(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 640 394 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.04.2020 Bulletin 2020/17

(51) Int Cl.:
D06F 58/28 *(2006.01)*

(21) Application number: **18425079.3**

(22) Date of filing: **16.10.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Bonferraro S.p.A.**
37060 Bonferraro (VR) (IT)

(72) Inventors:
- **Olivieri, Andrea Mario**
  37054 Nogara VR (IT)
- **Bissoli, Attilio**
  37057 Raldon di San Giovanni Lupatoto VR (IT)
- **Tosi, Mauro**
  37051 Bovolone VR (IT)

(74) Representative: **Concone, Emanuele et al**
Società Italiana Brevetti S.p.A.
Via Carducci 8
20123 Milano (IT)

(54) **METHOD FOR DETECTING RESIDUAL MOISTURE IN LINEN DURING A DRYING CYCLE AND MACHINE THAT CARRIES OUT SAID METHOD**

(57) A method for detecting residual moisture in linen (3) during a drying cycle, performed by a machine comprising a rotating drum (1) driven by an electric motor (5) connected to a general control unit (4) of the machine, includes the steps of: a) making an initial reading (LI) of the mass of the wet linen (3) by measuring the current absorbed by the electric motor (5); b) making multiple further readings in the same way (L2, L3, L4, L5,...) during the drying cycle; c) transmitting the data of these readings to the general control unit (4); d) extrapolating the residual moisture content of the linen (3) using an algorithm programmed in the general control unit (4) which compares the readings of the mass of the wet linen (3) with a time-mass diagram stored in the general control unit (4).

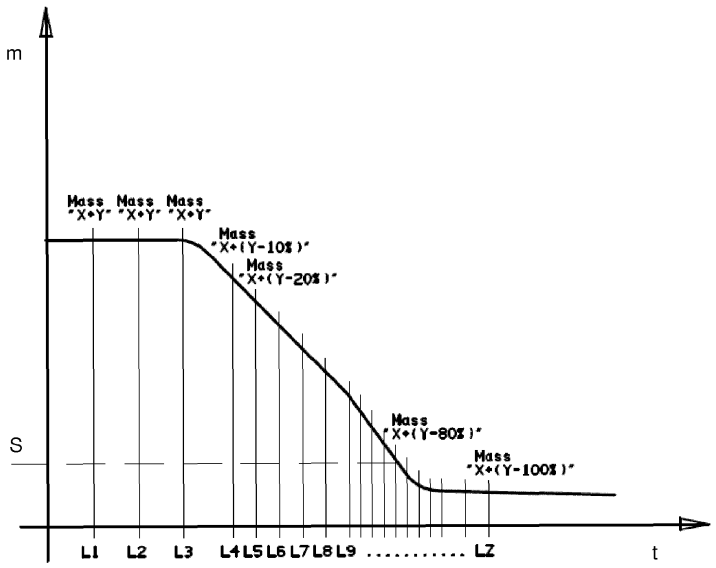

Fig.2

EP 3 640 394 A1

Description

[0001] This invention concerns tumble dryers and washing machines provided with a drying circuit, and in particular a method for detecting the residual moisture in linen during a drying cycle and a machine that carries out said method (where "machine" is understood to refer to both tumble dryers and washer-dryers).

[0002] It is known that, at the end of the washing cycle, the wet clothes can be subjected to a drying cycle by transferring them to a dryer or by starting this cycle in the same washing machine, if it is also able to perform the function of dryer being equipped with a drying circuit. Since the duration of the drying cycle cannot be predetermined as it depends on several parameters such as, for example, the degree of drying set by the user and/or the initial moisture level (in turn dependent, for example, on the type of linen and the spin drying phase), the degree of residual moisture in the clothes must be detected in order to determine when the drying cycle can be completed.

[0003] Current machines use several methods to do this, each of which has its drawbacks.

[0004] A first method is to use the electric current flowing through a capacitive or conductive circuit. In the capacitive type, the entire machine system of drum+tank+linen is considered as a large capacitor where the principle of charging and discharging is exploited. The linen is the dielectric of the system and based on its residual moisture the charge and discharge times of the condenser change. On the basis of these times it is possible to determine the level of residual moisture of the clothes.

[0005] Similarly, with the conductive type, the linen is a resistance and, depending on its residual moisture, the electrical current passing through it changes. On the basis of the current value, it is possible to determine the level of residual moisture of the clothes.

[0006] Both systems, conductive and capacitive, use plates, discs, sliding contacts or the like, to detect the passage of current or to create the plates of the capacitor and detect the time of charge/discharge. All these elements must be connected to dedicated electronic control circuits and must be provided with adequate protections to ensure user safety (insulated circuits).

[0007] Capacitive and conductive methods guarantee a good reliability in the detection of residual moisture, however they have a high cost in terms of components, assembly labour and homologation.

[0008] A second method consists in measuring the air moisture in the drum by means of moisture sensors that can be of various types such as, for example, hygroscopic polymers, plastic films applied to metal sheets, etc. In any case, the operation of the sensors consists in providing an output voltage or current variation, so that based on this variation it is possible to detect the moisture of the air.

[0009] These sensors and their control circuits are less expensive than the components used in the first method described above, this method, however, does not directly measure the residual moisture of the clothes but the moisture of the air in the drum and is therefore less accurate since it is also affected by the moisture of the environment. Moreover, working in a closed system with high moisture, the sensors easily reach the saturation level, thus preventing the desired detection.

[0010] A third method of moisture detection is based on the variation of the temperature inside the drum. Based on the temperature gradients detected by sensors (e.g. NTC or similar) already present in the machine for other uses, such as detecting the water temperature during the heating phase, a software algorithm correlates the detected temperature with the possible residual moisture of the clothes using a previously determined comparison table.

[0011] This method is extremely economical, since it does not require any additional components, but its accuracy is low since it is an indirect method that is affected by many variables such as the level of centrifugation, the weight of the clothes, the ambient temperature, etc.

[0012] The object of this invention is therefore to provide a method and a machine that is free from said drawbacks. This object is achieved by a method in which the reading of the current absorbed by the motor that drives the rotating drum, repeated at predetermined intervals during the drying cycle, allows to detect the variation of the mass present in the drum and then extrapolate through an algorithm the amount of moisture remaining in the mass of the clothes, through a comparison with one or more diagrams previously determined and stored in the control unit of the machine.

[0013] A machine that carries out this method only requires that the above algorithm and the relative diagrams be stored in its control unit, since the use of the motor current to obtain the mass present in the drum is already known and used in other phases such as, for example, to determine how many litres of washing water to load or for detecting the mass before a centrifugation phase as a support data in the subsequent detection of unbalanced weights, etc.

[0014] The main advantage of this method is that it is more precise than "indirect" methods that detect the moisture or temperature of the air in the drum, such as the second and third prior art methods described above, but without requiring additional components as in the first method.

[0015] It follows that even the machine that carries out this method has the advantage of being made with a simple structure, without additional components, which is therefore economical to build and reliable in use.

[0016] Further advantages and characteristics of the method and of the machine according to the present invention will be evident to those skilled in the art from the following detailed description of an embodiment thereof with reference to the annexed drawings in which:

Fig.1 is a schematic perspective view in transparency of a machine according to the invention; and
Fig.2 is an example of a time/mass diagram used in the algorithm.

[0017] Referring to the above figures it can be seen that a machine according to the present invention traditionally includes a drum 1 closed by a door 2 and containing the linen 3 to be dried, the operation of the machine being managed by a general control unit 4. The drum 1 is driven by an electric motor 5, which is in turn preferably controlled by its own specific control unit 6 operatively connected to the general control unit 4.

[0018] As mentioned before, by carrying out a first reading of the current absorbed by motor 5 through control unit 6 in order to obtain the mass of the clothes 3 contained in drum 1 at the beginning of the drying cycle and, subsequently, by carrying out others at certain intervals during the drying cycle, it is possible to acquire multiple mass values that, when put together, will allow to construct a graph of the trend of the mass.

[0019] There is a close correlation between the variation of the mass and the quantity of residual moisture in clothes 3 and therefore, through a software algorithm programmed and stored in the general control unit 4, which receives the readings from control unit 6 or makes them directly on motor 5, it is possible to establish the degree of residual moisture and automatically stop drying according to the degree of drying required by the settings entered by the user.

[0020] As an example, the diagram in Fig.2 shows the variation in mass *m* during a drying cycle. Start is with an initial value of mass X equal to the weight of the dry linen + the mass Y of water still contained in the linen, for a total value of mass *m* = X+Y.

[0021] The readings L1, L2, L3,... of the mass detect its value at certain intervals of time *t*, and you can see that over time the mass Y of the water inside the clothes will start to drop and consequently the total mass X+Y will also drop.

[0022] At the beginning, the mass X+Y remains substantially constant while the clothes warm up progressively up to the temperature at which the water evaporation starts (initial horizontal stretch, readings L1-L3), then it decreases in an almost linear way becoming X+(Y-10%) at L4, X+(Y-20%) at L5, etc. until the complete drying X+(Y-100%), when it will stop decreasing because only the mass X of the dry linen is left (final horizontal stretch).

[0023] According to the trend of the *t-m* diagram, the software algorithm contained in the general control unit 4 is able to extrapolate the residual moisture level and to give the drying stop signal near the "S" threshold requested by the user (equal to about Y-85% in the example shown), or when it detects the complete drying because the mass does not decrease further.

[0024] It is clear that the embodiment of the method and machine according to the invention described and illustrated above is only one example that can be subject to numerous variations. In particular, in the general control unit 4, multiple *t-m* diagrams can be stored, to be used from time to time according to any parameters available, such as initial mass, set drying threshold, type of clothes, etc.

[0025] This is particularly advantageous in a washer-dryer where the general control unit 4 can have at its disposal all the information relating to the washing cycle that preceded the drying cycle, such as the weight of the dry linen, the centrifugation speed, the type of washing performed and the like.

Claims

1. Method for detecting residual moisture in linen (3) during a drying cycle performed by a machine including a rotating drum (1) containing said linen (3) and driven by an electric motor (5), which is operatively connected to a general control unit (4) of the machine, preferably through its own specific control unit (6), said method being **characterized by** comprising the following steps:

   a) making an initial reading (LI) of the mass of the wet linen (3) at the beginning of the drying cycle by detecting the current absorbed by said electric motor (5);
   b) taking multiple further readings (L2, L3, L4, L5,...) of the mass of the wet linen (3) in the same way during the drying cycle at pre-set time intervals;
   c) transmitting the data of these mass readings to said general control unit (4);
   d) extrapolating the residual moisture content of the linen (3) using an algorithm programmed in the general control unit (4) which compares these readings of the mass of the wet linen (3) with a time-mass diagram stored in the general control unit (4).

2. Method according to claim 1, **characterized in that** that the time-mass diagram used in phase d) is previously selected from a plurality of time-mass diagrams stored in the general control unit (4), said selection being made by the algorithm on the basis of the available parameters of the linen (3).

3. Method according to claim 2, **characterized in that** that the available parameters of the linen (3) include the data on the washing cycle which the linen (3) has undergone.

4. Dryer or washer-dryer comprising a rotating drum (1) designed to contain linen (3) to be dried and driven by an electric motor (5), which is operatively connected to a general control unit (4) of the machine,

preferably through its own specific control unit (6), **characterized in that** in said general control unit (4) there is programmed an algorithm which compares a plurality of readings of the mass of the wet linen (3), carried out according to phases a) and b) of the method of claim 1, with a time-mass diagram stored in the general control unit (4).

5. Dryer or washer-dryer according to claim 4, **characterized in that** the general control unit (4) contains a plurality of time-mass diagrams which are selected by the algorithm on the basis of the available linen parameters (3).

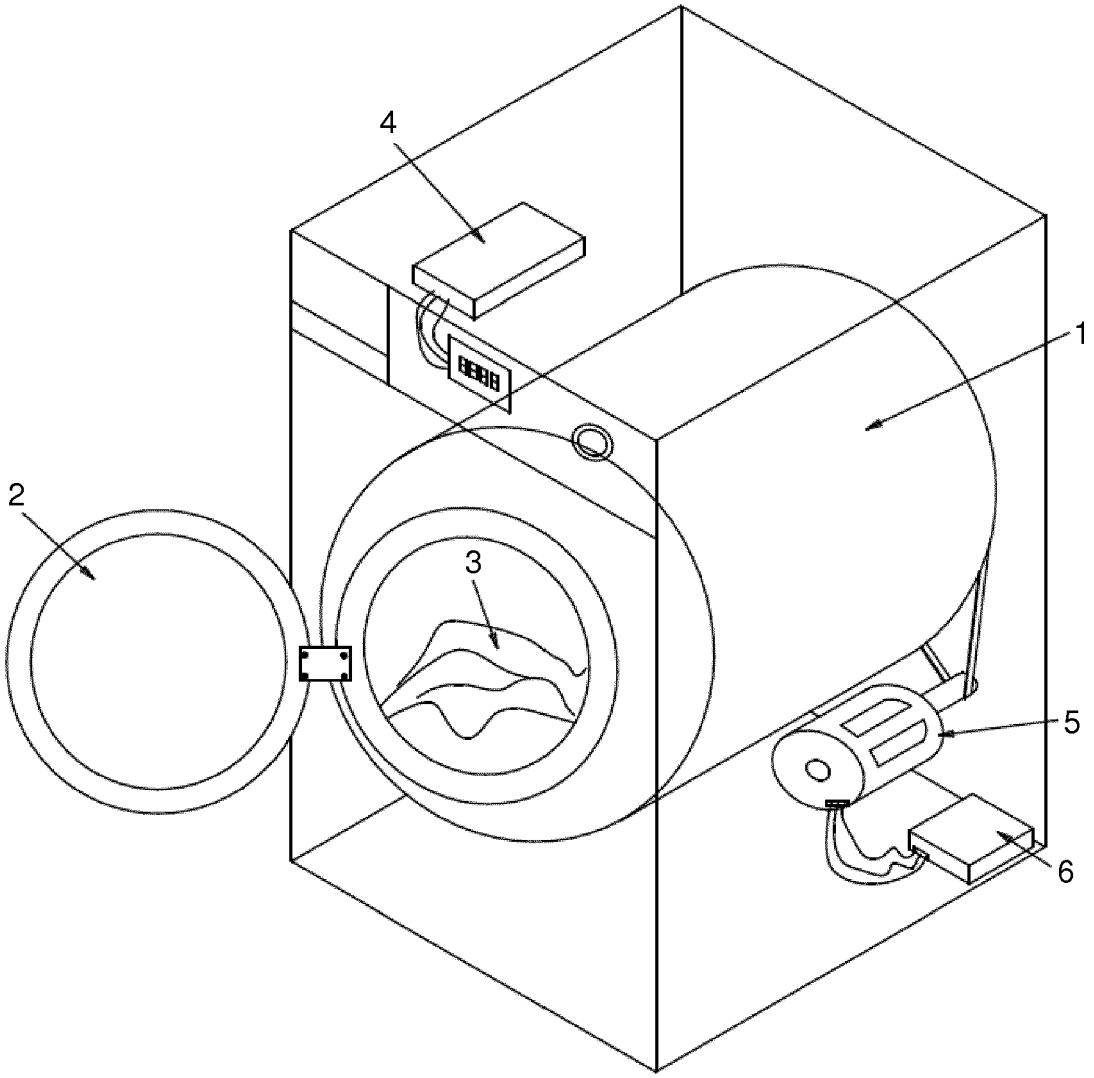

Fig.1

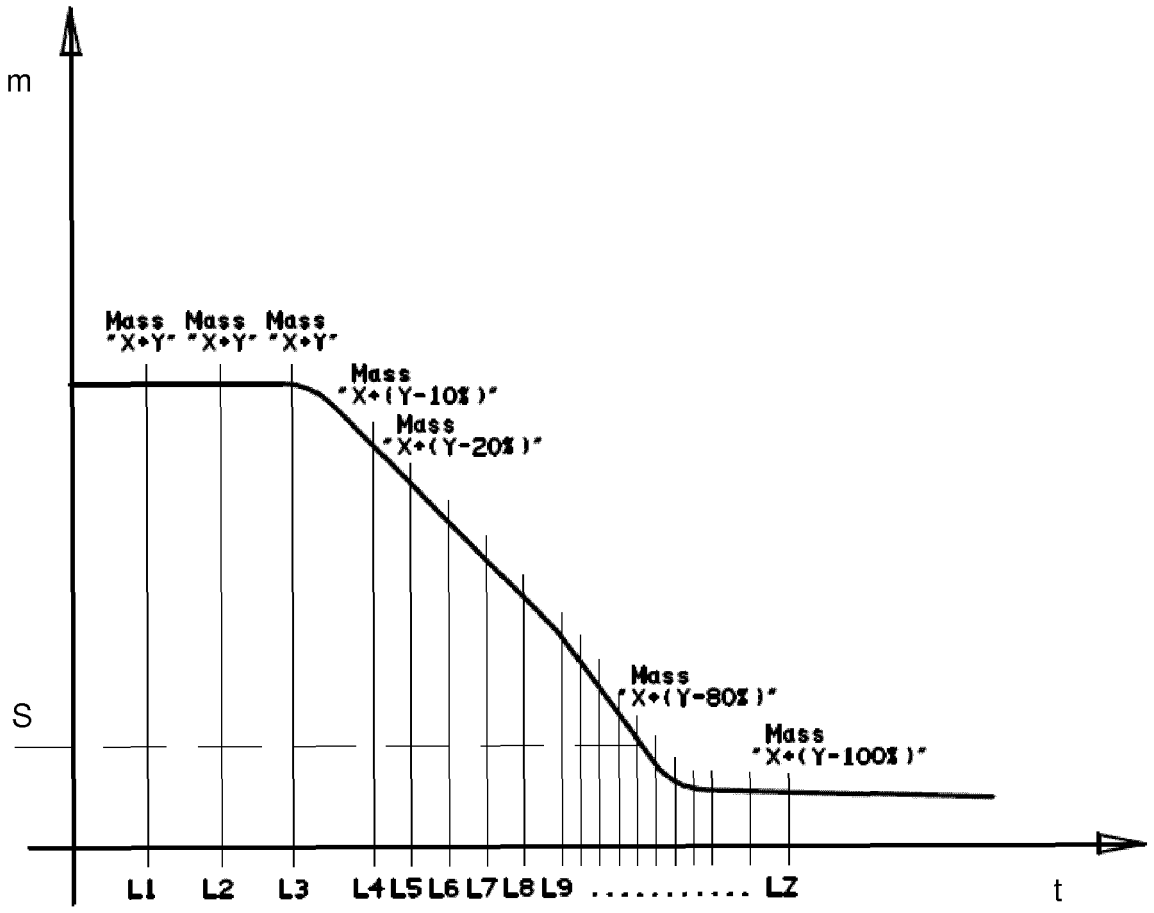
m
Mass "X+Y"
Mass "X+Y"
Mass "X+Y"
Mass "X+(Y-10%)"
Mass "X+(Y-20%)"
Mass "X+(Y-80%)"
Mass "X+(Y-100%)"
S
L1
L2
L3
L4
L5
L6
L7
L8
L9
LZ
t

Fig.2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 42 5079

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2004/200093 A1 (WUNDERLIN WILLIAM JOSEPH [US] ET AL) 14 October 2004 (2004-10-14) * paragraph [0035] - paragraph [0084]; figures 1-4 *	1,4	INV. D06F58/28
A	US 2012/096738 A1 (BELLINGER RYAN R [US] ET AL) 26 April 2012 (2012-04-26) * paragraphs [0027], [0036] *	1-5	
X	EP 1 457 594 A2 (LG ELECTRONICS INC [KR]) 15 September 2004 (2004-09-15) * paragraph [0021] - paragraph [0024]; figures *	1,4	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 March 2019	Diaz y Diaz-Caneja

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 42 5079

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-03-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004200093 A1	14-10-2004	CA 2345631 A1	02-11-2001
		US 6845290 B1	18-01-2005
		US 2004200093 A1	14-10-2004
		US 2006191161 A1	31-08-2006
US 2012096738 A1	26-04-2012	DE 102011052796 A1	26-04-2012
		US 2012096738 A1	26-04-2012
EP 1457594 A2	15-09-2004	CN 1530621 A	22-09-2004
		EP 1457594 A2	15-09-2004
		JP 2004267782 A	30-09-2004
		KR 20040079771 A	16-09-2004
		US 2004177529 A1	16-09-2004

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82