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(54) Dryer with modified drying program

(57) The invention relates to a method of drying textiles in a dryer (2), in particular a tumble-dryer or washing machine having dryer function, comprising: providing at least one drying program sequence; detecting the start humidity of laundry loaded into the dryer; and automatically modifying a drying cycle of the drying program in dependency of the detected humidity. A dryer comprises

a control unit (12,13,14) adapted to control at least one program sequence, a control panel (8) for selecting the at least one program sequence by the user, and a sensor unit adapted to detect the humidity of the laundry loaded into the dryer. According to the invention, the control unit (4) is adapted to modify and control the at least one program sequence in dependency of the detected humidity.

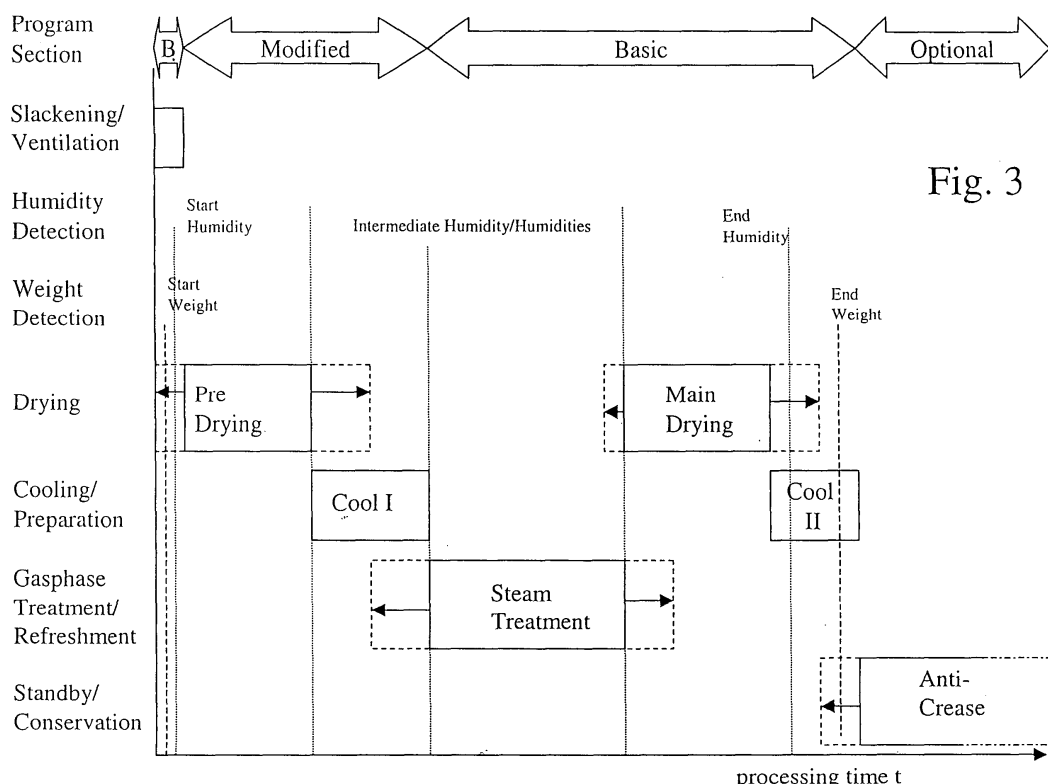


Fig. 3

Description

[0001] The present invention relates to a dryer having at least one drying program sequence and a sensor unit for detecting the humidity of the laundry loaded into the dryer.

[0002] EP 1 441 060 A1 discloses a tumble dryer having one or two injection units arranged in proximity of the loading door of the dryer to inject an additive like water steam, a cleaning detergent, a fragrance or a disinfectant into the drum. It is proposed to reduce, stop or reverse the air flow through the drum to optimize the efficiency of the injected additive. For modifying the air flow, a fan is arranged in an air channel supplying drying air into the drum, wherein the fan is driven by a motor separate from the driving motor of the drum and which is independently controlled by a control unit.

[0003] It is an object of the invention to provide a method for drying textiles and a dryer, which increase the user comfort and optimize the drying effect and the consumption of the dryer.

[0004] The invention is defined in claims 1 and 17, respectively.

[0005] Particular embodiments are set out in the dependent claims.

[0006] According to the method of claim 1 at least one drying program sequence is provided for drying laundry stored in a compartment of the dryer. The drying cycle performed according to the drying program sequence is automatically adapted in dependency of the humidity of the laundry detected by a humidity sensor. The detection of the humidity by a humidity sensor is preferably made when the drying cycle is already running. By adapting the drying cycle in this way, the effect of the complete drying cycle or at least a portion of sub-sequences of the drying cycle is optimized and the energy and time consumption are also modified according to the need determined on the actual starting humidity. In case that the drying method is performed in a washing machine having a dryer function, the starting humidity is of course an intermediate humidity of the laundry prior to starting the drying sequence of the washing machine, for example after spinning the laundry in the washing machine's drum. As the start or intermediate humidity is automatically detected and the drying cycle is automatically modified, the user does not have to manually optimize the drying program in dependency of the laundry's humidity. For example he does not have to manually activate a pre-drying cycle when wet laundry has been loaded into the dryer. In an alternative embodiment of the method or the dryer, the starting humidity is not detected but input by the user when selecting or starting the program sequence. Then an modification of the drying cycle is also made automatically.

[0007] In a preferred embodiment the drying program sequence includes at least one treatment sub-sequence executed during the drying cycle and including the supply of at least one additive to the laundry in the dryer. In

particular the effectiveness of the supplied additive(s) depends on the humidity of the laundry or textiles loaded in the dryer. If for example hot water steam is introduced during the treatment sub-sequence for removing crinkles or creases of the laundry, the effect is reduced, if the laundry is too wet or too dry during this steam treatment sub-sequence.

[0008] Preferably the modified portion of the drying cycle is preceding the treatment sub-sequence such that for example water is previously added to wet the laundry being too dry or a pre-drying sequence is added preceding the treatment when wet laundry has been loaded to achieve a lower degree of humidity.

[0009] The treatment sub-sequence may be for example a refreshment sequence, a chemical dry-cleaning sub-sequence, a disinfectant sequence, a softening sub-sequence or a combination thereof.

[0010] Preferably a fragrance or scent is not added to or included in the additives supplied during the treatment sub-sequence and, if a fragrance is to be added at all, a separate fragrance sub-sequence is provided during a main drying sub-sequence or a cooling sub-sequence thereafter. Thereby the efficiency of adding perfumes to the laundry is not eliminated or adversely affected by the treatment sub-sequence or the main drying sub-sequence.

[0011] According to an embodiment the drying cycle is modified in that an additional sub-sequence is introduced into the basic drying program, a standard sub-sequence is deleted and/or a standard sub-sequence is modified. Thereby a diversity of drying programs sequences is generated from a standard or basic drying program sequence without the requirement that the user selects an option or one of a plurality of drying programs. The humidity detection automatically results in a modified drying program optimized to the laundry condition and without the additional interaction with the user.

[0012] A pre-drying sequence is for example automatically selected by a program control when wet laundry has been loaded. Preferably before starting a treatment sub-sequence, a cooling or ventilation sequence is added - for example between a pre-drying sequence and the treatment sequence - such that laundry heated during the pre-drying sequence is cooled down to a temperature being optimal for the effectiveness of the treatment sub-sequence. A pre-wetting sequence is used for example before starting the treatment sub-sequence, if the laundry is too dry.

[0013] Preferably the humidity is detected by a humidity sensor which detects the air humidity in the drying air circulating through the storing compartment for the laundry. Or the humidity is detected by a conductivity sensor which is at least partially in contact with the laundry and detects the conductivity value of the laundry. Alternatively or additionally a temperature sensor is used for recording the temperature profile over time, for example after starting a heating sequence. In this case the temperature profile is an implicit method to determine the humidity - for

example the temperature rises with decreasing humidity of the laundry when the heating energy is kept constant. Alternatively a weight profile maybe recorded to determine the humidity wherein the loss of weight saturates when the laundry is reaching a dry level.

[0014] In an embodiment the humidity is detected in a starting phase of the drying cycle, for example when slackening the laundry by rotating and counter-rotating the drum in a tumble dryer or after having started the ventilation in a condensation dryer. The humidity can also be detected when a drying sub-sequence or pre-drying sub-sequence has been started.

[0015] The dryer according to claim 17 comprises a control unit modifying at least one program sequence in dependency of the humidity detected by a sensor unit of the dryer. As mentioned above in connection with the drying method, the drying result is optimized and the user comfort of starting the dryer is improved. The embodiments and the advantages connected therewith and as mentioned above for the embodiments of the method accordingly apply to embodiments of the dryer.

[0016] Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings which show:

Fig. 1 a scheme of input program selections and program options,

Fig. 2 control elements of a dryer, and

Fig. 3 a diagram depicting an exemplary program cycle including different sub-sequences of the drying cycle.

[0017] Fig. 1 schematically shows available programs and program options to be selected by the user. Mandatory selections (program selection) and optional selections (weight input, final humidity input) are shown. For running the exemplary dryer 2 of Fig. 2 not all of the optional user selections or the input of all detection results have to be implemented. In the following exemplary embodiment all input types shown in Fig. 1 are described - while keeping in mind that these have not to be implemented in any case or in any model of the dryer. Some of the inputs are made prior to the start of the program cycle (for example the program selection) while other inputs are made in the starting phase. For example the start humidity is determined by a humidity sensor 14 of the dryer 2 when the drying process has already been started. Preferably the user selections and user inputs are made prior to starting the drying cycle.

[0018] It is an object to reduce the extent of the interaction between a user and a user interface (here input panel 8 as mentioned below) to a minimum, while providing an optimum drying and/or dry/treatment result for the laundry or textiles and reducing consumption of resources (e.g. electrical energy and additives). Minimum user inputs reduce the time being necessary for the user

to start the dryer and the number of options (option button) to be provided at the input panel 8 for the user's selection.

[0019] As indicated in Fig. 1 an input of the type of textiles or laundry (cotton, synthetics, wool, silk etc.) is made either by a program selection or manually by the user. If for example the user selected program is specific for the type of textiles, no separate input for the type of textiles has to be made by the user. If the program is not destined for a specific type of textiles, a corresponding input can be optionally requested from the user. The type of the textiles results in an adaptation of the drying program sequence in respect of the temperature during the drying or treatment sub-sequences and/or the type and amount of additives supplied to the laundry.

[0020] In the same way the final humidity input for the final humidity of the laundry at the end of the drying cycle is either predetermined by a corresponding program selection or can optionally be input by the user. If, for example, a program is selected including "iron aid" or "pre-ironing" then the final humidity of the laundry is higher than in a program without such iron-specific determination. Optionally the user may manually select this for any of the drying programs. For example selection is made by pressing an option button "iron aid" assisting the subsequent ironing by a higher residual humidity of the laundry.

[0021] The weight of the laundry loaded into the compartment of the dryer 2 can either be automatically determined by a weight sensor 12 or is input by the user. For example the user input is a weight selection like "high", "medium" and "low". Or it may be a drum volume input like "full", "half full" and "few pieces". If such load input by volume is made, the type of textiles can be considered to derive the actual weight of the laundry (see arrow between inputs 'weight' and 'type' in Fig. 1). Also after inputting the weight and after detecting the start humidity, the dry weight of the textiles can be deduced by subtracting the expected water weight estimated on the basis of the humidity value (see arrow between inputs 'start humidity' and 'type' in Fig. 1). Of course also the type of textiles can be considered to calculate the dry weight which in turn is one of the factors to be included when determining an additive parameter like the amount of additive to be supplied to the laundry.

[0022] The starting humidity of the laundry is automatically determined by the humidity sensor 14 in a starting phase of the drying sequence. If for example a refreshment program is selected, the laundry loaded into the dryer is normally dry and no pre-drying sequence is required.

[0023] Fig. 2 shows principal elements of the tumble dryer 2 in a block diagram. The tumble dryer 2 is an electronically controlled program dryer, the program being executed and controlled by a central processing unit 4. The user interface of the dryer comprises a display section 10 and an input panel 8. The input panel 8 has a program selector 20 for selecting the main program, an

indicator section 22 to input for example the type of textile and the laundry weight. Options can be activated/deactivated by an option selector unit 24 to select for example the "iron aid" and so on. The signals of a temperature sensor 13, the weight sensor 12 and the humidity sensor 14 are transmitted to the CPU for monitoring and controlling the drying process. Control signals are sent from the CPU 4 to a motor 6 driving the drum (not shown) and to an additive injector 16 to inject the additives as for example known from DE 103 02 864 A1 having a spraying device 31 and a steam generator 33 as described therein.

[0024] An exemplary user interaction with the user interface for the selection and options shown in Fig. 1 is now described: The display section 10 is a touch screen accepting user inputs by touching soft buttons displayed on the screen which represent at least a portion of the input panel 8. As soon as the dryer is energized, the basic programs to be selected by the user are shown on the display and one of these basic programs is selected by the user. If a type of textiles is not determined by the basic selection, different types of textiles for selection are displayed. Thereafter a selection for the loaded volume as described above is shown - thereby implementing an implicit weight selection. When the weight or load selection has been made, a start button is displayed at the same time with additional options like the final humidity option button as mentioned above. These additional options can be activated by the user or can be skipped by starting the drying cycle with the start button.

[0025] Due to the main program selection, option selection, weight input, the textile type input and the detected starting humidity, the CPU 4 adapts the flow of sub-sequences involved, the duration of the sub-sequences (if not determined for example by a final parameter for the sub-sequence as the humidity), the temperature during the sub-sequence, as well as the type and amount of additive to be applied to the laundry (if necessary in the respective sub-sequence).

[0026] Fig. 3 shows a time diagram illustrating a basic drying program sequence including a steam treatment. The double arrows named "B" or "Basic" in the diagram indicate that these sections of the total drying cycle represent the core or basic program executed for a drying sequence when the laundry is dry and no option has been selected. "Modified" indicates which program section has been added due to the detection of a high starting or initial humidity (laundry wet) and "Optional" indicates a modification due to the user-selected option 'anti-crease'.

[0027] Here the basic drying program includes a steam treatment sub-sequence being executed to remove creases or crinkles in the laundry. During steam treatment hot and droplets-free steam is directly applied to the laundry in the drum. The anti-crease efficiency of applying steam to the laundry strongly depends on the type of textiles and the humidity of the textiles (see double-arrow between 'type of textiles' and 'start humidity' in Fig.

1). E.g. synthetic textiles require a residual humidity in a predefined range such that an overheating is prevented when applying the hot steam from the steam injector of injector unit 16. Additionally or alternatively the laundry temperature has to be below a specific temperature for some textile types and the laundry has to be agitated during a tumbling-mode to remove the crinkles efficiently in the treatment sub-sequence. In consequence and in dependency of the starting conditions (starting humidity, temperature for starting the treatment) the CPU 4 modifies the drying cycle such that at the start of the treatment sub-sequences the conditions are optimized or nearly optimized for the treatment. For example a pre-drying is activated due to the detection so that the laundry has a high starting humidity. In this case the high start humidity is not compatible with the steam treatment which requires a lower degree of humidity of the laundry for starting the steam treatment.

[0028] Another option which has been selected by the user is an 'anti-crease' sub-sequence following the main drying sub-sequence and preventing the generation of crinkles in the laundry when it is not immediately removed from the dryer's drum after finishing the main drying.

[0029] In Fig. 3 the program cycle starts with a ventilation sub-sequence in which the start humidity and the start weight of the laundry are determined by humidity sensor 14 and weight sensor 12. Alternatively the start humidity is determined by using the temperature sensor 13 and comparing the detected temperature profile over time with a prerecorded temperature profile to derive the starting humidity. To improve the result of such a determination of the start humidity the type of textiles and/or the starting weight of the laundry are parameters being used for correction (see double-arrows in Fig. 1). Heating of the drying air may be started in the ventilation sub-sequence as a part of the pre-drying sub-sequence (or the steam treatment sub-sequence if pre-drying is not necessary due to dry laundry).

[0030] The slackening and ventilation sub-sequence is followed by the pre-drying sub-sequence during which the start humidity is reduced. The pre-drying sub-sequence is followed by a cooling sub-sequence to reduce the temperature of the laundry to a value where the steam treatment sub-sequence can be started. During the steam treatment sub-sequence an additive is applied to the laundry via the additive injector 16. Preferably only water is used as additive during the steam treatment sub-sequence. In dependence of the selected program sequence during the steam treatment sub-sequence other additives are injected in addition to water or in combination or mixture with water, like a detergent for dry-cleaning or refreshment of the laundry.

[0031] The steam treatment sub-sequence is followed by the main drying sub-sequence in which no additive is supplied and which dries the laundry to the end humidity value given by the principal program or to the value modified by the program option selected by the user. A second cooling sub-sequence cools the laundry for removal from

the dryer or to a temperature where an anti-crease sub-sequence can follow.

[0032] After the main drying sub-sequence the anti-crease sub-sequence is started which keeps or preserves the laundry in the state as has been achieved with the end of the main drying sub-sequence. An additive is also supplied during the anti-crease sub-sequence in dependency of a weight determination which is indicated in Fig. 3 as end weight detection. The additive injected during the anti-crease sub-sequence is preferably, water only.

[0033] As indicated by the dotted lines, the individual sub-sequences may partially overlap each other. For example the steam treatment sub-sequence may partially overlap with the cooling and/or the main drying sub-sequence.

Reference Numerals List

[0034]

- 2 tumble dryer
- 4 CPU
- 6 motor
- 8 input panel
- 10 display section
- 12 weight sensor
- 13 temperature sensor
- 14 humidity sensor
- 16 additive injector
- 20 program selector
- 22 indicator section
- 24 option selector

Claims

1. Method of drying textiles in a dryer (2), in particular a tumble-dryer or a washing machine having dryer function, comprising:
 - providing at least one drying program sequence;
 - detecting the start humidity of laundry loaded into the dryer (2); and
 - automatically modifying a drying cycle of the drying program sequence in dependency of the detected start humidity.
2. Method of claim 1, wherein the drying program, sequence includes at least one treatment sub-sequence, the treatment sub-sequence in particular comprising supplying an additive to the laundry.
3. Method of claim 2, wherein the modification of the drying cycle is made in the sequence preceding the at least one treatment sub-sequence or each treatment sub-sequence.

4. Method of claim 2 or 3, wherein the at least one treatment sub-sequence includes applying at least one of the following additives to the laundry: pure water, a mixture comprising water, a dry detergent, a disinfectant, a softener.
5. Method according to any of the previous claims, wherein at least one sub-sequence of the drying program sequence is added, skipped or replaced by another sub-sequence during the drying cycle in dependency of the detected humidity.
6. Method of claim 5, wherein the sub-sequence is at least one of a pre-drying sub-sequence, a cooling sub-sequence, a ventilation sub-sequence, or a pre-wetting sub-sequence
7. Method of claim 5 or 6, wherein a pre-drying sub-sequence and/or a cooling sub-sequence are introduced into the drying cycle preceding a treatment sub-sequence.
8. Method according to any of the previous claims, wherein the humidity is detected by a humidity sensor (14), a conductivity sensor, a temperature sensor (13), a weight sensor (12) or a combination thereof.
9. Method according to any of the previous claims, wherein the humidity is detected in a starting phase of the drying cycle, in particular during a slackening and/or ventilation sub-sequence.
10. Method according to any of the previous claims, wherein no modification of the program sequence is made for a detected humidity in a first predetermined range of humidity, in particular in the humidity range from 0 to 10%, preferably in the range of 0 to 5% or 2 to 7%.
11. Method according to any of the previous claims, wherein at least a pre-drying sub-sequence is added for a detected humidity in a second predetermined range of humidity, in particular in the humidity range above 10%, preferably in the range above 5% or 7%.
12. Method according to any of the previous claims, wherein at least a pre-wetting sub-sequence is added for a detected humidity in a third predetermined range of humidity, in particular in the humidity range of 0 to 5%, preferably in the range of 0 to 2%.
13. Method according to any of the previous claims, wherein the time and/or temperature of the pre-drying sub-sequence depends on the detected humidity of the laundry.
14. Method according to any of the previous claims, wherein the modification of the drying cycle addition-

ally depends on the type and/or the weight of the laundry.

15. Method according to any of the previous claims, wherein the program sequence is one program sequence out of a plurality of sequences selectable by a user. 5
16. Method of claim 15, wherein at least two programs of the plurality of selectable program sequences is modified in dependency of the starting or intermediate humidity. 10
17. Dryer, in particular tumble dryer (2), comprising:
 - a control unit (4) adapted to control at least one program sequence;
 - a control panel (8) for selecting and/or starting the at least one program sequence by the user; and
 - a sensor unit (12, 13, 14) adapted to detect the start humidity of the laundry loaded into the dryer; 20

characterized in that 25

the control unit (4) is adapted to modify and control the at least one program sequence in dependency of the detected humidity.

- 18. Dryer according to claim 17, comprising a supply unit (16) adapted to supply at least one additive to the laundry to be dried in the dryer (2), wherein the control unit (4) is adapted to control at least one treatment sub-sequence as part of the at least one program sequence. 30
- 19. Dryer according to claim 17 or 18, wherein the at least one treatment sub-sequence includes applying at least one of the following additives by the supply unit (16) to the laundry: pure water, a mixture comprising water, a dry detergent, a disinfectant, a softener. 40
- 20. Dryer according to any of claims 17 to 19, wherein the control unit (4) is adapted to add, skip or replace by another sub-sequence at least one sub-sequence of the drying program during the drying cycle in dependency of the detected humidity. 45
- 21. Dryer according to claim 20, wherein the sub-sequence is at least one of a pre-drying sequence, a cooling sequence, a ventilation sequence, a pre-wetting sequence. 50
- 22. Dryer according to any of claims 17 to 21, wherein the control unit (4) is adapted to introduce a pre-drying sequence and/or a cooling sequence into the drying cycle preceding a treatment sub-sequence. 55

23. Dryer according to any of claims 17 to 22, wherein the sensor unit comprises a humidity sensor (14), a conductivity sensor, a weight sensor (12) and/or a temperature sensor (13) adapted to detect at least the start humidity.

24. Dryer according to any of claims 17 to 23, wherein the control panel (8) comprises at least one of the following:

a program selector (20), a weight selector (22), and a final humidity selector (22).

25. Dryer according to any of claims 17 to 24, wherein the control unit (4) is adapted to execute a program implementing the method of any of claims 1 to 16.

Fig. 1

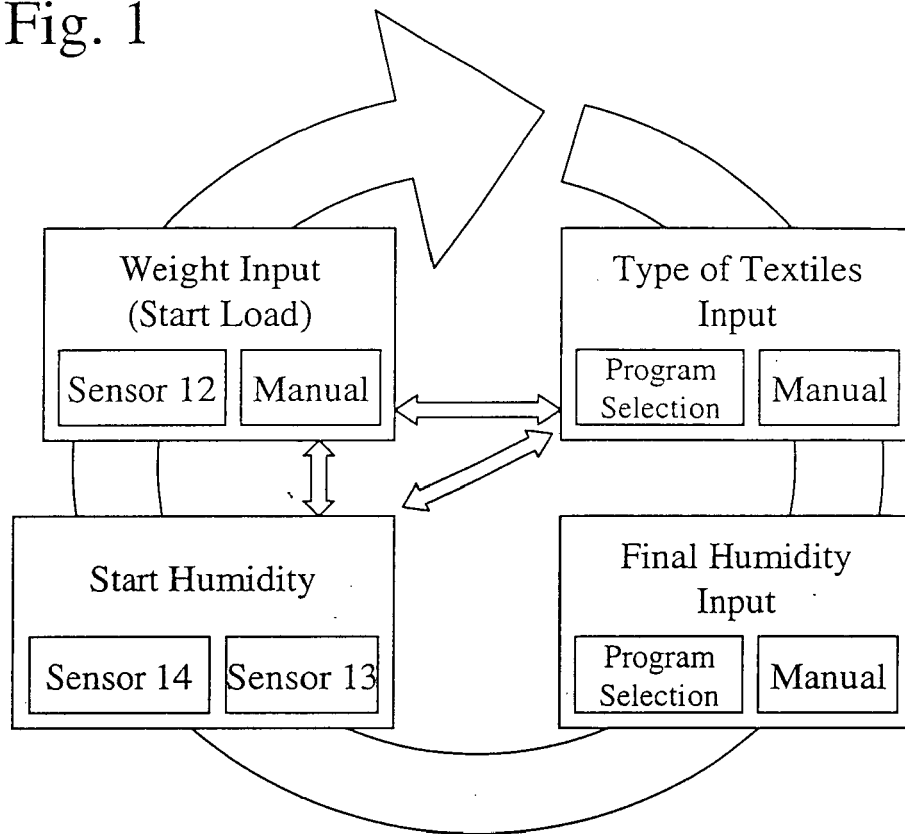
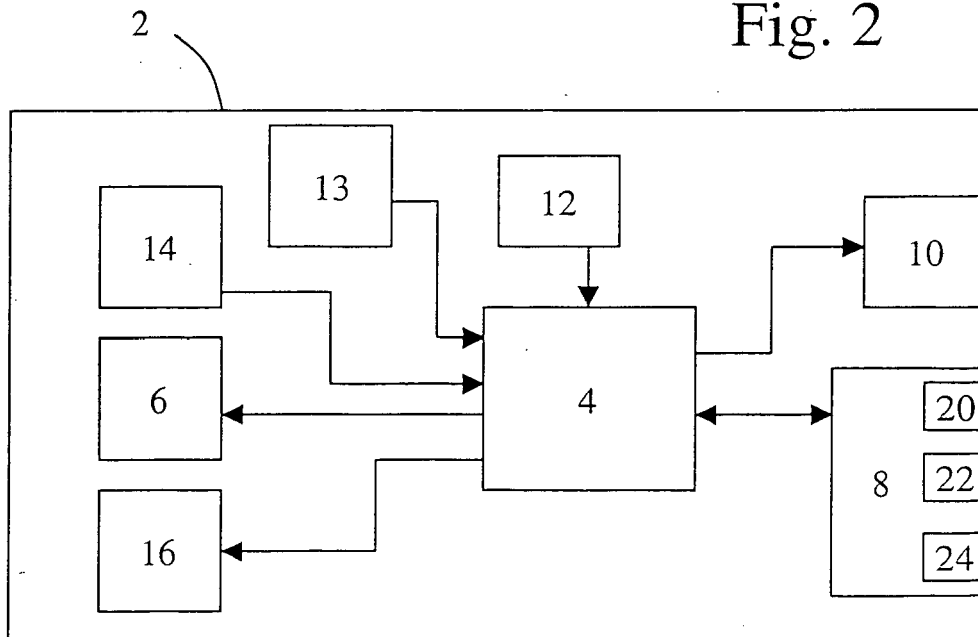


Fig. 2



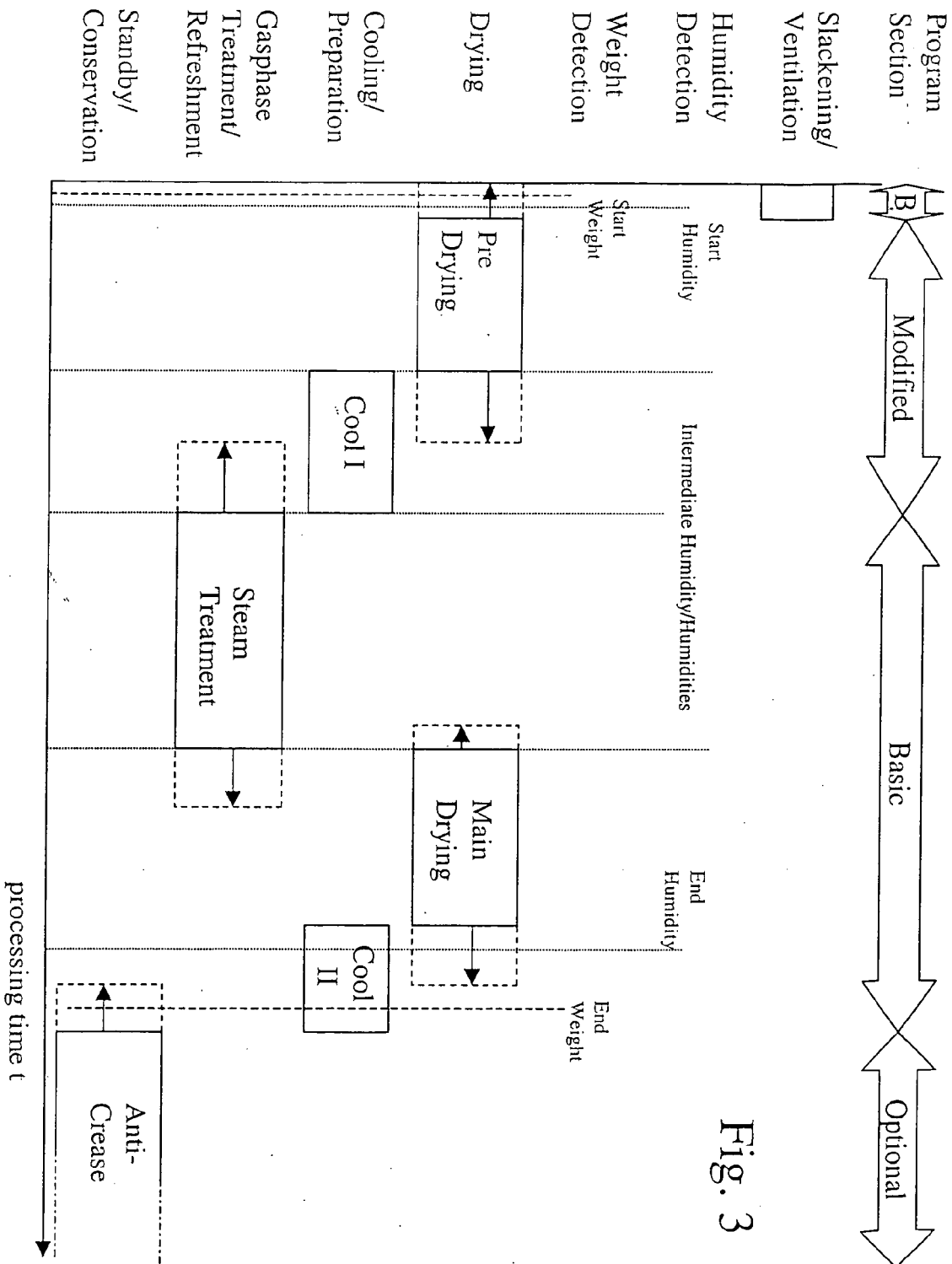


Fig. 3



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 06 00 9015

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 August 2006	Examiner DIAZ, M
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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