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

(11) **EP 2 267 214 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.12.2010 Bulletin 2010/52

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

(21) Application number: **09163389.1**

(22) Date of filing: **22.06.2009**

(84) Designated Contracting States:
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 SE SI SK TR
Designated Extension States:
AL BA RS

(71) Applicant: **Whirlpool Corporation**
Benton Harbor, MI 49022 (US)

(72) Inventors:
- **Colombo, Davide**
  21025, Comerio (IT)
- **Martinello, Daniele**
  21025, Comerio (IT)
- **Spranzi, Paolo**
  21025, Comerio (IT)
- **Carow, James P.**
  21025, Comerio (IT)

(74) Representative: **Guerci, Alessandro**
Whirlpool Europe S.r.l.
Patent Department
Viale G. Borghi 27
21025 Comerio (VA) (IT)

(54) **A method for estimating the load of clothes in a household dryer and dryer using such method**

(57) A method for estimating the load of clothes in a household tumble dryer, such dryer being provided with a contact band for a moisture measuring circuit, comprises monitoring a parameter linked to the degree of clothes dryness vs. time, for instance the conductivity value vs. time, and estimating the load of clothes by analysing the dynamic behaviour of the conductivity value.

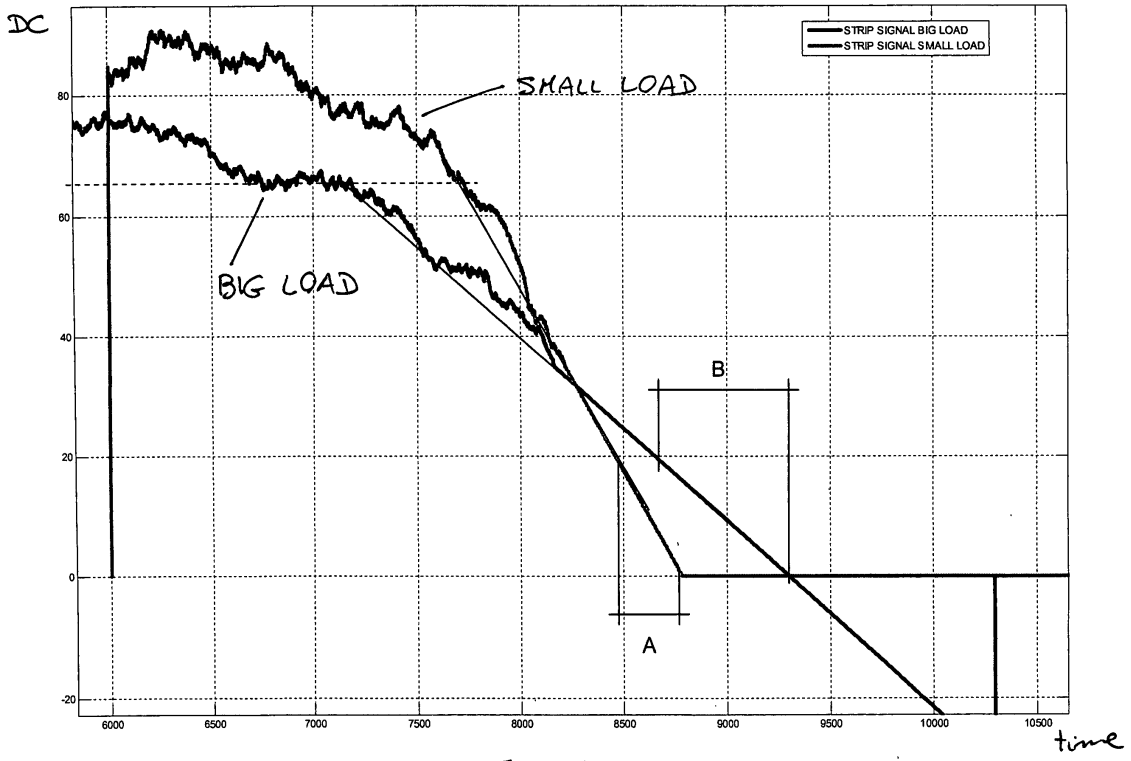


Fig. 9

EP 2 267 214 A1

Description

[0001] The present invention relates to a method for estimating the load of clothes in a household tumble dryer, such dryer being provided with a contact band or strip for moisture measuring circuit. With reference to figure 1 a known tumble dryer is composed by the following components: a rotating drum actuated by an electric motor aimed at containing a certain amount of clothes inside; a heating element that heats the air to be blown inside the drum according to a predefined number of heating power levels; an air channel that conveys air either outside the appliance (vented dryer) or to a condenser (condensing dryer); two temperature sensors that measure the air temperature before entering the drum and the air temperature at the drum outlet; at least a contact strip normally used to measure the conductivity or resistivity of wet clothes; an optional spray nozzle used, in some dryer, to spray water and/or chemical substances on dry clothes in order to refresh them; a control unit that is able to read the actual value of the temperature sensors and of the other available sensors, including the conductivity value of the clothes and it is able to store the values in some memory registers, actuate the motor driving the rotation of the drum, the heating element according to predefined power levels, and the other actuators eventually available; and a digital regulator calculated by the control unit that keeps the clothes temperature close to a predefined temperature setpoint by modulating the heater input power.

[0002] In the above kind of dryer it is important not only to monitor the conductivity of clothes versus time in order to determine the appropriate duration of the drying cycle, but it is also important to assess such conductivity value depending on the total load of clothes. In most dryers the conductivity target value (and therefore humidity target value) is chosen for a predetermined or average load size. This target value may not accurately reflect different load sizes. A solution to this technical problem is disclosed by US-A-2008/0052954 which shows a drying algorithm that sets its target conductivity value by taking into consideration the influences associated with load size. The algorithm disclosed by such document is based on the comparison, after a predetermined fixed drying time has elapsed, of the actual measured voltage (across contact strips or the like) and a predetermined voltage limit, in order to assess whether a small or large load signal has to be generated within the central process unit of the dryer. This known method has the drawback of not providing reliable signals on loads due to the determination of a single minimum value of conductivity. Moreover this method can only distinguish between a large or small load signals, giving therefore only a very rough possibility of adjusting the drying cycle on the basis of load size. Then, in order to increase the reliability of such rough assessment, the above document teaches to check the load estimation value by comparing it to a load signal generated by monitoring air flow temperature, therefore increasing the complexity and cost of the estimation system.

[0003] It is therefore an object of the present invention to provide a method for estimating the load of clothes in a tumble dryer which overcomes the above drawbacks and which is more reliable and more accurate if compared to prior art. Another object is to improve the automatic termination of the drying cycle based on conductivity values of the clothes.

[0004] These objects are reached thanks to the features listed in the appended claims.

[0005] By monitoring continuously during time an electrical parameter linked to the degree of clothes dryness, for instance the area under the curve conductivity/time, slope of such curve, time interval between two predetermined values of dryness or delay time for reaching a predetermined dryness, it is possible not only to discriminate among different values of load sizes, but also to carry out such estimation also near the end of the drying process.

[0006] Another advantage of the method according to the present invention is to allow the designer building an experimental relationship between conductivity target values and actual loads of clothes on the basis of input humidity target values chosen by the user.

[0007] The method according to the invention can be used also in the so called refresh cycle where the clothes are loaded dry in the dryer drum. During the refresh cycle it is necessary to spray water and/or chemical substances in order to reach a fixed value of humidity. If the spray flow is constant the voltage signal shape, read by the strip of the moisture measuring circuit, is strictly related to fabric mass. A big load needs more time than a smaller one to achieve the same value of humidity content. The method according to the invention allows to exactly evaluating the amount of water and/or chemical used in a refresh cycle for each type of load (small, medium, big). This allows a water/chemicals/time saving.

[0008] The gist of the present invention is to use not only the voltage value but also the information related to its change vs. time, i.e. slope, derivatives, integral, time gap and all other voltage signal shape characteristics.

[0009] Further features and advantages of a method and of a dryer according to the present invention will become clear from the following detailed description, given by way of non limiting example, with reference to the attached drawings in which:

- figure 1 is a schematic view of an air vented tumble dryer;
- figure 2 is a diagram showing how the voltage signal changes with time when a big load is put in the dryer and a refresh cycle is started;
- figure 3 is a diagram similar to figure 2 and relates to a small load;

- figure 4 is a diagram showing the relationship between load size and time for reaching a predetermined humidity content;

- figures 5-8 are diagrams showing the relationships between different dynamic parameters linked to voltage signal and time during a refresh cycle, particularly the area under the voltage signal curve, the changing slope of such curve, the time gap between two predetermined voltage values and a delay time before a certain voltage value is reached;

- figure 9 is a diagram showing how the voltage signal (strip values) changes vs. time, particularly at the end of a drying cycle, allowing an accurate discrimination on the load size based for instance on time elapsed between two fixed DC or voltage value, such time being proportional to the load value;

- figure 10 shows an experimental diagram on a commercial dryer in which the voltage signal (strip values) is linked to actual measured humidity content according to four different tests, two with load of 7 Kg and two with loads of 1 Kg; and

- figure 11 is a schematic algorithm flowchart according to the invention.

[0010] With reference to figures 2 and 3 referring to a refresh cycle, when the nozzle in the drum starts to spray water the moisture measuring circuit doesn't work; only when the humidity content (called MR - moisture retention - in the following) is higher than a certain value, the moisture measuring circuit works well. As a consequence this "delay time" is strictly related to fabric mass. In figure 2 the "shape" of the curve voltage vs. time is typical of a big load, i.e. for instance of a load higher than 3 kg, while the one of figure 3 is typical of a small load, i.e. for instance lower than 3 kg. According to figures 2 and 3, by analyzing the voltage signal shape is possible to estimate the fabric load accurately and choose the most appropriate value to end the drying cycle.

[0011] Figures 5 to 8 describe different relationships between fabric mass and voltage signal shape during a refresh cycle where water is prayed onto the clothes. Of course the same considerations apply to drying cycle too. Also in this case the voltage signal shape is strictly related to fabric mass but of course it decreases instead of growing up.

[0012] With reference to figures 9 and 10, the voltage value is decreasing but the behaviour of big loads is different from the behaviour of small ones. In figure 9 the time A or B elapsed between two fixed voltage values is proportional to a certain load, the shorter the time, the smaller the load. The experimental diagram of figure 10 shows how the method according to the invention can discriminate not only among different load sizes (and therefore not only between "low" and "high"), but also among different final humidity values requested by the user, linking for instance the voltage curve vs. ideal values for interrupting the drying cycle, taking automatically into account the preference of the user and actual load of clothes in the dryer. In figure 10 it is clear how the strip conductivity threshold value for a certain target humidity of the clothes is strictly related to the actual load. Without a precise load assessment according to the present invention, there is the risk that for a small load the drying process is interrupted too early, therefore giving unsatisfactory drying results.

[0013] With reference to figure 11, the algorithm inputs are:

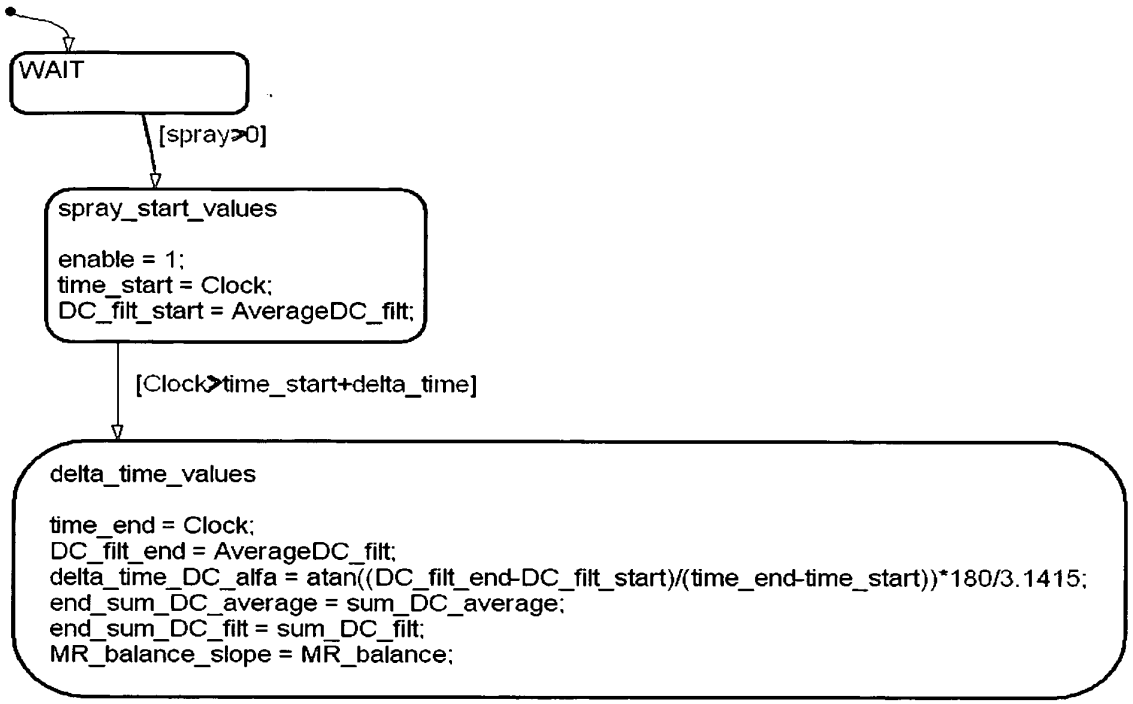
- DC Value (moisture measuring circuit data, expressed in terms of duty cycle values of a voltage related signal)
- Spray status (the algorithm computation starts when the spray nozzle is open)
- Delta time (the algorithm computation can be stopped by time)
- DC Fixed value (the algorithm computation can be stopped by reaching a particular DC Value)

[0014] The output data, obtained by any known shape analysis, could be compared using a look up table or a regressor approach. The final output is the fabric load estimation.

[0015] A possible way to carry out the shape analysis according to the slope-concept (Fig. 6) could be the following:

- The subsystem "spray_start_values" set some parameters when the spray cycle starts;
- After a certain "delta_time" the subsystem "delta_time_values" evaluates the slope angular coefficient "delta_time_alfa".

[0016] The "Shape analysis" stops and the "delta_time_alfa" could be processed by a regressor or a look up table in order to find the fabric load mass.



Claims

1. Method for estimating the load of clothes in a household tumble dryer, such dryer being provided with a contact band for a moisture measuring circuit, **characterized in that** it comprises:

   - monitoring a parameter linked to the degree of clothes dryness vs. time, and
   - estimating the load of clothes by analysing the dynamic behaviour of the above parameter.

2. Method according to claim 1, wherein said parameter is selected in the group consisting of area under the curve conductivity vs. time, shape of the curve conductivity vs. time, time interval between two predetermined conductivity value, or delay time for reaching a predetermined conductivity value.

3. Method according to claim 1 or 2, wherein the monitoring phase is carried out after having started a wetting of the clothes with a predetermined water flow rate and for a predetermined time.

4. Method according to claim 3, wherein the amount of water and/or chemical used during wetting is evaluated for each type of load size.

5. Method according to claim 1 or 2, wherein the monitoring phase is carried out in the final phase of the drying process.

6. Method according to any of the above claims, wherein a target conductivity value is determined on the basis of the assessed load of clothes.

7. Household tumble dryer, having a contact band or the like and related electrical control circuit for assessing the moisture content of the load, **characterized in that** the control circuit is adapted to monitor a parameter linked to load conductivity vs. time and to estimate the load of clothes by analysing the dynamic behaviour of said parameter.

8. Dryer according to claim 7, wherein said parameter is selected in the group consisting of area under the curve conductivity vs. time, shape of the curve conductivity vs. time, time interval between two predetermined conductivity value, or delay time for reaching a predetermined conductivity value.

9. Dryer according to claim 7 or 8, wherein it comprises a water nozzle for spraying water on clothes, the monitoring phase being carried out after having started a wetting of the clothes with a predetermined water flow rate and for a predetermined time.

10. Dryer according to claim 9, wherein the control circuit is adapted to evaluate the amount of water and/or chemical used during wetting for each type of load size.

11. Dryer according to claim 7 or 8, wherein the monitoring phase is carried out in the final phase of the drying process.

12. Dryer according to any of claims 7-11, wherein the control circuit is adapted to calculate a conductivity target value based on a target humidity value (MR) and on the assessed load of clothes.

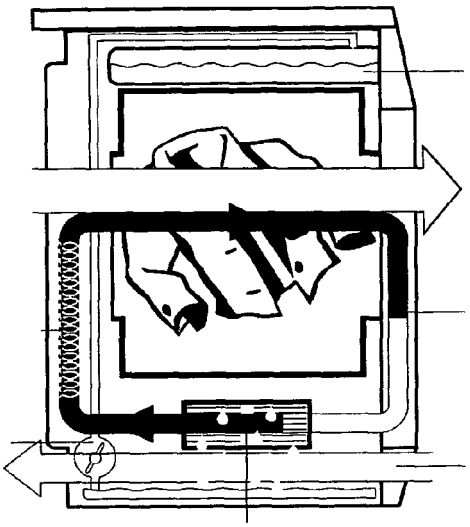


Fig. 1

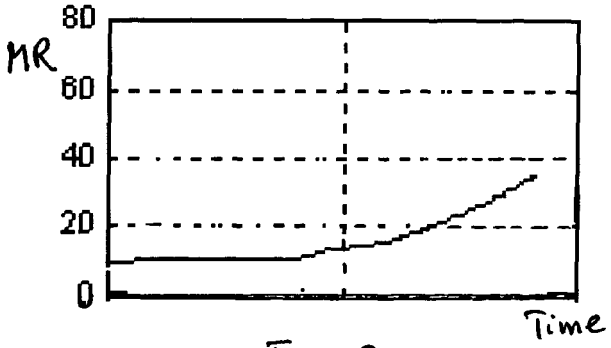


Fig. 2

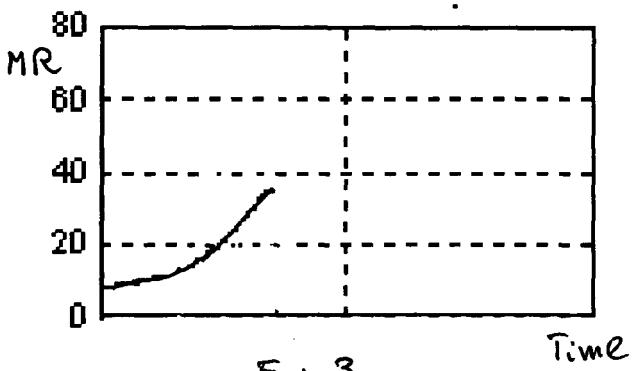


Fig. 3

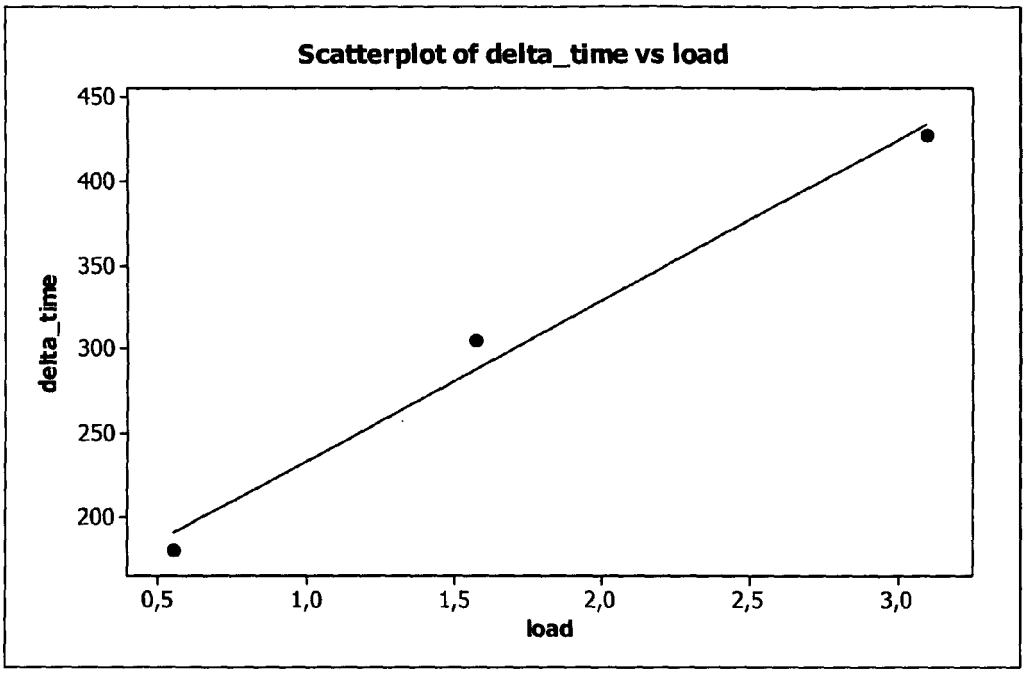


Fig. 4

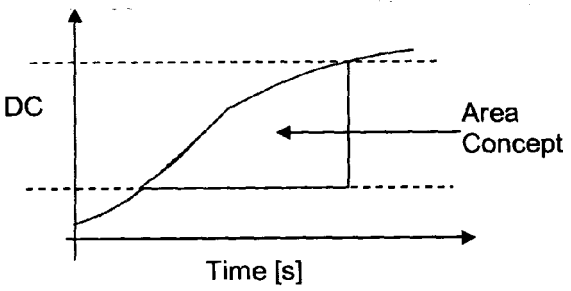


Fig. 5

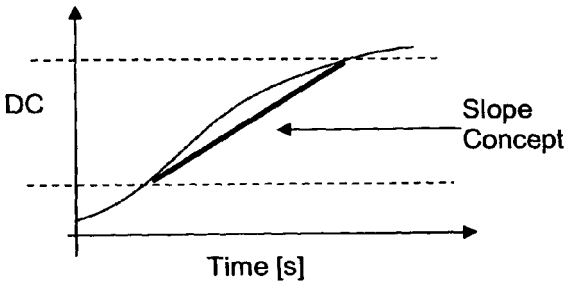


Fig. 6

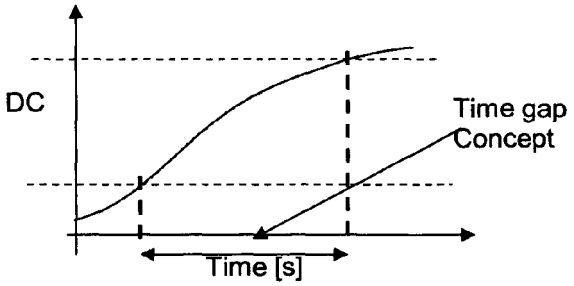


Fig. 7

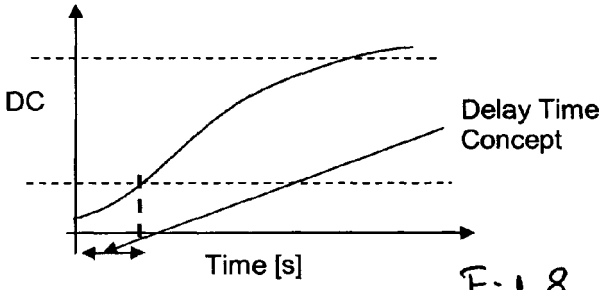


Fig. 8

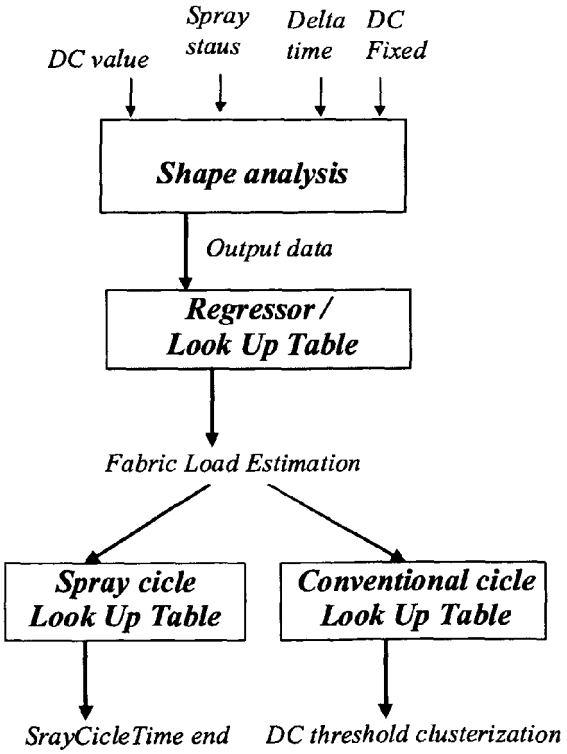


Fig. 11

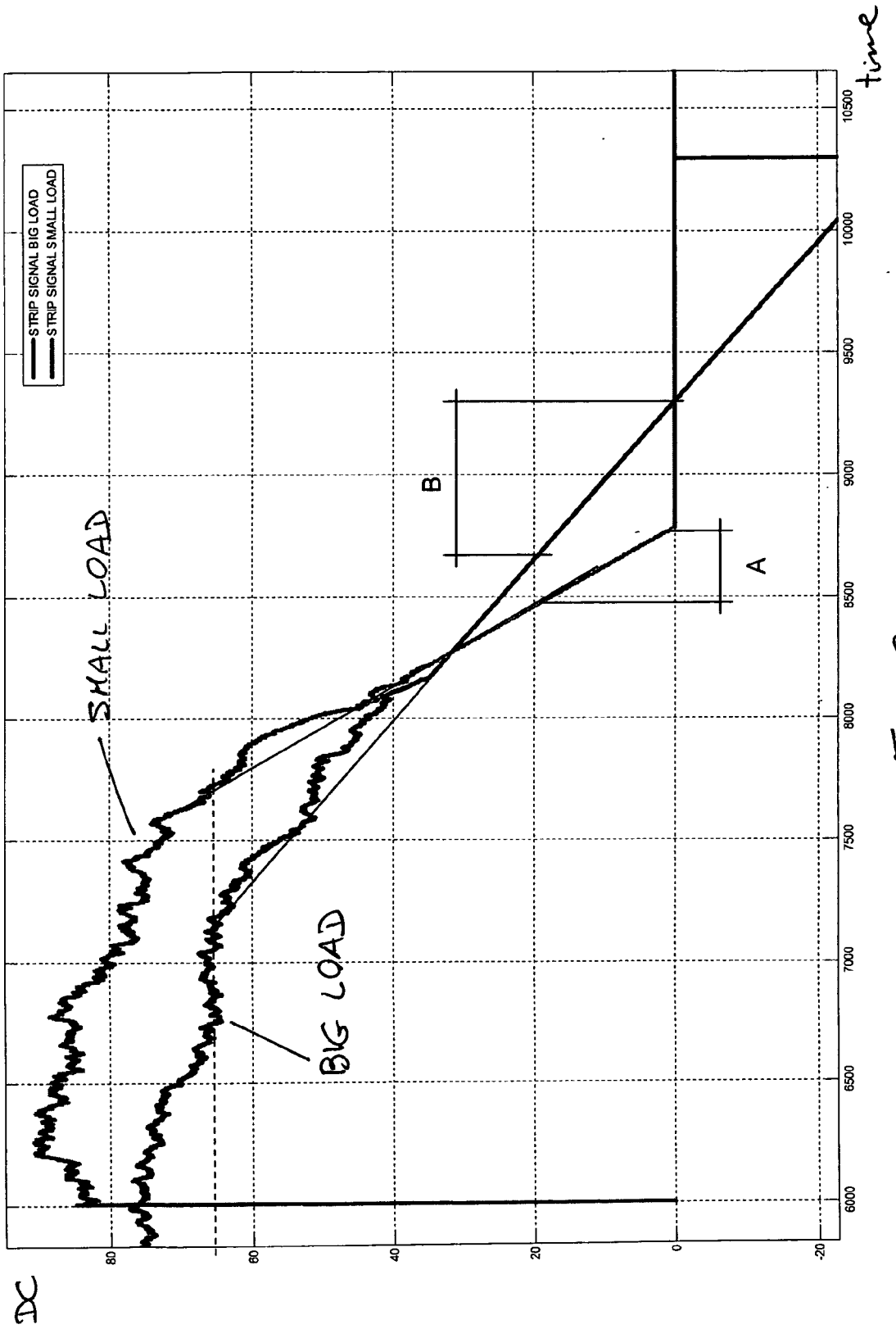

STRIP SIGNAL BIG LOAD
STRIP SIGNAL SMALL LOAD
SMALL LOAD
BIG LOAD
A
B
time
DC
80
60
40
20
0
-20
6000
6500
7000
7500
8000
8500
9000
9500
10000
10500

Fig. 9

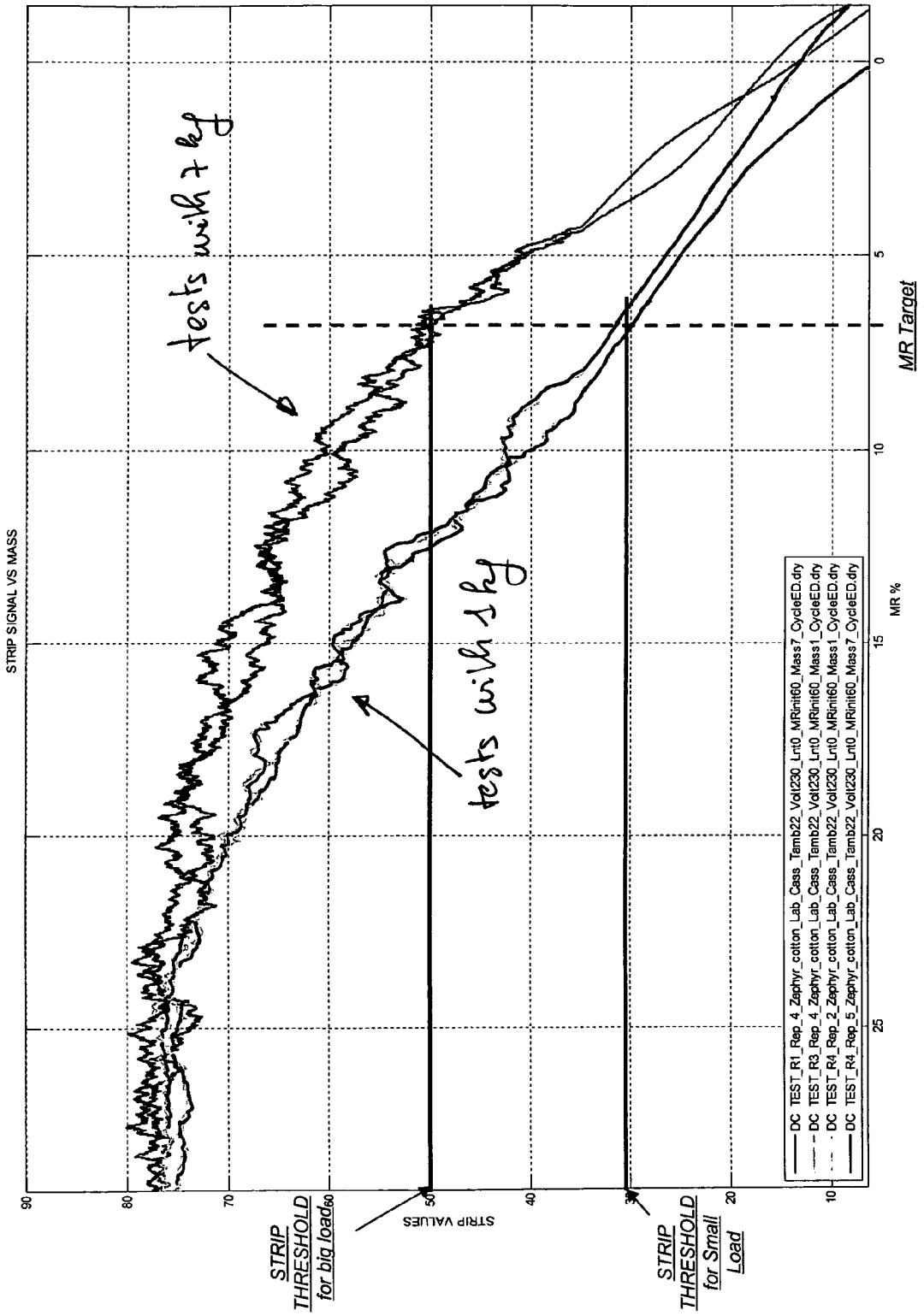

STRIP SIGNAL VS MASS
tests with 7 kg
tests with 1 kg
STRIP THRESHOLD for big load
STRIP VALUES
STRIP THRESHOLD for Small Load
MR Target
MR %
DC TEST_R1_Rep_4_Zephyr_cotton_Lab_Cass_Tamb22_Volt230_Lnt0_MRinit60_Mass7_CycleED.dry
DC TEST_R3_Rep_4_Zephyr_cotton_Lab_Cass_Tamb22_Volt230_Lnt0_MRinit60_Mass1_CycleED.dry
DC TEST_R4_Rep_2_Zephyr_cotton_Lab_Cass_Tamb22_Volt230_Lnt0_MRinit60_Mass1_CycleED.dry
DC TEST_R4_Rep_5_Zephyr_cotton_Lab_Cass_Tamb22_Volt230_Lnt0_MRinit60_Mass7_CycleED.dry

Fig. 10

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 16 3389

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 Y A	EP 1 988 209 A2 (ELECTROLUX HOME PROD CORP [BE]) 5 November 2008 (2008-11-05) * paragraphs [0008], [0014] - [0016], [0020] - [0031]; claims; figures * -----	1-2,5, 7-8, 11-12 6 3-4,9-10	INV. D06F58/28
Y A	EP 1 457 594 A2 (LG ELECTRONICS INC [KR]) 15 September 2004 (2004-09-15) * paragraphs [0002], [0015] - [0028]; claims; figures * -----	6 1-5,7-12	
A	EP 0 226 209 A2 (TOSHIBA KK [JP]) 24 June 1987 (1987-06-24) * column 2, line 46 - column 7, line 55; claims; figures * -----	1-12	
A	DE 44 03 625 A1 (MIELE & CIE [DE]) 10 August 1995 (1995-08-10) * the whole document * -----	1-12	
A,D	US 2008/052954 A1 (BEAULAC SEBASTIEN [CA]) 6 March 2008 (2008-03-06) * the whole document * -----	1-12	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	25 November 2009	Clivio, Eugenio

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 09 16 3389

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.

25-11-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1988209 A2	05-11-2008	WO 2008131876 A2	06-11-2008
EP 1457594 A2	15-09-2004	CN 1530621 A	22-09-2004
		JP 2004267782 A	30-09-2004
		KR 20040079771 A	16-09-2004
		US 2004177529 A1	16-09-2004
EP 0226209 A2	24-06-1987	DE 3675746 D1	03-01-1991
		US 4738034 A	19-04-1988
DE 4403625 A1	10-08-1995	NONE	
US 2008052954 A1	06-03-2008	NONE	

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20080052954 A **[0002]**