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(54) **Method and system for measuring the linen humidity in washing machines, dryers and the like**

(57) A method for measuring the humidity of the linen (3) contained in washing-machines (1), clothes-dryers and the like, characterized in that it comprises the following operative steps:

- arranging the plates (4, 5) of a condenser (6) around

- the linen (3), so that the latter acts as a dielectric;
- measuring the capacity (C) of this condenser (6);
- determining the humidity of the linen (3) according to the measured capacity (C).

The present invention also relates to a system for carrying out said method.

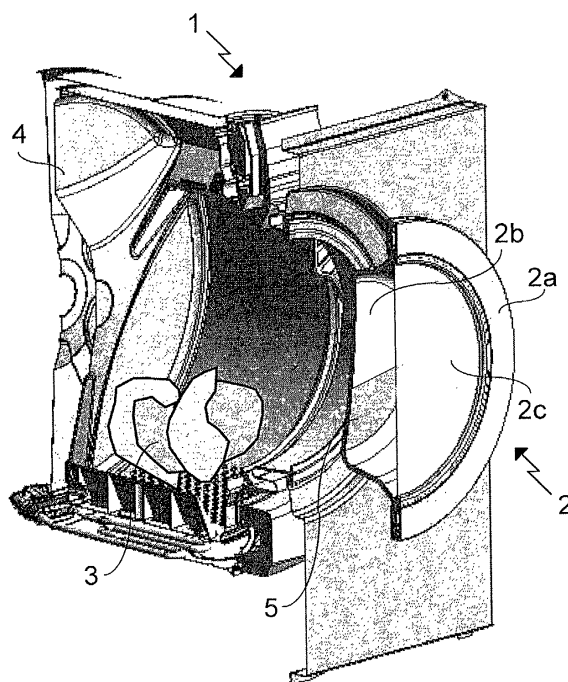


Fig. 1

Description

[0001] The present invention relates to a method for measuring the humidity of the linen in washing-machines, clothes-dryers and the like, and particularly to a method that allows to automatically control the drying of the linen according to the humidity thereof. The present invention relates also to a system for carrying out said method.

[0002] It is known that the clothes-dryers and many washing-machines comprise a drying system wherein warm air flows to dry linen. These electric household appliances generally do not comprise a linen humidity measuring system, so that the user has to set a drying program by choosing its duration according to a table provided by the constructors, with consequent excessive and useless consumptions if the maximum duration is always set, or with variable and not always optimal results if the duration indicated by table is set.

[0003] The present systems for measuring humidity, if present, are based on a linen conductivity measurement, that is on the resistivity thereof, which varies as a function of humidity. This measuring method, being directly carried out on linen, causes the two following drawbacks that make said known systems complex and expensive.

[0004] First of all, it is necessary to accomplish an electric connection with the linen, which is constant during the time when the position of the linen inside the basket, which is a moving member, varies. This connection is generally carried out by means of wiping contacts, which however have a poor reliability during the time, or by means of terminals arranged in the inner side of the door, which however do not always ensure an electric continuity. These two solutions are both complex from a manufacturing point of view.

[0005] Secondly, since the basket is grounded, being metallic and thus conductive, the measurement electronic circuit must ensure the perfect insulation between the main network power source and the measurement signal of the linen resistivity, in order to overcome the normative dielectric rigidity tests. This causes a considerable increase of the complexity and the costs of the control electronics, which otherwise would be simple and economic for this products category.

[0006] The object of the present invention is therefore to provide a method and a measuring system which are free from said drawbacks, i.e. which are simple, reliable, safe and cheap. This object is achieved with a method and a system whose main features are specified respectively in claims 1 and 9, while other features are specified in the remaining claims.

[0007] The method and the system according to the present invention are based on the measurement of the variations of the electric permittivity or dielectric constant of the linen during the drying program and on the conversion of this permittivity, by means of a suitable control device, into a quantity, for example a voltage or

a frequency, which depends on the humidity of the same linen. By virtue of this solution a direct contact with the linen is not necessary anymore, thus avoiding the above-mentioned drawbacks.

[0008] The system according to the present invention thus allows to automatically adjust the duration of the drying program according to one or more drying levels selectable by the user, thus obtaining a constructive simplification of the apparatus in which it is inserted, as well as an easier use thereof. For example, in a washing-machine provided with this system the user can directly choose the drying degree of the linen at the end of the washing cycle without worrying about the definition of the duration of the drying period.

[0009] Further advantages and features of the method and of the system according to the present invention will be clear to those skilled in the art from the following detailed and not limiting description of two embodiments thereof with reference to the attached drawings wherein:

- figure 1 shows a partial perspective and exploded view of a washing-machine comprising the system according to the present invention;
- figure 2 shows an electric scheme of the system according to the present invention;
- figure 3 shows an electric scheme of the control device of the system according to the first embodiment of the invention;
- figure 4 shows a working diagram of the device of figure 3; and
- figure 5 shows an electric scheme of the control device of the system according to the second embodiment of the invention.

[0010] Referring to figure 1, it is visible that a washing-machine 1 provided with the system according to the present invention comprises in a known way a door 2 for introducing linen 3 in the washing basket 4. Door 2 generally has a circular shape and comprises a metal frame 2a in which a glass chamber cylindrically or frustoconically shaped provided with an inner wall 2b and an outer wall 2c, both substantially circular, is inserted.

[0011] According to the invention, a metal plate 5 is fixed, for example with a biadhesive tape, to the outer surface of the inner wall 2b of door 2. In the present embodiment, the metal plate 5 has a substantially semicircular shape and is arranged in the lower half of wall 2b. The outer wall 2c of door 2 prevents from a possible direct contact of the user with the metal plate 5, thus avoiding the measure to be altered by eddy conductivities introduced by this contact.

[0012] Referring to figure 2, it is visible that basket 4 and the metallic plate 5, which are electrically insulated one from the other, act as the plates of a condenser 6 having as dielectric the inner wall 2b of door 2, linen 3 and the air 7 contained in the basket 4. The latter is earthed in a known way, while plate 5 is connected to an electric and/or electronic control device 8, which

measures the capacity C of the condenser 6 and supplies a control signal to the drying system of the washing-machine 1 according to the measured capacity C . The permittivity of linen 3, in fact, varies considerably according to the humidity thereof, while the permittivities of wall 2b and of air 7 are substantially constant or vary insignificantly.

[0013] Referring now to figure 3, it is visible that for measuring the capacity C of condenser 6 the control device 8 can comprise a charge transfer sensor, for example a Q-PROX™ device of the firm Quantum. In the present embodiment of the invention, this sensor comprises a reference condenser 9 which has a known and constant capacity C_r and is connected in parallel to condenser 6 as well as to a reference voltage generator 10 which supplies a known and constant voltage V_r at the terminals of condensers 6 and 9.

[0014] The voltage generator 10 can be separated by condenser 6 through a first switch 11, while condensers 6 and 9 can be separated one from the other through a second switch 12, as well as short-circuited by a third switch 13. Condensers 6 and 9, apart from being connected in parallel one to the other, are also connected in series between the earth and an amplifier 14.

[0015] Through series of electric pulses controlling the opening and closing of switches 11, 12 and 13 it is possible to obtain a remarkable value of transferred charge, so as to significantly increase voltage V_s on condenser 9. By measuring this value, amplified of a factor A by amplifier 14, it is possible to supply from the outside a voltage $A \times V_s$ proportional to the capacity C of condenser 6, that is depending on the humidity of linen 3.

[0016] Figure 4 shows an experimental diagram containing a graph 15 of the real measure of the voltage $A \times V_s$ in volt during the drying cycle, as well as a graph 16 corresponding to an average of two adjacent values of graph 15.

[0017] Finally, referring to figure 5, it is visible that in a second embodiment of the invention the control device 8 can comprise an astable multivibrator, in particular a square wave generator, for measuring the capacity C of condenser 6. The frequency of the wave generated by the astable multivibrator is inversely proportional to a product RC , where R is a resistive component and C is a capacitive component depending on the used circuit. If the resistive component is kept constant, the variations of the capacitive components cause a variation of the frequency of the signal generated by the astable generator. With this arrangement it is possible to carry out not a capacity, but a frequency measurement, which can be elaborated more easily by low-cost commercial microprocessors, especially if the generated signal is a square wave.

[0018] Figure 5 shows an astable generator which uses an integrated circuit 17, for example a known NE555 integrated circuit, which is connected to a pair of resistors 18 and 19, in turn connected in series between a

source of direct current V_{cc} and the earthed condenser 6. Once the resistances of the resistors 18 and 19 have been fixed, the frequency of the output signal V_s depends only on the value of the capacity C of condenser 6. The astable multivibrator can further comprise a diode 20 connected in parallel to resistor 19 to obtain a duty cycle of the square output wave of 50% when the resistances of resistors 18 and 19 are the same. The integrated circuit 17 may further be earthed through a condenser 21 acting as a filter.

[0019] A measurement of the frequency of the output signal V_s before and during the drying can thus give information about the progress of the humidity of linen 3 and allow the automatic regulation of the drying cycle in the washing-machine 1.

Claims

1. A method for measuring the humidity of the linen (3) contained in washing-machines (1), clothes-dryers and the like, **characterized in that** it comprises the following operative steps:
 - arranging the plates (4, 5) of a condenser (6) around the linen (3), so that the latter acts as a dielectric;
 - measuring the capacity (C) of this condenser (6);
 - determining the humidity of the linen (3) according to the measured capacity (C).
2. A method according to the previous claim, **characterized in that** one plate of the condenser (6) is formed of a metallic basket (4) containing the linen (3).
3. A method according to one of the previous claims, **characterized in that** one plate of the condenser (6) is formed of a metallic plate (5) fixed to a door (2) for introducing the linen (3) inside the basket (4).
4. A method according to one of the previous claims, **characterized in that** one plate of the condenser (6) is connected to earth and the other plate (5) is connected to an electric and/or electronic control device (8), which measures the capacity (C) of the condenser (6) and supplies a control signal (V_s) according to the measured capacity (C).
5. A method according to claim 4, **characterized in that** the control device (8) comprises a charge transfer sensor (9, 10).
6. A method according to claim 4 or 5, **characterized in that** the voltage of the control signal (V_s) varies according to the capacity (C) of the condenser (6).

7. A method according to claim 4, **characterized in that** the control device (8) comprises an astable multivibrator (17, 18, 19).
8. A method according to claim 4 or 7, **characterized in that** the frequency of the control signal (Vs) varies according to the capacity (C) of condenser (6).
9. A system for measuring the humidity of the linen (3) contained in washing-machines (1), clothes-dryers and the like, **characterized in that** it comprises a condenser (6) having the plates (4, 5) arranged around the linen (3) and is connected to a control device (8) suitable for measuring the capacity (C) of the condenser (6) and determining the humidity of the linen (3) according to the measured capacity (C).
10. A system according to claim 9, **characterized in that** one plate of the condenser (6) is formed of a metallic basket (4) containing the linen (3).
11. A system according to claim 9 or 10, **characterized in that** one plate of the condenser (6) is formed of a metallic plate (5) fixed to a door (2) for introducing the linen (3) inside the basket (4).
12. A system according to claim 11, **characterized in that** said door (2) comprises an inner wall (2b) and an outer wall (2c), both electrically insulated, and that said metallic plate (5) is fixed to the outer surface of the inner wall (2b).
13. A system according to claim 12, **characterized in that** the inner wall (2b) of the door (2) has a substantially circular shape, while the metallic plate (5) has a substantially semicircular shape and is arranged in the lower half of the inner wall (2b).
14. A system according to one of the claims 9 to 13, **characterized in that** one plate (4) of the condenser (6) is connected to earth and the other plate (5) is connected to an electric and/or electronic control device (8), which measures the capacity (C) of the condenser (6) and supplies a control signal (Vs) according to the measured capacity (C).
15. A system according to claim 14, **characterized in that** the control device (8) comprises a charge transfer sensor (9, 10).
16. A system according to claim 15, **characterized in that** the charge transfer sensor (9, 10) comprises a reference condenser (9) having a known and constant capacity (Cr) and is connected in parallel to said first condenser (6), as well as to a reference voltage generator (10) which supplies a known and constant voltage (Vr) to the terminals of these condensers (6, 9).
17. A system according to claim 16, **characterized in that** the voltage generator (10) can be separated from the first condenser (6) through a first switch (11), while both condensers (6, 9) can be separated one from the other by a second switch (12), as well as short-circuited by a third switch (13), so that through series of electric pulses, which control the opening and the closing of switches (11, 12, 13) it is possible to obtain a remarkable value of transferred charge, such to significantly increase the voltage (Vs) on the reference condenser (9).
18. A system according to claim 16 or 17, **characterized in that** both condensers (6, 9), apart from being connected in parallel one to the other, are also connected in series between the earth and an amplifier (14).
19. A system according to one of claims 15 to 18, **characterized in that** the charge transfer sensor comprises a Q-PROX™ device of the firm Quantum.
20. A method according to claim 14, **characterized in that** the control device (8) comprises an astable multivibrator (17, 18, 19).
21. A system according to claim 20, **characterized in that** the astable multivibrator (17, 18, 19) comprises an integrated circuit (17) connected to a pair of resistors (18, 19), in turn connected in series between a source of direct current (Vcc) and the condenser (6) connected in series to earth.
22. A system according to claim 21, **characterized in that** the integrated circuit (17) is a NE555 integrated circuit.
23. A system according to claim 21 or 22, **characterized in that** the astable multivibrator (17, 18, 19) comprises a diode (20) connected in parallel to one (19) of the two resistors (18, 19).

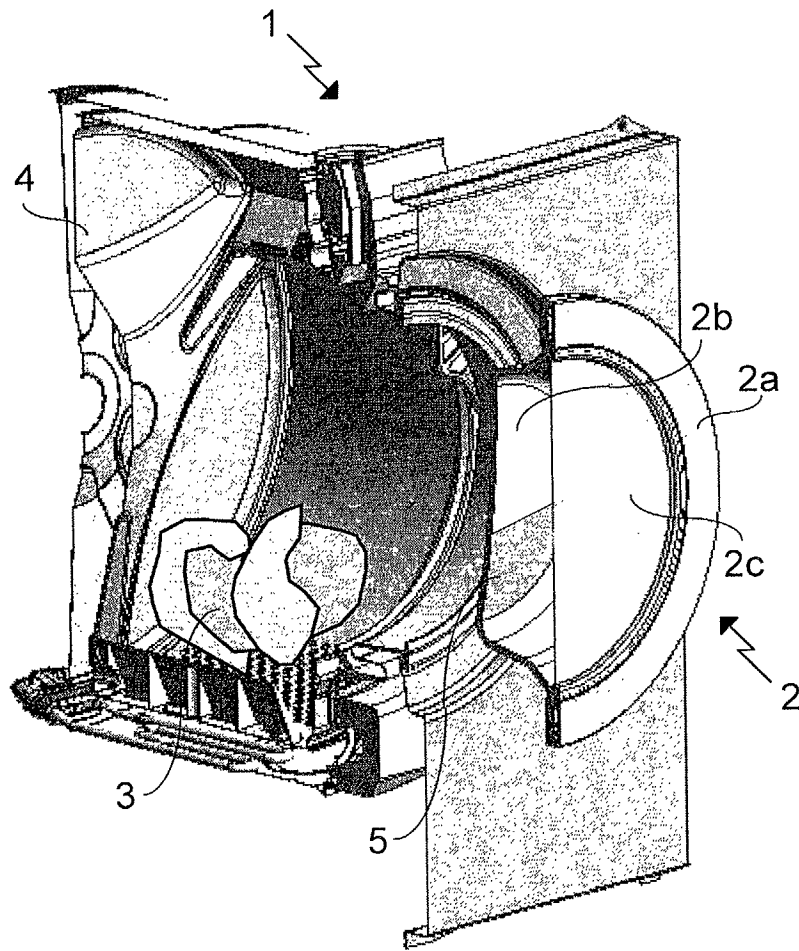


Fig. 1

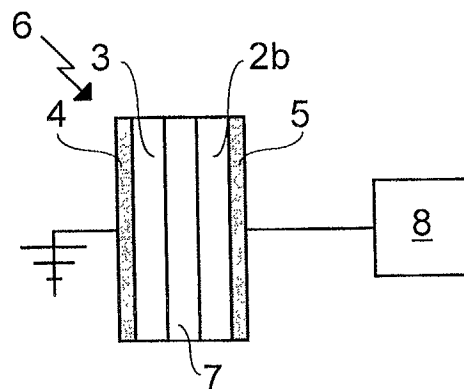


Fig. 2

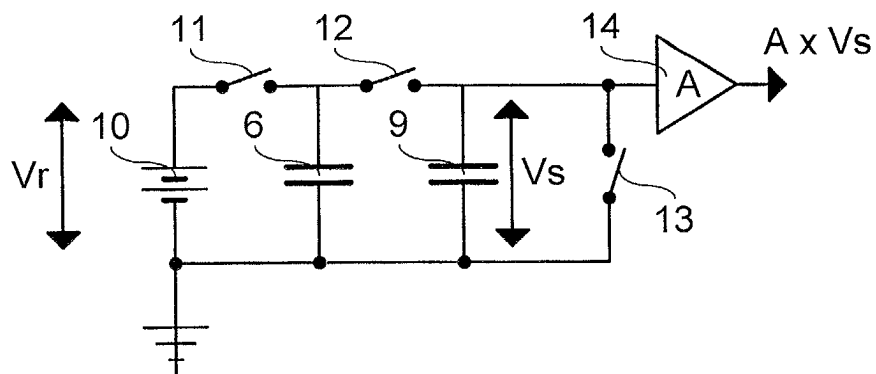


Fig. 3

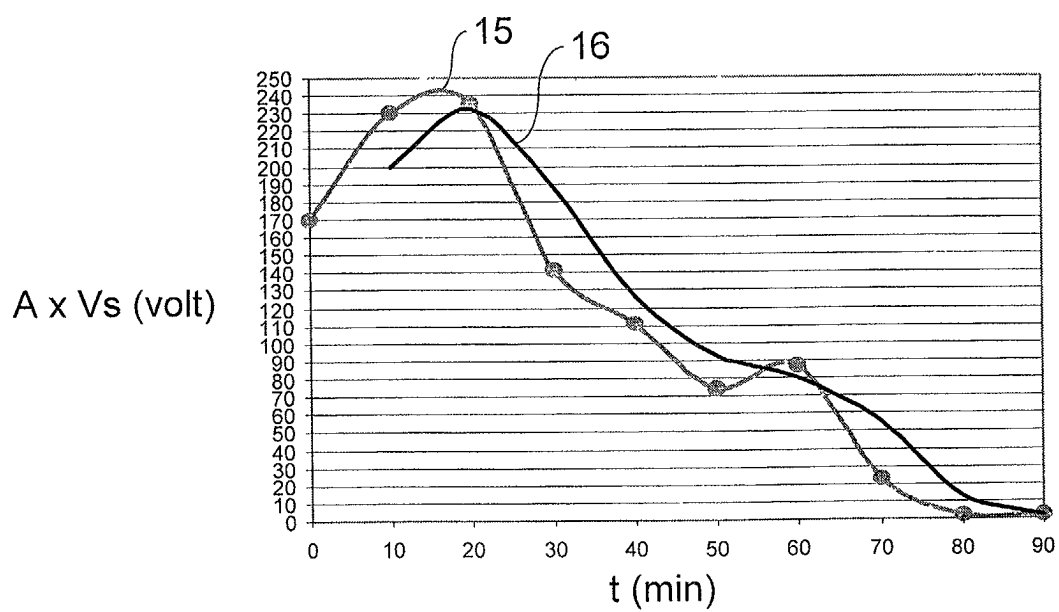


Fig. 4

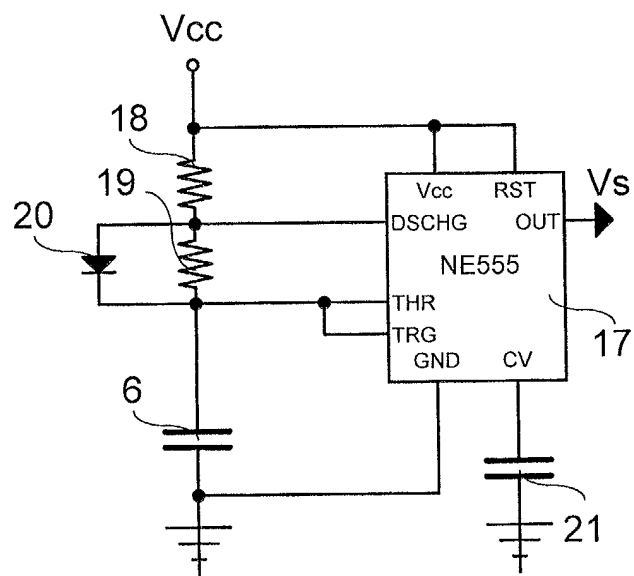


Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 02 42 5637

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Place of search		Date of completion of the search	Examiner
THE HAGUE		20 March 2003	Norman, P
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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