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(54) Laundry drier and method for drying laundry which uses such drier

(57) A laundry drier of domestic type comprises an air distributor placed at the bottom of the laundry chamber in order to dry laundry in a fluidized bed condition. The use of a rotating drum is avoided and energy saving is obtained.

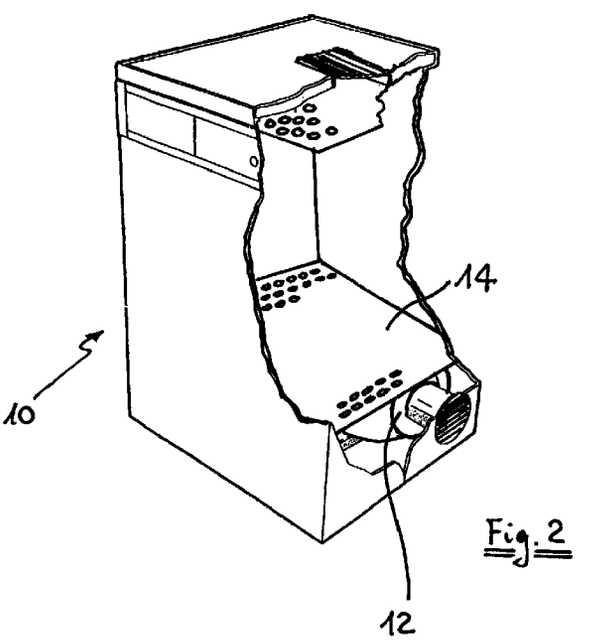

Fig. 2

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Description

[0001] The present invention relates to a laundry drier, particularly of the domestic type, comprising a chamber where laundry is contained, an outer casing housing said chamber, a blower to feed drying air through said chamber and conduits suitable to convey said drying air into and outside said chamber.

[0002] In the conventional laundry driers the chamber where laundry is placed in order to be dried is a rotating drum through which the air flow is mainly horizontal. The movement of the laundry is a tumbling motion caused by the rotation of the horizontal drum. Conventional laundry driers are quite complicate and expensive domestic appliances since they have to control both air flow and drum rotation. Moreover they are not actually efficient in term of energy-saving.

[0003] It would be desirable, and it is actually an object of the present invention, to provide a laundry drier which is capable of assuring an improved energy efficiency and, at the same time, a low cost due to a simpler construction.

[0004] This aim is reached according to the present invention in a laundry drier which comprises air distribution means placed substantially at the bottom of the chamber, the laundry being maintained in a substantially fluidized condition in said chamber by the drying air flowing through said air distribution means.

[0005] Another aim of the present invention is to provide a new method of laundry drying according to which an air flow entering through an air distributor agitates the load, suspending and moving it like a fluid.

[0006] This new and innovative technology permits to improve considerably the actual performances of the clothes dryers. The benefits are the following: energy savings, fabric care, time savings and cost savings. In view of energy saving advantages of the laundry drier according to the invention, it is more easy for appliances producers to cope with European Community guidelines relating to energy savings in domestic appliances, for instance in producing laundry driers in class A, without the need to provide the drier with a heat pump. The remarkable potential of the new drying method permits to reach class A, using a drying process different from the traditional method. High air flow and floating of the laundry expose, on average, more surface of clothes, increasing the rate of evaporation. There is thus the possibility to improve considerably the efficiency of the drying process and to reach an efficiency closer to the theoretical limit (0.7 kWh per kg of water). Furthermore, due to the high air speed, it is possible that some of the liquid water is removed mechanically in form of liquid droplets. That water doesn't need to be evaporated, and so the above mentioned theoretical limit could be even passed.

[0007] In other words, the drying time and energy consumption can be considerably reduced. Another improvement concerns the fabric care: the temperatures involved in the drying process are lower than in the traditional method and also the mechanical action on the fibers is reduced (reduced or avoided tumbling of the load).

[0008] For a better understanding, the invention will be further described by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a perspective, schematic view of a laundry drier according to the present invention,
- Figure 2 is a see-through view of the inner side of the laundry drier shown in Figure 1,
- Figure 3 is a schematic view of the air flow circuit of a laundry drier according to a second embodiment of the present invention,
- Figure 4 is a schematic, perspective view of a component of a laundry drier according to a third embodiment of the present invention, and
- Figure 5 is a schematic view of the laundry chamber of a laundry drier according to a fourth embodiment of the present invention.

[0009] The use of "fluidized bed" in a clothes dryer is a radically different method for drying. Basically the "fluidized bed" system consists of few components: a top-loading cabinet 10, a fan or blower 12, and a perforated plate 14 between the fan 12 and the load to be dried. The laundry drier according to the present invention does not need a heating element; of course, in order to shorten the drying time, a heating element may be included in the air flow path, upstream the bower 12. Using a velocity of the air comprised preferably between 0.5 and 20 m/s, and more preferably between 1 and 10 m/s, that is sufficient to counterbalance the gravitational force, it is possible to suspend and move the load like a fluid. In order to obtain that, it is necessary to have a volume available that is much bigger than the volume of the drum of a conventional dryer (typically around 100 liters). This is obtained by removing completely the drum, due to the fact that now the agitation or surface renewal of the load isn't obtained any more by the tumbling motion of the laundry due to rotation of the drum itself, but just by the air flow. The volume available becomes in this way around 200-300 liters.

[0010] The resulting construction is simply a box as the one shown in Figure 2, with the same external size of a conventional domestic appliance (in Europe typically cm. 60 x 60 x 85h), with the perforated plate 14 at the bottom, a blower 12 which blows the air through the perforated bottom 14 and the load and a connection funnel-shaped conduit between the blower 12 and the perforated plate 14. The air distributor, i.e. the perforated bottom plate 14, may have different configurations; it may be formed by concentric rings in the same plane, by concentric rings in the form of a cone, by parallel slots in a flat plate or by dished and perforated plates concave both upward or downward. In order to provide a good distribution of the fluidized bed made by

single items of clothes, it is necessary to restrict the air flow so that a pressure drop across the restriction is created. The pressure drop across the air distributor 14 should be at least 30% of the bed pressure drop. The embodiment shown in Figure 2 applies to a dryer conceptually equivalent to a so called "air vented dryer".

[0011] Figure 3 shows another embodiment which can be compared to the so called "condenser dryer". In this case an heating element 16 and an heat exchanger 18 are added to the components disclosed with reference to the above first embodiment, and the air flow is closed in an air channel 19. Another blower 20 should be added to improve the cooling of the process air. The functioning is similar to the one of a conventional condenser dryer, but due to the increased air flow, the energy consumption is significantly reduced. The heater 16 and the condenser 18 could be conveniently substituted by a condenser and an evaporator of a heat pump, to get a further reduction of the energy consumption.

[0012] Figure 4 shows another embodiment which relates to a different type of air distributor which is derived from the mechanism of the dishwasher. In this case the air is driven in the laundry chamber 10 through a rotating arm 22, similar to the ones used in the dishwashers, a part from its size, in order to enhance the even distribution of the air through the load. The rotating arm 22 is provided with a plurality of air nozzles 23. The concentration of the air flow in "stronger" streams does improve the movement of the laundry.

[0013] All the above embodiments shown in Figures 2-4 relate to a laundry drier in which the horizontal cross section of the cabinet 10 corresponds (if the insulation thickness of the appliance is disregarded) to the cross section of the chamber in which the laundry is placed. If an increase of laundry movement in the fluidized bed is desired, mainly in order to decrease the drying time, the embodiment shown schematically in Figure 5 may be adopted, in which the chamber 24 for the laundry has a circular cross section. In this embodiment auxiliary air conduits 26 link the plenum chamber P downstream the blower 12 and upstream the air distributor 14 with lateral cylindrical wall 24a of the chamber 24. The auxiliary conduits 26 are placed in the interspace between the side wall 24a of the chamber 24 and the side walls of the cabinet or casing 10. The nozzles 26a of the conduits 26 adjacent the wall 24a are substantially tangential to such wall, in order to cause a swirling action on the fluidized laundry. In Figure 5, for sake of simplicity, only two conduits 26 are shown; of course the number of such conduits has to be chosen depending on the desired degree of swirling action.

[0014] In all the above embodiments a pulsing air flow may be chosen; the pulsing flow may avoid problems of clogging of the fluidized bed. The frequency of air pulse and the duration of each pulse may vary in a wide range, for instance drying air flow pulses of 5-20 seconds spaced by intervals of 5 to 10 seconds.

[0015] The laundry drier according to the present invention may comprise a humidity sensor downstream the fluidized bed in order to end the drying cycle when the degree of humidity of air leaving laundry has reached a predetermined level. The degree of humidity and/or the pressure drop across the fluidized bed may be also used for adjusting, through a control process unit of the drier, the rotational speed of the motor of blower 12 and hence the air flow rate through the fluidized bed.

Claims

1. Laundry drier, particularly of the domestic type, comprising a chamber (10, 24) where the clothes are contained, an outer casing (10) housing said chamber, a blower (12) to feed drying air to said chamber, and conduits suitable to convey said drying air into and outside said chamber, characterized in that it further comprises air distribution means (14, 22) placed substantially at the bottom of said chamber (10, 24), laundry being maintained in a substantially fluidized condition in the chamber by the drying air flowing through said air distribution means.

2. Laundry drier according to claim 1, characterized in that the horizontal cross section of the chamber (10) corresponds substantially to the horizontal cross section of the outer casing (10).

3. Laundry drier according to claim 1 or 2, characterized in that said conduits comprise cooling means (18, 20) for condensing humidity downstream the chamber (10, 24) and means (19) for recirculating drying air.

4. Laundry drier according to claim 1, characterized in that said chamber (24) has a substantially circular horizontal cross section and is provided with auxiliary air distribution means (26, 26a) flowing into a side wall (24a) of the chamber (24).

5. Laundry drier according to claim 4, characterized in that said auxiliary air distribution means (26) comprise nozzles (26a) arranged in a substantially tangential arrangement on the circular wall (24a) of the chamber (24).

6. Laundry drier according to any of the preceding claims, characterized in that air distribution means comprise a perforated plate (14) at the bottom of the chamber (10, 24).

7. Laundry drier according to any of claims 1-5, characterized in that air distribution means comprise a horizontal arm (22) rotating around a substantially vertical axis and having a plurality of air nozzles (23) for improving the fluidization of laundry.

8. Laundry drier according to any of the preceding claims, characterized in that the air speed in the chamber (10, 24) is comprised between 0,5 and 20 m/s, preferably between 1 and 10 m/s.

9. Method for drying clothes, particularly in a laundry drier of domestic type, which comprises blowing drying air through clothes, characterized in that said clothes are maintained in a substantially fluidized condition by means of the drying air flow.

10. Method according to claim 10, characterized in that the drying air flow is pulsating.

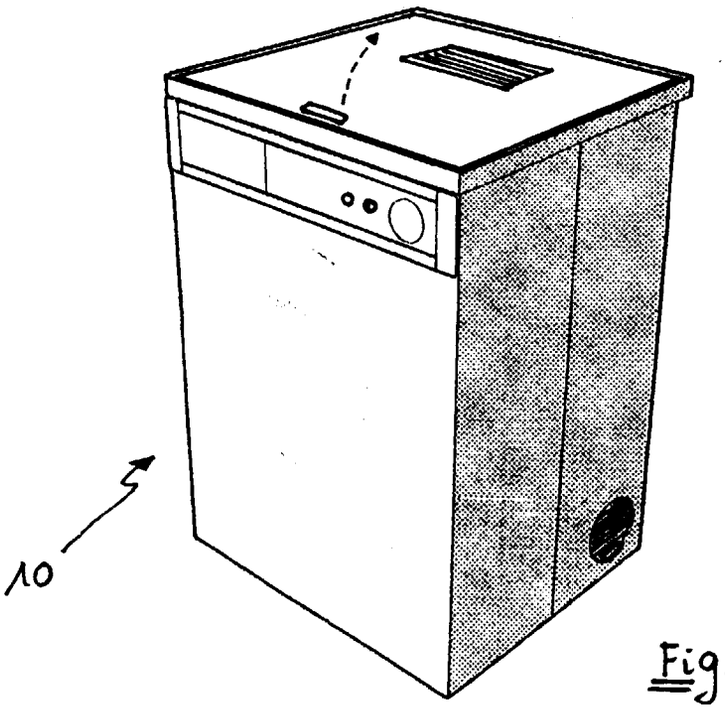

Fig. 1

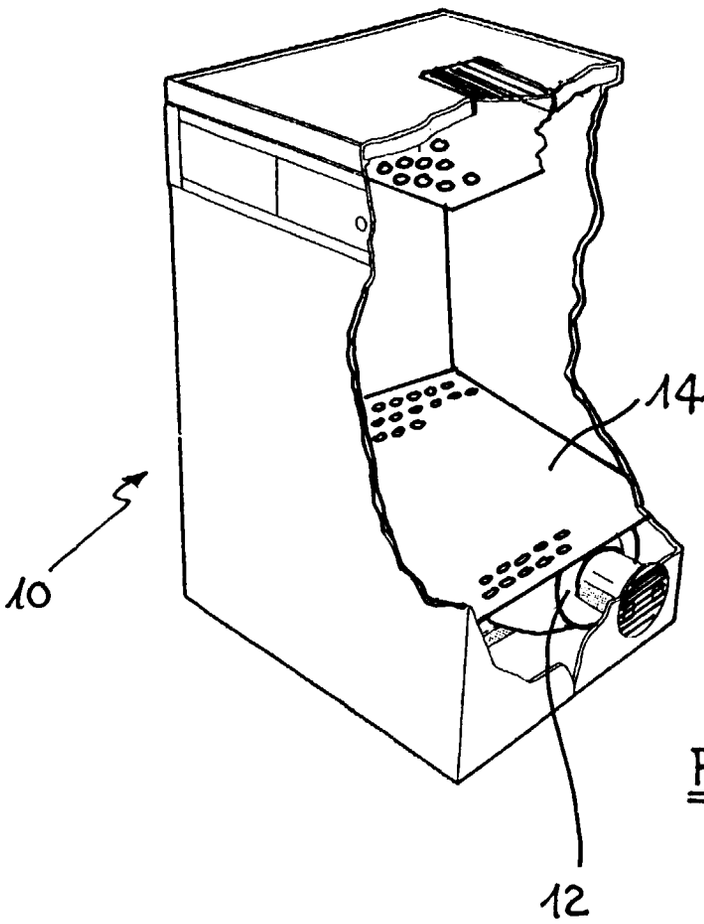

Fig. 2

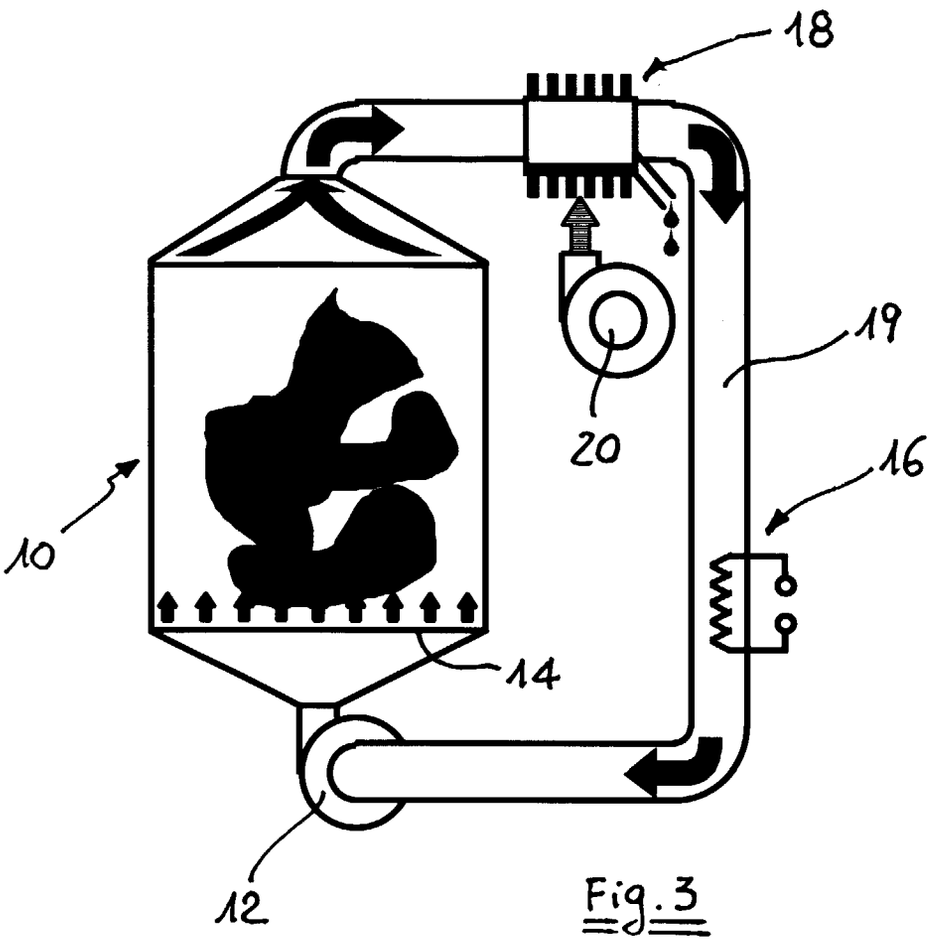

Fig. 3

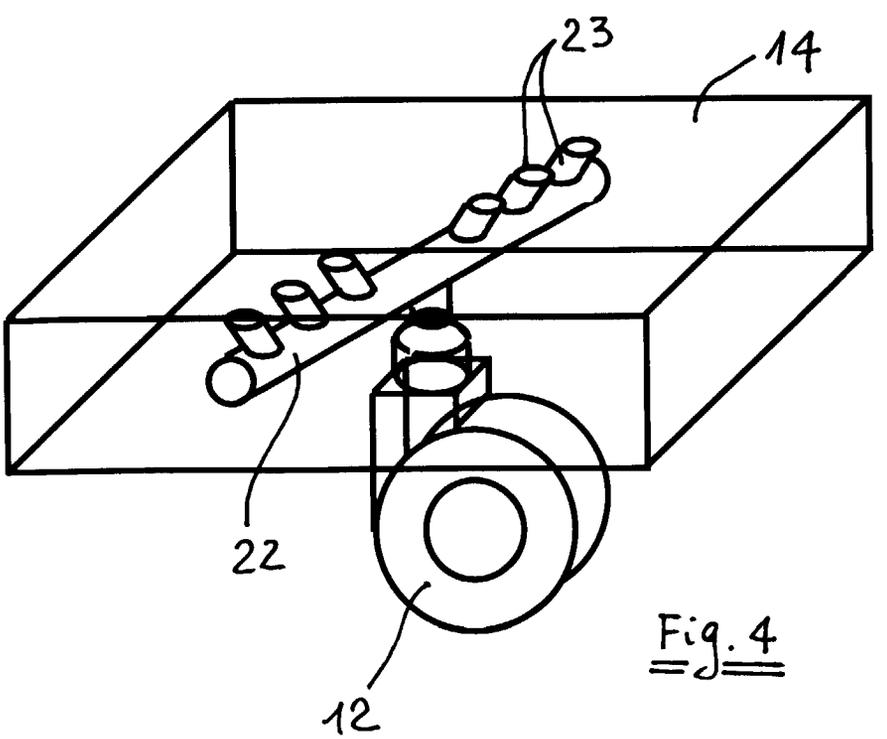

Fig. 4

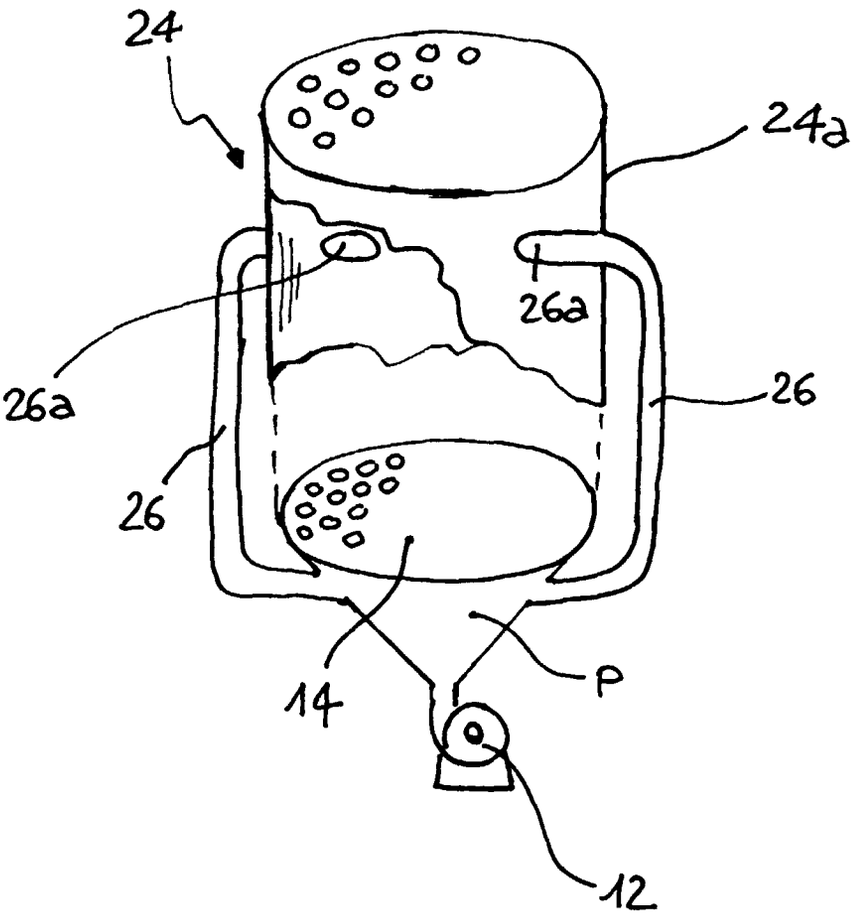

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 98 10 1607

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 3 668 784 A (TEAGUE WALTER DORWIN JR ET AL) 13 June 1972 * column 1, line 63 - column 3, line 27; figures 1,2 *	1,2,8,9	D06F58/10
A		4,6	
X	PATENT ABSTRACTS OF JAPAN vol. 015, no. 141 (C-0822), 10 April 1991 -& JP 03 023896 A (MASUKI TAKASU), 31 January 1991, * abstract; figure 1 *	1,8,9	
X	US 3 303 577 A (LAING NICKOLAUS) 14 February 1967 * column 1, line 72 - column 3, line 3; figure 1 *	1,6,8,9	
A	EP 0 556 907 A (DURAND GEORGES) 25 August 1993 * column 5, line 12 - column 7, line 54; figure 2 *	1,3	
A	FR 2 279 878 A (VENDOME CIE) 20 February 1976 * claim 1 *	1,9,10	TECHNICAL FIELDS SEARCHED (Int.Cl.6) D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 June 1998	Norman, P

CATEGORY OF CITED DOCUMENTS

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