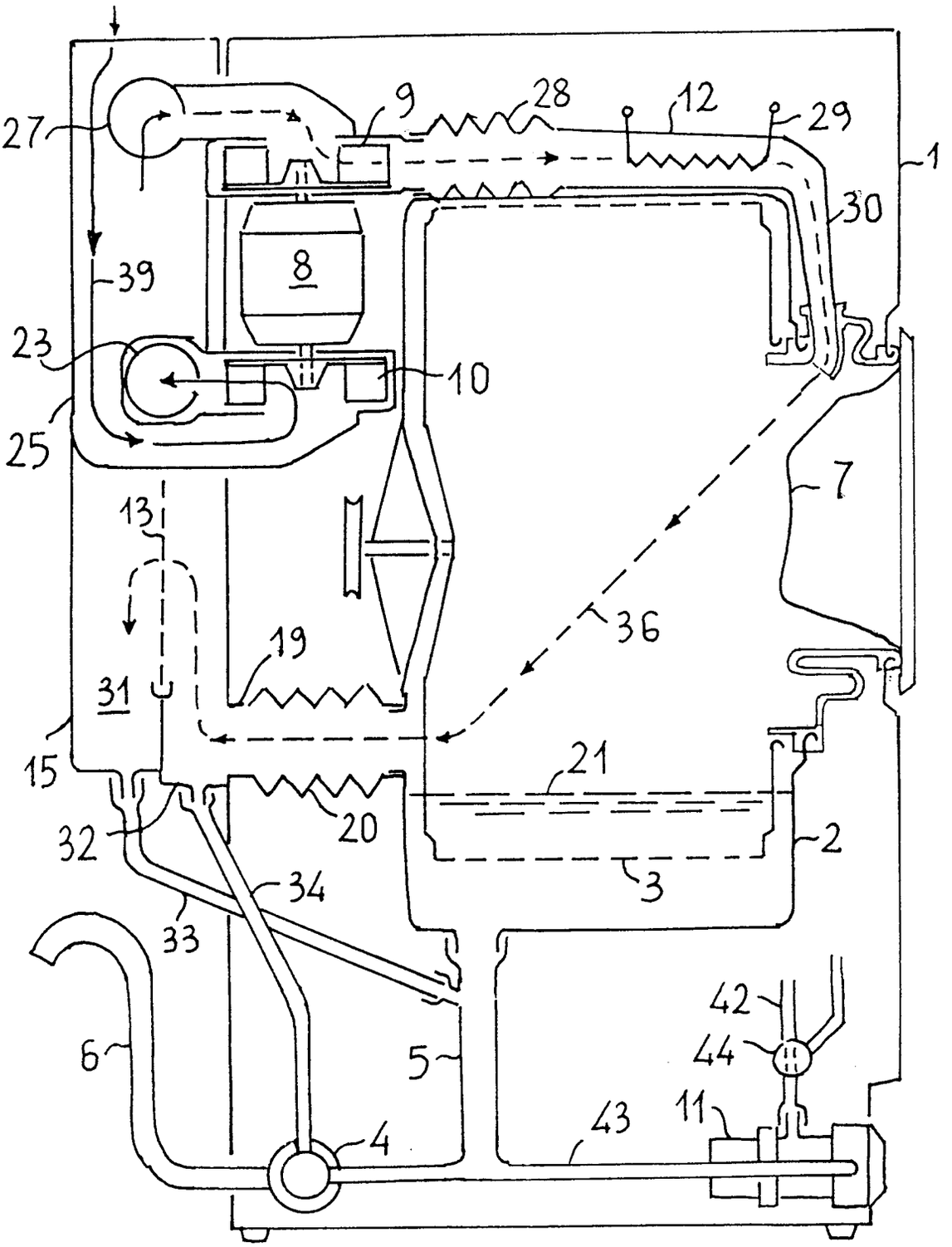
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FIG. 1

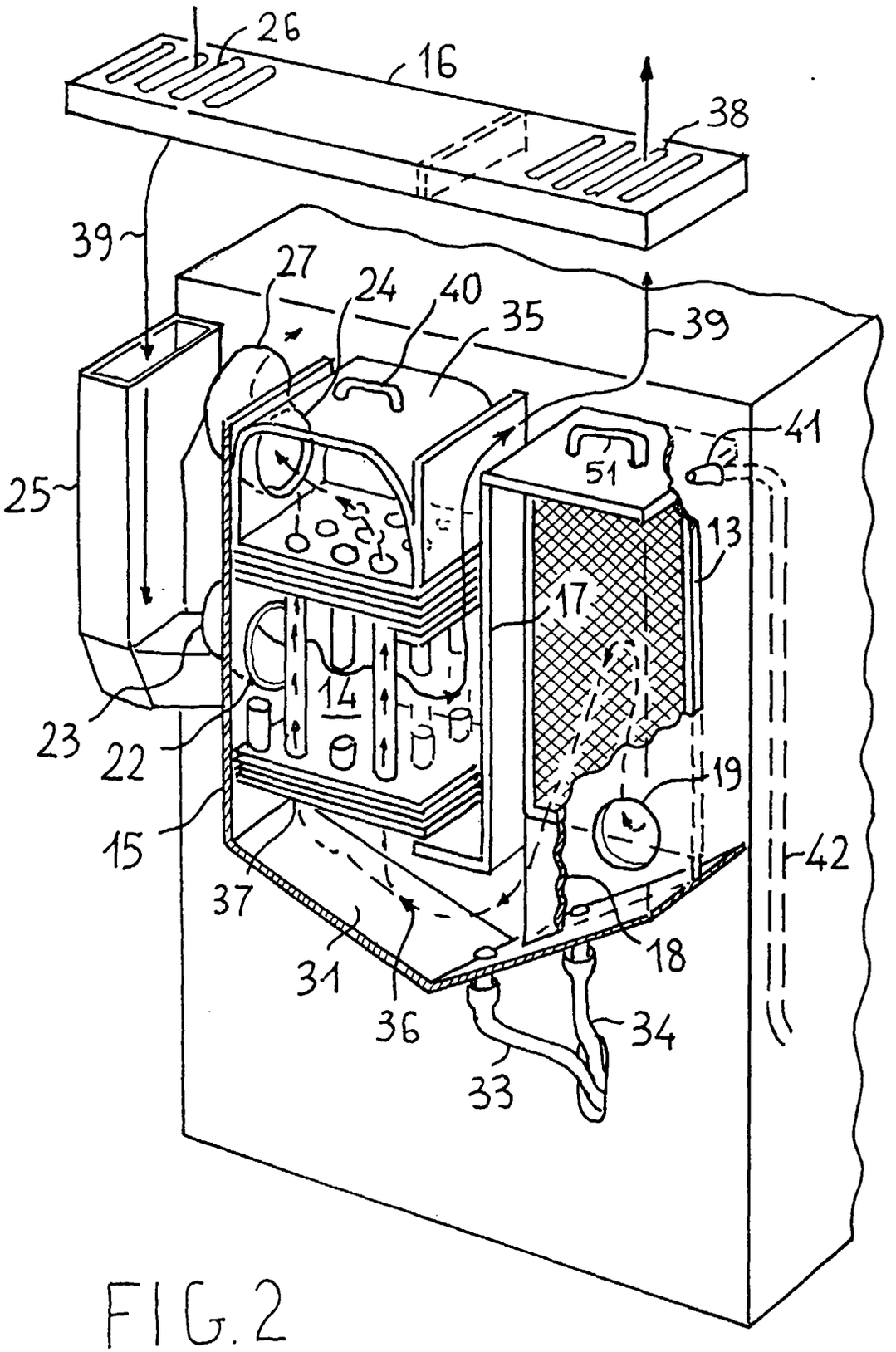
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FIG. 2