(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
1 March 2007 (01.03.2007)

PCT

(10) International Publication Number
WO 2007/023510 A1

(51) International Patent Classification:
D06F 58/24 (2006.01)

(21) International Application Number:
PCT/IT2005/000499

(22) International Filing Date: 25 August 2005 (25.08.2005)

(25) Filing Language: Italian

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **RENZACCI S.P.A. INDUSTRIA LAVATRICI** [IT/IT]; Via R. Morandi, 13, I-06012 Città di Castello (IT).

(71) Applicant and
(72) Inventor: **RENZACCI, Gabrio** [IT/IT]; Località S. Giovanni, 2, I-06012 Città di Castello (IT).

(74) Agents: **BARDINI, Marco, Luigi** et al.; Società Italiana Brevetti S.p.A., Corso dei Tintori, 25, I-50122 Firenze (IT).

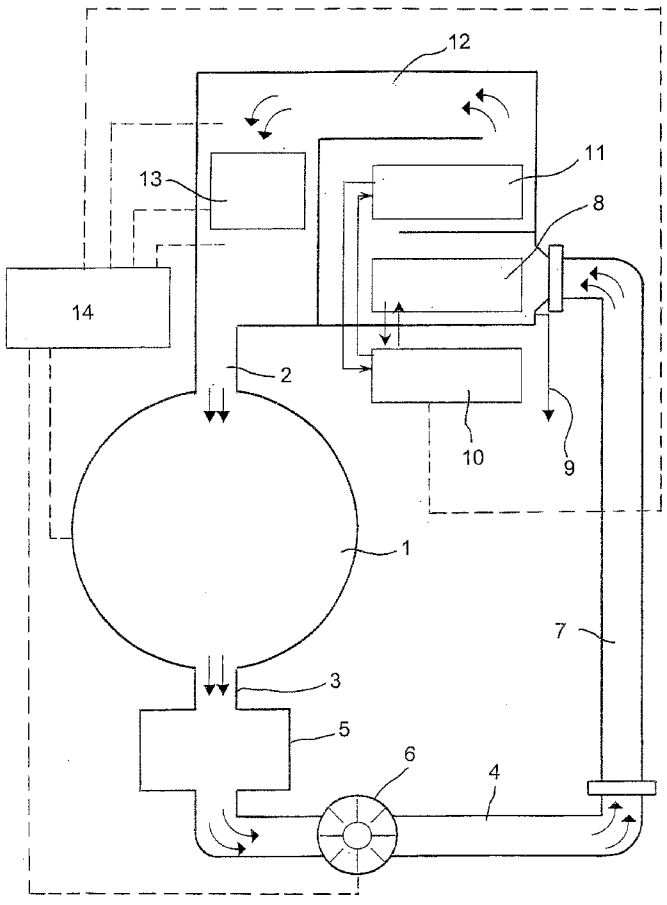
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: LAUNDRY DRYING MACHINE



(57) **Abstract:** Laundry drying machine comprising a revolving perforated drum (1), in which textile articles that have been washed in a water washing machine are placed, means (13) for heating a flow of air for drying said articles and means (6) for circulating said heated air through said revolving drum (1). The machine also includes a circuit (7) for recirculating the damp air coming from the revolving drum (1) and a unit (8) for condensing the water vapor contained in the recirculated air flow. The condensation unit communicates with a refrigeration unit (10) for removing the condensation heat, and heat exchange means (11) are also provided to transfer the heat released by the refrigeration unit (10) to the dried air flow coming from the condensation unit (8).

WO 2007/023510 A1

TITLE

LAUNDRY DRYING MACHINE

DESCRIPTION

Scope of the invention

The present invention relates to the domestic and industrial laundry machinery sector and, more precisely, refers to a machine for drying textile articles, e.g. clothing, household linen, fabrics, and the like, after said articles have been in water washing machine.

Description of the state of the art

A conventional drying machine consists of a body containing a perforated drum in which the batch of washed textile articles to be dried is placed through a door. The drum is rotated by a motor by means of a transmission system. A forced circulation of hot air through the batch is produced by a fan and an air heating system, which may consist of a battery of electric heating elements, a steam heating battery or a gas burner. A filter is provided on the air circuit to protect the fan from the fibers generated by the batch and to prevent them from leaving the machine through the pipe for discharging the air entraining the water vapor extracted from the batch and also the combustion fumes in the case of a gas heating system. In conventional drying machines, there is also a system for controlling the operating parameters, e.g. temperature, drying time, degree of residual humidity and, sometimes, the rotation speed of the drum.

The operating principle behind a conventional drying machine involves circulating hot air through the batch while keeping said batch in motion. As it moves through the batch, the hot air makes its water content evaporate. The forced air circulation extracts the water vapor

released by the batch and discharges it outside the machine. The degree of residual humidity in the batch is consequently progressively reduced until the batch is perfectly dry. Thus, in conventional drying machines, drying is obtained by passing through the clothes air drawn continuously from the outside environment heated and then discharged - together with the water vapor extracted from the clothes - into the outside environment by using expensive and cumbersome piping systems, which in some cases require specific authorization from local authorities and/or building managements, while in other cases they may require building permission.

Object and summary of the invention

The object of the present invention is to provide a laundry drying machine that does not need to discharge the air used in the drying process outside the machine, so there is no need for any costly air extractor systems for its operation.

This object is achieved by the laundry drying machine according to the present invention, comprising a perforated revolving drum for containing textile articles that have been washed in a water washing machine and equipped with means for heating a flow of air and means for circulating the heated air through the revolving drum. The machine also comprises a circuit for recirculating the damp air leaving the revolving drum and a unit for condensing the water contained in the recirculated airflow. The condenser unit communicates with a refrigerator unit for removing the condensation heat and heat exchange means are also provided to transfer the heat released by the refrigerator unit to the flow of dried air coming from the condenser unit.

So, in the drying machine according to the invention, the air and water vapor leaving the drum are no longer discharged outside the machine, but are returned to the drum inlet via a recirculating pipe. The air is forced to pass through a finned battery cooled by a refrigerator unit. As it does so, almost all of the water vapor it contains is condensed and the condensation water is discharged through a pipe. The dried air passes through a second finned battery serving as a heat pump, in that it is heated by the excess heat produced by the refrigerator unit. The resulting preheating of the dried air enables a significant recovery of energy that would otherwise be lost. This preheated air then passes through a further heating unit, e.g. an electric or steam heating system, to bring it up to the working temperature required for the drying cycle before it is delivered to the drum.

The characteristics and advantages of the laundry drying machine according to the present invention will emerge more clearly from the following description of one of its embodiments, given simply as a non-restrictive example with reference to the attached drawing, wherein figure 1 shows the flow chart for the laundry drying process of the machine according to the invention.

Detailed description of the invention

With reference to figure 1, the numeral 1 indicates a revolving perforated drum, in which a batch of textile articles to be dried is placed, said textile articles having been washed in a water washing machine. The revolving drum 1, which is connected to a motor (not shown), has a drying air inlet 2 and drying air outlet 3 connected to an air discharge pipe 4 on which an air filter 5 for removing any fibers entrained by the air flow

and a fan 6 are installed in series. The damp air is conveyed by a recirculation pipe 7, in communication with the air discharge pipe 4, to an air condensation unit 8, where the water vapor condenses and the resulting water is either recovered or disposed off through a drain 9. The condensation unit 8 is connected to a refrigerator unit 10, which absorbs the condensation heat and in turn releases heat that is used to preheat the air by means of a heat exchanger 11 consisting, for instance, of a finned surface of the refrigerator unit 10 over which the air flows after leaving the condensation unit 8.

The preheated air is fed to a heating unit 13 through a heating pipe 12 so as to bring it up to the working temperature required for the drying cycle. The heating unit may preferably be of the electric or steam heating type. The air heated in this way is finally delivered to the revolving drum 1 through the air inlet 2.

The working parameters of the various parts of the machine are automatically controlled by means of a programmable control unit 14. In particular, the unit 14 can control the rotation speed of the revolving drum 1, the power of the fan 6, the inlet and outlet temperatures of the heating unit 13 and the working parameters of the refrigeration unit 10.

The continuous recovery and recycling of the flow of air not only increases the machine drying efficiency, but also drastically reduces its energy consumption, entirely to the advantage of the user's productivity. The total air recycle and the most favourable use of the refrigeration unit 10 enable a reduction in the duration of the drying cycle, thus increasing the productivity and reducing the

operating cost. It should also be noted that, if a water-cooled instead of an air-cooled refrigerator unit is used, the resulting hot water (which reaches a temperature of approximately 40°C) can be used outside the drying machine, e.g. as hot water for a washing machine installed in the same room.

A multiple filtration system, for example two filters, is preferably used, which enables the fibers and dust removed from the batch to be retained and prevents said impurities from clogging the piping, and the condensation unit in particular. Thus, the efficiency of the machine is ensured by the maintenance of the filters only, while any more demanding maintenance inside the piping can be avoided.

The drying machine with a total air flow recovery and a refrigeration unit for condensing the water vapor extracted from the batch, according to the present invention, offers several advantages over the conventional drying systems currently available on the industrial and domestic markets.

In particular, there is a reduction in the installation and equipment costs with the drying machine according to the present invention, because its closed-circuit drying system does away with the need for any masonry work for its installation, or for the costly waste air extractor and/or suction systems that are not only a problem of costs, but also make it more difficult to find rooms suitable for carrying out the drying operation.

Moreover, the drying machine according to the invention requires no permission from the building management and/or owner, so it can be installed in rooms where any waste discharge to the outside is not allowed or

is subject to the installation of costly fumes and gas extraction systems).

The drying machine according to the present invention can also be used by users who are not authorized to install gas dryers, or who would be obliged to considerably increase the required installed power if they wished to install dryers with an electric heating system.

Thanks to the preheating of the air through the finned surface 11, which uses the heat produced by the refrigeration unit 10, there is a considerable reduction in the installed electrical energy requirement and energy consumption. The reduction in the installed power requirement not only results in a saving of the fixed costs of the energy bill, but also in that it is easier to find suitable rooms in areas where limits are imposed on the maximum power available for non-industrial activities. It should also be noted that, while the machine is operating, it is also heating water at the same time, since it raises the water temperature in the cooling circuit the refrigeration unit, thus making this water suitable for storing in a tank and for another operating use without the need for any further energy consumption. For instance, the water used for a drying cycle in the drying machine can be used for the pre-washing and washing cycles in a washing machine situated in the same room, thus achieving a significant energy saving in the overall production cycle.

The drying machine according to the invention has the same overall dimensions as a conventional drying machine, thus maintaining the same productivity per square meter, which is a factor of considerable importance for

users with a limited amount of space available.

The reduction in the investment and operating costs combined with a reduction in the duration of the drying cycle, enables users to achieve a considerable economic benefit.

The drying machine according to the present invention enables the replacement of the traditional systems using gas in places that are generally accessible to the public, and consequently potentially hazardous, with the result of eliminating any emissions of potentially polluting fumes and gas into the outside air and, at the same time, a lower environmental impact thanks to the markedly reduced energy consumption.

Finally, it is worth noting that the opportunity to do away with drying systems using gas is particularly advantageous where said systems coexist with dry cleaning systems that use tetrachloroethylene, entirely to the benefit of the operators' health and the safeguarding of the environment. In fact, any tetrachloroethylene vapors (even in very low concentrations) accidentally coming into contact with the high temperatures of the gas dryer's burner flame can generate hydrochloric acid in gaseous form, and expose the operators to a very serious risk.

Variants and/or modifications may be made to the laundry drying machine according to the present invention without departing from the scope of the invention.

CLAIMS

1. Laundry drying machine comprising of a revolving perforated drum (1), in which textile articles that have been washed in a water washing machine are placed, means (13) for heating a flow of drying air and means (6) for circulating said heated air through said revolving drum (1), characterized in that it also comprises a circuit (7) for recirculating the damp air coming from said revolving drum (1) and a unit (8) for condensing the water vapor contained in said recirculated air flow, said condensation unit communicating with a refrigeration unit (10) for removing the condensation heat, heat exchange means being further provided (11) for transferring the heat released by said refrigeration unit (10) to the flow of dried air coming from said condensation unit (8).

2. Drying machine according to claim 1, wherein said refrigeration unit (10) comprises a heated finned surface over which the air coming from said water vapor condensation unit flows.

3. Drying machine according to claims 1 or 2, wherein said drying air heating means (13) and said air-preheating heat exchange means (11) are installed in an air heating pipe provided downstream of the recirculation circuit (7) and the condensation unit (8).

4. Drying machine according to any of the previous claims, wherein said heating means (13) are of the electrically heated type.

5. Drying machine according to any of the claims from 1 to 3, wherein said heating means (13) are of the steam heated type.

6. Drying machine according to any of the previous claims, further comprising a programmable control unit for

adjusting the drying cycle working parameters.

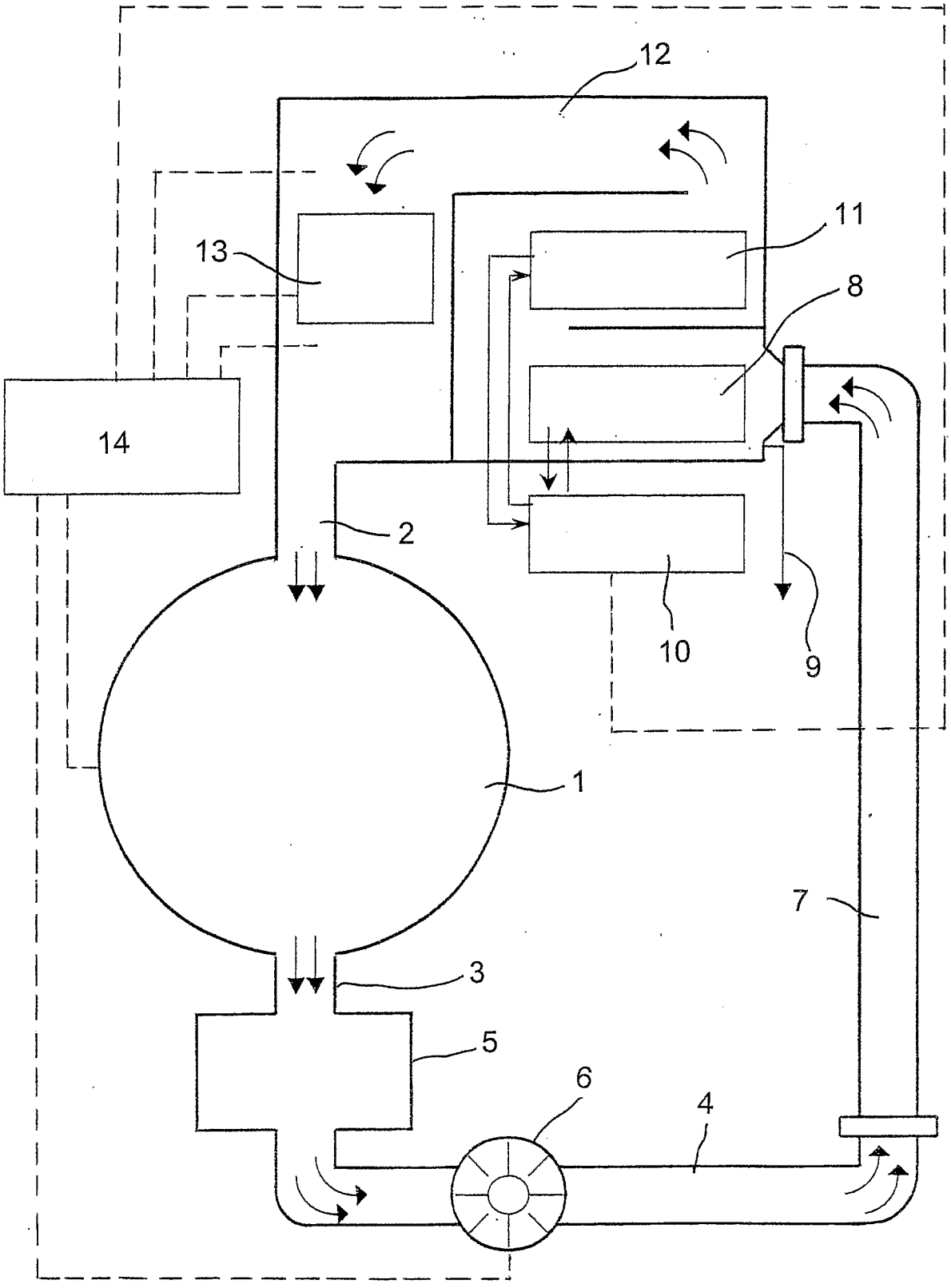


Fig. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2005/000499

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06F58/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 1 291 597 A (ESSWEIN S.A) 12 March 2003 (2003-03-12) column 4, paragraph 38 - column 5, paragraph 50 column 8, paragraph 102 - column 10, paragraph 124; claim 1; figure 4	1,3,4,6 2,5
X Y	EP 1 550 829 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD) 6 July 2005 (2005-07-06) column 12, paragraph 56 - column 14, paragraph 66; claim 4; figure 6	1 2
X	WO 00/58545 A (MAREUIL, GINO) 5 October 2000 (2000-10-05) page 2, line 40 - page 4, line 39; figure 1	1

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 April 2006	10/05/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lodato, A

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2005/000499

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 44 22 191 A1 (MIELE & CIE GMBH & CO, 33332 GUETERSLOH, DE) 19 January 1995 (1995-01-19) column 2, line 33 - column 3, line 24; claim 1; figure 1	1
Y	US 4 549 362 A (HARIED ET AL) 29 October 1985 (1985-10-29) column 4, line 16 - line 17; figure 1	5
A	DE 201 01 641 U1 (AKG-THERMOTECHNIK GMBH & CO. KG) 6 June 2002 (2002-06-06) the whole document	1-6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2005/000499

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1291597 A	12-03-2003	FR 2829231 A1	07-03-2003
EP 1550829 A	06-07-2005	WO 2004029516 A1	08-04-2004
WO 0058545 A	05-10-2000	AU 3662200 A	16-10-2000
		EP 1173638 A1	23-01-2002
		FR 2791709 A1	06-10-2000
DE 4422191 A1	19-01-1995	NONE	
US 4549362 A	29-10-1985	NONE	
DE 20101641 U1	06-06-2002	NONE	