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(71) Applicant: **CANDY S.p.A.**
I-20052 Monza (Milano) (IT)

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

(74) Representative:
Falcetti, Carlo et al
c/o JACOBACCI & PERANI S.p.A.
Via Visconti di Modrone, 7
20122 Milano (IT)

(54) **Washing machine of domestic type with open drying circuit and associated accessory equipment for converting the drying circuit into a closed circuit with condensation of the water vapour by air**

(57) Laundry washer dryer of domestic type in which the drying circuit, comprising a suction unit (8), a chamber (11) in which the in-drawn air is heated and the washing and drying tub (2), is open to receive air for drying from the environment through a suction mouth (9), and to expel moist air through an outflow mouth (14). The drying circuit may optionally be fitted with a filter (22) for trapping fluff and connected to the outflow mouth; with rigid or flexible hoses for conveying the moist air out of the environment in which the machine is installed; or with auxiliary equipment comprising a removable filter (26), an air/air heat exchanger (27), a condensation collecting chamber (29) and, if required, a fan (28), to convert the open drying circuit into a closed circuit

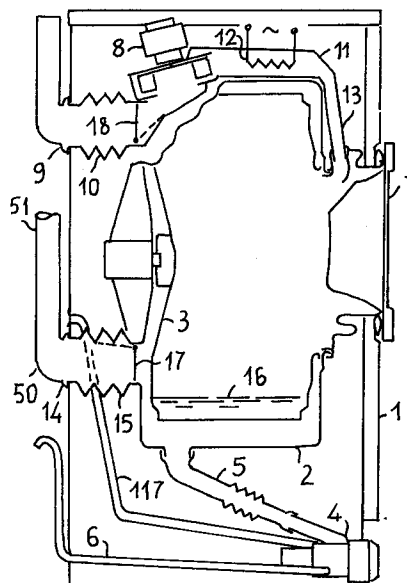


FIG. 1

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Description

The present invention relates to a washing machine of domestic type incorporating an open drying circuit and accessory equipment for converting the drying circuit into a closed circuit, with condensation of the water vapour by air.

The prior art includes washing machines of domestic type known as washer dryers, which not only wash the laundry but also dry it with a flow of heated air drawn in in a closed drying circuit which includes, in order, a washing tub and drum assembly, an air/water heat exchanger, a suction unit, and a heating unit consisting of electrical resistors.

The flow of air produced by the suction unit is heated by the electrical resistors and conveyed into the washing drum, where, as it passes through the wet laundry, evaporates the absorbed water. In the heat exchanger, which is usually of the spray type, the moist air is cooled down by a stream of cold water taken from the water main and discharged into the sump. This cooling causes the water vapour to condense and it is then collected in the washing tub and discharged together with the cooling water.

The dried air is then drawn in by the suction unit and recycled.

Besides a heavy consumption of electrical energy to heat the air in the drying circuit, there is therefore also a not insignificant consumption of cooling water, of the order of 40 - 50 litres per drying cycle, which is completely wasted.

Also in the prior art are dryers having the sole function of drying the laundry, which use the same concept of drying by means of a flow of hot air in a closed cycle: such machines have an air/air heat exchanger which, in order to cool the moist air and condense the water vapour, use air from the environment, which a suction unit circulates through the heat exchanger, in place of mains water.

These machines are fitted with a collecting tank for the condensed liquid, do not require connection to the water main or to the sump and do not consume water, but they do have the disadvantage of a large cost additional to that of a washing machine, and take up as much space as a washing machine.

These disadvantages become more serious as the need to save space becomes more pressing, to the point where in many cases there is a tendency to fit and instal the larger domestic electrical appliances outside the actual rooms of the dwelling, for example in conservatories, on balconies and sun roofs.

The present invention solves the disadvantages of both categories of washer dryer and dryer mentioned above by providing a versatile washer dryer that is economical and simple to manufacture, and equipped in its basic version with only an open-type drying circuit that can be converted, if circumstances so require, to a closed circuit, by using accessory equipment, the cost

of which does not necessarily impact on the basic washer dryer model but only if the accessory equipment is indispensable.

The accessory equipment can easily be installed as an option on the basic model, either in the final stage of production as a special version of the product or as an option brought in later by the user.

The accessory equipment, which is also the subject of the present invention, may comprise in its simplest form a filter for trapping fluff and lint and an air/air heat exchanger water vapour condenser.

In a more elaborate form the accessory equipment may also comprise an auxiliary fan unit for drawing a secondary flow of cooling and condensing air through the heat exchanger.

In one particular aspect of the present invention, rather than converting the drying circuit into a closed circuit, the accessory equipment acts only as a filter at the outlet of the drying circuit.

The features and advantages of the present invention will be made clearer in the following description of a preferred embodiment and variants thereof, which description is provided for non-restrictive illustrative purposes with reference to the accompanying drawings in which:

- Figure 1 shows schematically, in a composite section from front to rear on several planes, a preferred embodiment of a domestic washer dryer in accordance with the present invention,
- Figure 2 is a top view of the machine of Figure 1, with the top closing panel removed,
- Figure 3 is a rear view of the machine of Figures 1 and 2 equipped with an accessory device for filtering the expelled air, in a sectional view,
- Figure 4 is a front to rear section through the filtration device of Figure 3, and
- Figure 5 is a "transparent" perspective view of a preferred embodiment of the accessory equipment, combined with the machine of Figures 1 and 2 in order to convert the open drying circuit into a closed circuit.

Referring to Figures 1 and 2, a washer dryer according to the present invention comprises a structure 1 of standardized dimensions, for example, width 60 cm, depth 50 cm, height 80 cm, in which is housed, on sprung mountings, a washing tub 2 containing a rotating drum 3, drive members (not shown), a discharge filter/pump unit 4 whose inlet is connected to the bottom of the tub 2 by a flexible tube 5, while its outlet is connected to a discharge pipe 6.

The drum 3 is generally loaded with washing through a front door 7.

Devices for heating the washing water, taken from the water main under the control of programmed devices (all not shown and conventional in themselves) complete the structure of the machine.

For the operation of the machine as a dryer, the structure of the machine includes a fan unit 8 which, unlike ordinary washer dryers, sucks in air from the environment through a suction mouth 9 that opens on the rear wall of the machine and is connected to the fan unit 8 by a flexible hose 10.

The fan unit 8 conveys the in-drawn air into a heating chamber 11, in itself conventional, where the in-drawn air is heated by means of electrical resistors 12.

The hot air is conveyed through a pipe 13 and the loading mouth of the washing drum 3, into the drum itself. The hot air passes through the washing drum before leaving the washing tub through an outflow mouth 14 connected to the washing tub by a flexible tube 15 and open to the external environment through the rear wall of the machine.

The outflow mouth 14 is of course open at a higher level than the maximum level to which the tub 2 can be filled with washing water, this level being indicated by the numeral 16.

The delivery pipe 13 and the outflow mouth are conveniently arranged in diametrically opposite positions with respect to the washing tub, for a more efficient sweeping of the washing drum and of the laundry contained inside it and hence for a more efficient drying action.

In the embodiment shown in Figure 1, the fan unit 8 and the heating chamber 11 are mounted directly on the tub 2. However, it is obvious that they can also be attached to any suitable frame integral with the machine structure 1, in which case the flexible hose 10 can be replaced by a rigid pipe.

For reasons which will be seen later, the machine shown in Figs 1 and 2 is advantageously fitted with a pipe 117 for collecting the condensed water: it opens through the rear wall of the machine at a higher level than the maximum filling level and is connected to the discharge filter/pump unit 4.

The machine's programme selector is of course also designed to execute a drying cycle in the course of which the drum 3 is rotated at a predetermined speed, and the fan 8 and heating elements 12 are on.

With these simple additions, of relatively little cost, the machine is made able to operate also as a dryer.

If the machine is installed in an open and ventilated environment, the hot moist air emitted through the mouth 14 disperses freely into the atmosphere.

By contrast, for use in closed environments, in which there is a risk of saturation of the environment by the moisture which is generated (for a drying cycle on laundry with a high absorbent power it may be estimated that the water vapour produced amounts to 2 - 2.5 kg), it is sufficient to provide a rigid or flexible tube connected to the outflow mouth 14 to convey the outgoing air out of the environment, as is commonly done, for another function, in the case of air conditioning systems, through a window that is set slightly open or is fitted with an aperture, through a ventilation grille (legally

required in rooms containing fuel-burning apparatus) or through a ventilation stack.

To this end, as shown in Fig. 1, the outflow mouth 14 may conveniently be provided with an elbow joint 50 that can be orientated in different directions and is connected to a rigid or flexible tube 51 in order to convey the hot air up to the top level of the machine or to one side, in order to make it easier to connect the outflow mouth 14 to ventilation apertures without the need to move the machine out when installed against a wall, as is normally the case.

To take one particular case, if the machine is installed in a domestic kitchen having an extraction stack, the moist air can be removed by using the extraction hood without having to make a direct connection to the ventilation stack.

In order to ensure that, in the course of a normal washing cycle with hot water, hot air inside the machine is not lost to the outside by diffusion or convection through the suction mouth 9 and/or the outflow mouth 14, it may be appropriate to provide the outflow mouth and optionally also the suction mouth with a normally closed valve 17, 18 which is only opened during the drying cycle.

This valve, which during washing operations is not subject to any pressure difference, may consist of a butterfly valve whose normal position is closed and which is opened by the pressure difference produced when the fan 8 is turned on.

Alternatively, the valve may be controlled by a thermomechanical actuator of known type which is often used in this field or by any other functionally equivalent means.

A machine of the type described can, either towards the end of the manufacturing process or in the user's home, be fitted with different levels of optional equipment to increase its performance and range of possible uses.

From a single basic module it is therefore possible to build different models with different levels of performance.

Leaving aside the simpler options, such as rigid or flexible (or even mixed) tubing for connecting the outflow mouth to pipes or apertures communicating with the external environment, it is possible to fit the washer dryer shown in Figs 1 and 2 with a filter for trapping fluff carried by the moist air.

This version is shown in Figures 3 and 4 which show, in a partially sectioned rear view and in a front-to-rear transverse section, respectively, a portion of the washer dryer.

At the rear of the upper surface of the machine, a housing is formed for a diffusion chamber 19 connected at the bottom to and communicating with the outflow mouth 14 via a tube 20, or alternatively directly.

The diffusion chamber 20 is closed at the top by a removable grille 21 that functions as a frame for a gauze filter 22.

The grille 21 has relief ribs 23 in the upper plane of the machine to ensure that there are always communication slits between the inside and outside of the chamber, even if objects are placed on the grille which could obstruct the apertures of the grille.

The air passing out of the mouth 14, at a relatively high speed (20 m/s or more), diffuses into the diffusion chamber 19, shedding speed by at least an order of magnitude in the process, passes through the filter 22, on which it deposits the fluff, and passes out through the grille 21 having been cleaned.

Any condensed liquid that may form on the filter and on the grille under exceptional working conditions with a very cold and wet environment, is led back down from the diffusion chamber, which is conveniently funnel-shaped, into the washing circuit of the machine, either through the pipe 117 (Fig. 1) provided for this purpose, or through the pipe 20 and the outflow mouth 14, as shown in Fig. 3.

In the exceptional case that, for reasons of installation and safety, it is wished at all costs to avoid any accumulation of moisture in the environment and the consequent risk of condensation, the machine can easily be converted into a washer dryer with a closed drying circuit by attaching to the back of the machine an accessory unit comprising a fan, an air/air heat exchanger and a fluff filter.

This accessory is illustrated, along with a portion of the machine only, in the "transparent" perspective view shown in Fig. 5.

Referring to this figure, the accessory consists of a flat casing 24 having depth D of the order of 7 - 15 cm, width W approximately equal to the width of the washer dryer (60 cm is a standardized dimension) and extending in height above the maximum level to which the machine can be filled with liquid, up to approximately the top surface of the machine.

Removably housed in the casing, which is closed at the top by a removable cover 25, and with suitable internal ribs and membranes to hold them in position, are a cassette filter 26, a heat exchanger 27 and a fan unit 28.

The bottom of the casing 24 forms a condensation collecting chamber 29.

The wall of the casing 24 placed against the rear wall of the washer dryer 30 includes an aperture 31 connected (by a pipe fitting, elastic flange and the like) to the outflow mouth carrying the hot moist air from the machine.

The hot air enters a chamber formed between the filter 26 and the wall of the casing unit placed against the rear wall of the machine, passes through the filter 26 and is conveyed, its path defined by a membrane 32, to the condensation collecting chamber 29.

From here it rises up through the vertical tube bundle of the heat exchanger 27 into the manifold 33 of the heat exchanger.

The manifold 33 contains an outflow aperture 34 opposite the suction mouth of the machine's drying circuit.

cuit.

The wall of the casing 24 placed against the rear wall of the machine has of course a corresponding aperture.

5 The broken line with arrows 35 represents the path of the air through the casing, from the inlet mouth 31 to the outlet mouth 34.

10 In the heat exchanger 27, the hot moist air is cooled down to produce condensation which drips into the collecting chamber 29, from where it is extracted by a discharge mouth 36 connected to the condensation collecting pipe 117 (Fig. 1) of the washer dryer and conveyed into the washing tub (where it can advantageously be kept for a later washing operation, hereby helping to reduce the amount of water consumed for the washing operation and reducing its hardness) or be directly expelled by the action of the discharge pump 4 (Fig. 1).

15 The fan unit 28 has an inlet mouth connected to a suction pipe 37, the top of which is open and communicates with the environment through a grille 38 in the removable cover 25.

20 The in-drawn air flows through the heat exchanger 27 where it strikes the radiating fins of the latter, its direction of flow being transverse to the air of the drying circuit, is collected in a collecting chamber formed between the heat exchanger 27 and the membrane 32 and is expelled into the environment through a second grille 39 in the cover 25.

25 The solid line with arrows 40 represents the path of the cooling air through the casing 24.

30 The filter 26, having an upper cap 41 with handle 42, can be lifted up out of its housing to allow periodic easy cleaning.

35 Likewise the heat exchanger 27, integral with the manifold 33 and having a handle 43, can be lifted up out of its housing for periodical inspection and cleaning, if necessary.

40 It will be obvious that the casing can easily be fitted securely to the rear wall of the washer dryer as an optional accessory using screws, hanging hooks or equivalent means.

45 The fan unit 28 can be connected up electrically by a plug connector into a power socket on the rear wall of the machine, or even by a terminal board accessible from the back of the machine.

In this way the washer dryer of Figures 1 and 2 with open drying circuit can easily be converted into a washer dryer with a closed drying circuit.

50 No modification to the programming of the washing and drying cycles is necessary: the fan 28 can be turned on at the same time as the fan 8.

55 If the condensed water is recovered for subsequent use there is no need to use the discharge pump; on the other hand the pump may be used at the end or for short intervals in the course of the drying cycle even if the accessory unit is not present.

The foregoing description relates only to a pre-

ferred embodiment and it will be clear that many variations may be made.

For example, the fan unit 8 of the washer dryer shown in Figs 1 and 2, in this case preferably mounted on the structure/frame of the machine and not on the washing tub, can be provided with a second rotor having a suction mouth and delivery mouth that open through the rear wall of the machine.

In this case the accessory unit formed by the casing 24 shown in Fig. 5 will not require its own fan and can be fitted with a suction pipe (such as 37) which is connected to the suction mouth of the second rotor as well as with a delivery pipe which connects with the delivery mouth of the second rotor to convey the cooling air through the heat exchanger.

In this case the accessory unit comprises only static components (filter and heat exchanger) and does not need to be connected electrically to the washer dryer.

To operate the washer dryer without the accessory unit, a removable cap may be fitted over the suction mouth of the second rotor, or even, conveniently, a connecting tube running between the outlet mouth of the second rotor and the suction mouth of the first rotor so as to use the two rotors in series and thus achieve a higher throughput of air.

Furthermore, although the accessory equipment is preferably installed on the rear wall of the washer dryer (primarily so that it can be slotted into a space in a modular kitchen and so that the top panel of the machine can be used as a work surface), it is also possible to manufacture accessory equipment, for converting the machine drying circuit from open to closed, that fits over the top of the volume of the machine and is firmly attached to the top panel.

Claims

1. Laundry washer dryer of domestic type of the type in which air heated by heating elements is drawn through a washing/drying drum (3) housed in a washing tub (2) by a suction unit (8) with a first rotor, to evaporate the liquid absorbed by laundry present in said washing drum (3), the washer dryer being characterized in that it comprises:
 - a suction mouth (9) open to the external environment of said washer dryer and connected to the inlet of said suction unit (8) and
 - an outflow mouth (14) connected to said washing tub (2) and open to the external environment at a higher level than a predetermined maximum level to which said tub (2) can be filled with washing liquid.
2. Washer dryer according to Claim 1 in which said suction (9) and outflow (14) mouths open through a rear wall of said washer dryer.
3. Washer dryer according to Claim 1 or 2 comprising means (17, 18) for blocking the flow of air through at least one of said suction and outflow mouths, these being normally closed but opened for a drying condition of said washer dryer.
4. Washer dryer according to Claim 3 in which said blocking means consist of at least one normally closed butterfly valve which is opened by a pressure difference upstream and downstream of said valve produced by said suction unit.
5. Washer dryer according to Claim 1, 2, 3, 4 or 5 in which said outflow mouth (14) comprises an elbow joint (50) that can be orientated in different directions.
6. Washer dryer according to previous claims, comprising a flexible outflow hose (51) connected to said outflow mouth (14), on the outside of said washer dryer.
7. Washer dryer according to previous claims, comprising a casing (24) connected to the outlet of said outflow mouth (14) and housing a filter (22, 26).
8. Washer dryer according to one of Claims 1 to 6, comprising a casing (24) removably attached to said washer dryer and housing a removable filter (26), an air/air heat exchanger (27) and a fan unit (28), said casing (24) forming a first recycling channel from said outflow mouth (14) to said suction mouth (9), through said filter (26) and said heat exchanger (27), a condensation collecting chamber (29) in said first channel and a second channel for cooling air sucked in from the environment by means of said fan unit (28) and conveyed through said heat exchanger (27).
9. Washer dryer according to one of Claims 1 to 6 in which said suction unit (8) comprises a second rotor with suction mouth and delivery mouth that are both open to the exterior of said washer dryer.
10. Washer dryer according to Claim 9, comprising a casing (24) removably attached to said washer dryer and housing a removable filter (26) and an air/air heat exchanger (27), said casing forming a first recycling channel from said outflow mouth (14) to said suction mouth (9), through said filter (26) and said heat exchanger (27), a condensation collecting chamber (29) in said first recycling channel and a second channel for cooling air sucked in from the environment by means of said second rotor and conveyed through said heat exchanger.
11. Washer dryer according to Claim 8 or 10 in which said casing (24) is attached to the rear wall of said

washer dryer.

12. Accessory equipment for washer dryer according to previous claims, comprising a casing (24) housing a removable filter (26) and also housing an air/air heat exchanger (27), said casing (24) forming a first channel for a first flow of air from an inlet mouth (31) and an outlet mouth (34), through said filter (26) and said heat exchanger (27), a condensation collecting chamber (29) and a second channel for a second flow of air through said heat exchanger (27).
13. Accessory equipment for washer dryer as claimed in Claim 11, comprising a fan (28) housed in said casing (24), in series with said heat exchanger (27), in order to activate said second flow of air.

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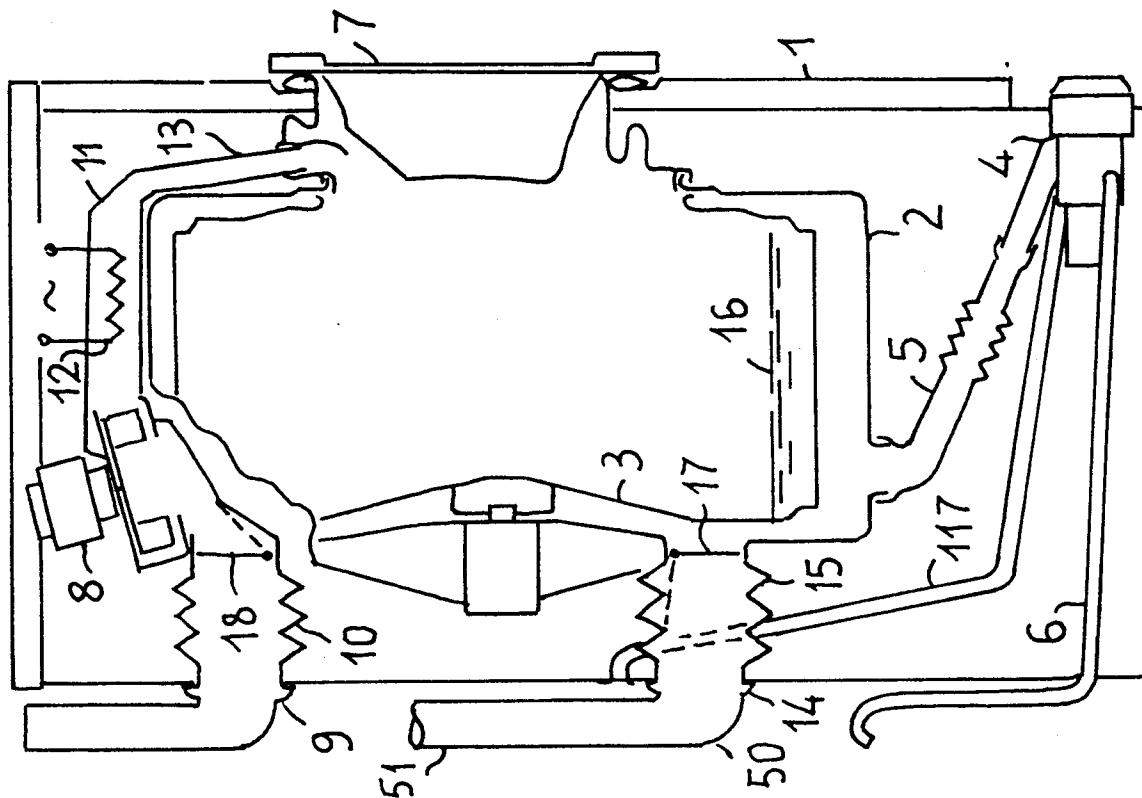


FIG. 1

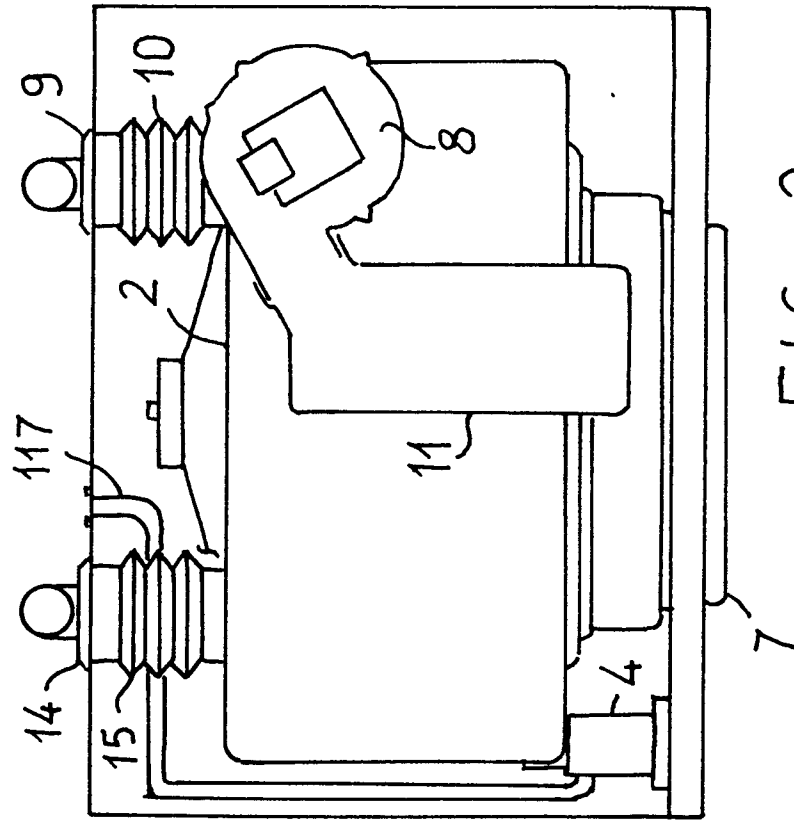


FIG. 2

