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(54) Ironing machines and methods

(57) An ironing machine 100 is disclosed, in which a fabrics workpiece 1 is fed past a heated ironing cylinder 7 by a set of endless belts 3 and associated rollers 6, 8, 9. The ironing machine 100 further comprises sensing means 15 connected to a control system 20, the sensing means 15 being arranged in use to supply to the control system 20 a signal indicative of humidity in at least a portion of the workpiece 1 upstream or downstream of the ironing cylinder 7. The control system 20 controls at least one operating parameter of the ironing machine 100 in response to that signal.

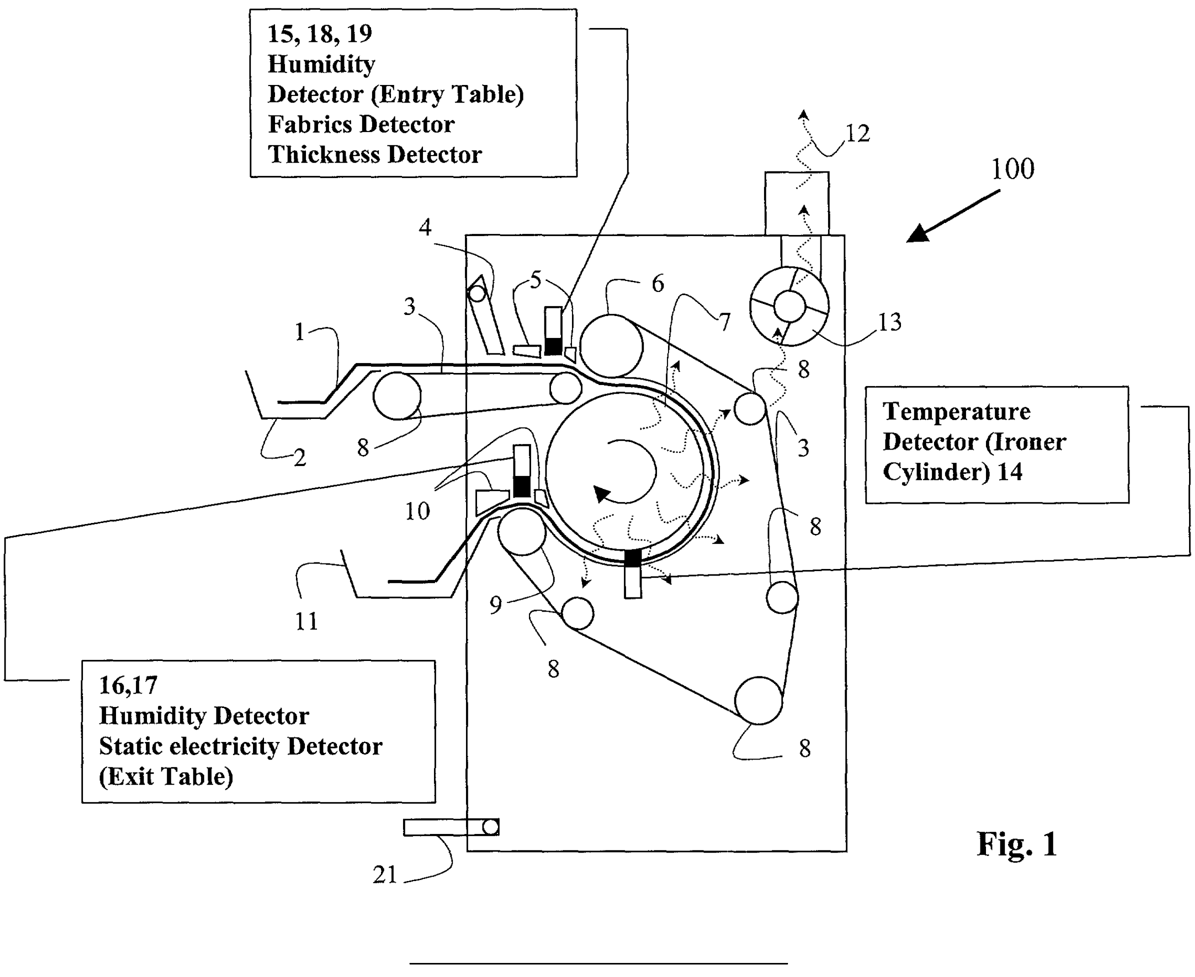

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to ironing machines and in particular, but not exclusively, to control of operating parameters of such apparatus and associated control methods.

BACKGROUND TO THE INVENTION

[0002] It is known to provide laundry apparatus adapted to iron fabrics on an industrial scale, such fabrics often comprising linen and sometimes being referred to for convenience as flatwork. Some such prior art apparatus comprise in general terms a heated main cylinder, having several small cylinders and textile belts that convey fabrics workpieces across and in contact with the heated main cylinder. Heating of the main cylinder may be provided by a variety of means, such as electrical elements, gas or steam and a preferred situation is to keep the main cylinder and the ironing process at a stable temperature. The efficiency of ironing depends on a combination of cylinder temperature, ironing pressure and the transportation speed of the fabric across the surface of the heated main cylinder.

[0003] In EP-0528745, an arrangement is proposed in which means are to be provided to control the speed and temperature of the ironing process. The proposed arrangement includes a detector device for measuring the surface temperature of a heated main cylinder and a control device that varies the speed of rotation of the ironing cylinder as a function of its measured surface temperature. This approach is based on a compromise between adding heat to the cylinder and its cooling from water that is evaporated during the ironing process.

[0004] DE-A-2219895 describes a mangle having a plurality of heated rollers in which humid air is drawn from each heated roller. The dew point of the air extracted is measured which gives an indication of the moisture content. This measurement is used in conjunction with the temperature of the rolls to control the speed of the machine.

[0005] In EP-1096053, an arrangement is proposed in which the atmosphere in the vicinity of an ironing cylinder is monitored for temperature and humidity. Samples are captured in a chamber for measurement and, on deviation from a nominal value, at least two parameters of the ironing action are modified in an attempt to bring the measured values into line with the nominal humidity value.

[0006] For the above-mentioned prior art proposals, the fabric moisture is measured indirectly and does not necessarily have a direct relationship with the actual humidity of the fabrics. Due to the heating in the ironing process, the water in the fabrics is vaporised and by means of a sensor for air humidity the system can detect in general if the ironed fabrics is wet or dry. But as a major disturbing factor, such a control system has to deal with the ambient air humidity. Air humidity depends at least in part on the weather and in previous solutions the improvements were related to compensation for the disturbing influences of the ambient humidity.

[0007] Another even greater disturbing factor is the volume of air extracted by the ventilator. As the extraction rate depends on the construction parameters of the exhaust system and of the amount of false air that is sucked in, the amount of humidity in the air is difficult to determine accurately. With a small amount of ambient air sucked in, the air measured will be easily saturated if you are ironing linen with a huge amount of humidity.

[0008] Because vapours must be produced before a measurement can be made, the ironing speed can only be adjusted when the ironing is already in progress. These prior art control systems can only react with an important delay time caused by the thermal inertia, as the fabrics must be heated first so that the detectors can function properly. A big disadvantage of these systems is that they work with a big time delay by which the speed of ironing is always adapted according to the piece of fabric that leaves the ironing machine and not according the fabric that enters the machine. This time delay is caused by the fact that the measuring systems must be placed at the exit, because otherwise they may be disturbed by condensation of the vapours and dust. Also, in order to keep the costs of the system reasonable, the vapours are tapped off at several points of the ironer but are only measured by one humidity device, which again gives an incorrect regulation of the speed.

[0009] The prior art systems are also not able to detect the difference between small parts or big parts of fabric, or between thin and thick parts. Small parts will not produce much vapour, while big parts can produce a lot. When the residual moisture of the ironed fabrics is already small (e.g. first dried in a tumble-dryer or similar) it is difficult to determine automatically the relationship between the size of the fabrics and the vapours produced.

[0010] For such solutions, the variation of the residual humidity of the ironed fabrics is not really controllable. As the operator does not know the residual humidity, in some cases the fabrics may be ironed in such a way that the fabrics will be drier than required. This will often reduce the lifetime and quality of the fabrics. On the other hand, if the fabrics are not dried well initially, the fabrics must be ironed again, which will cost extra labour and energy and reduces productivity.

[0011] If the residual humidity of the fabrics after ironing is still 8 to 12%, wet spots will probably still be present as before ironing the moisture is not always equally divided over the fabrics. If the fabrics are not sufficiently ironed, it will still have a too high residual humidity at such a spots. Without further notice, the moisture at these spots allows bacteria and mould to grow, so the fabrics may get damaged and must potentially be thrown away.

[0012] If the ironing speed is controlled in direct relation to the heating cylinder temperature, the temperature may be measured at the middle of the cylinder. When the temperature drops the ironing speed is reduced and vice versa. A main negative point is that the fabric has to be inserted always in the middle by which the temperature of the edges of the cylinder increases, thus causing unequal ironing quality. This may lead to overheating of the edges of the cylinder.

[0013] Another disadvantage is that only the speed of the ironer is adapted but not the power of the heating system. This is important in keeping the production capacity constant. In an ideal case, the ironing speed is always maximum independent of the moisture contain by the linen.

[0014] As a result, the prior art solutions discussed are not really satisfactory. The operator still has to guess and set the optimal ironing speed for each piece of ironed fabrics.

SUMMARY OF THE INVENTION

[0015] It is an object of the present invention to provide an improved ironing machine and in particular, but not exclusively, to provide improved control of operating parameters of such apparatus and associated improved control methods.

[0016] Accordingly, the present invention provides an ironing machine having an ironing means comprising an input and an output for receipt and discharge respectively of laundry workpieces and a feed means arranged in use to feed a said workpiece into said inlet and to feed said workpiece out of said outlet, said ironing machine further comprising sensing means connected to a control means, said sensing means being for direct in situ measurement of a value related to humidity in at least a portion of a workpiece, said sensing means being arranged in use to Supply to said control means a signal indicative of said humidity of at least the portion of said workpiece and said control means being arranged in use to control at least one operating parameter of said ironing machine in response to said signal. The arrangement of the present invention detects a humidity of the fabrics workpiece itself before and/or after ironing, thus taking a substantially direct measurement thereof rather than, for example, deriving an estimate from detection of environmental humidity. Thus the sensing means may be located at the input and/or output of the ironing machine.

[0017] The structure of the ironing machine may include an outer casing which houses the ironing means, the ironing means being expressed in one embodiment in the form of an ironing cylinder provided with a heating system to keep the ironing cylinder at a specific temperature. A pressure cylinder may also be provided, which may be arranged substantially parallel to and above the ironing cylinder. The pressure cylinder may comprise part of an inlet of the ironing means and may cooperate with a plurality of textile belts. Such an inlet means may be arranged in use to feed a fabrics workpiece into the ironing means and to drive it through the machine from the inlet to an outlet and to keep it in contact with the ironing cylinder. The inlet may comprise an entry table and the outlet may comprise an exit table of said ironing machine adapted for return to an operator of an ironed workpiece downstream of the ironing means.

[0018] A said operating parameter may comprise an ironing temperature. Said ironing temperature may comprise a reference ironing temperature and a further said operating parameter may comprise an ironing speed, said control means being arranged to control said ironing speed in such a manner that said workpiece approaches a target residual humidity set with respect to said reference ironing temperature.

[0019] A said operating parameter may comprise an ironing speed. Said ironing speed may comprise a reference ironing speed and a further said parameter may comprise an ironing temperature, said control means being arranged in use to control said ironing temperature such that said workpiece approaches a target residual humidity set with respect to said reference ironing speed.

[0020] Said ironing machine may therefore comprise sensing means arranged in use to supply to said control means an inlet humidity signal indicative of the humidity of at least a portion of said workpiece upstream of said ironing means, as well as a downstream sensing means to supply an outlet humidity. The upstream and downstream sensing means are preferably arranged to sense the humidity of said workpiece in a region having a portion at least partially common to both said sensing means. By sensing the humidity upstream, possibly at the entry table, the present invention enables a control system to set an ironing speed value to be used before heating of the fabrics is started and in relation to the temperature of the ironing cylinder and preselected residual humidity of the workpiece. This reduces the potential inaccuracies which might subsist if humidity were to be measure only downstream of the ironing means, thus introducing a propagation delay into the feedback provided to the control means.

[0021] Sensing means at the inlet and outlet are preferably in the same plane (e.g. vertical), such that at least part of the same portion of the workpiece passes associated sensing means operative upstream and downstream of the ironing means.

[0022] The sensing means (detectors) may comprise any suitable sensing means for direct measurement of humidity in the workpiece, i.e. a sensing means which measures a property of the material of the workpiece affected by humidity. Non-contact sensors are preferred. Capacitive sensors with multiple detection distances to measure the thickness of the fabrics and the distance of the fabrics to the detector head are preferred. Such sensors may be used to compensate for variations in the detection distance and thickness of the fabrics at the ironing process. Detectors can be capacitive detectors/sensors adapted to measure changes in dielectric value of the fabrics. The detectors may include one or more temperature sensing elements to compensate for variations in detected parameters, e.g. variations in the temperature of the fabrics and in the sensing capabilities of the capacitive sensors caused by variations in the dielectric constant of water. The detectors may be mounted at the same side or at opposite side of the fabrics.

[0023] Said ironing machine may further comprise sensing means arranged in use to supply to said control means a signal indicative of the thickness of at least a portion of said workpiece. The thickness may be measured by means of a non-contact method, e.g. by reflection of a light signal incident under a fixed angle on the fabrics. The location of a reflected signal may be a measure of the variation of the thickness of the fabrics and may be captured by a light sensitive sensor. The thickness may be measured by means of a contact method, e.g. by means of a mechanical arm that slides over the fabrics. The arm may have a hinge on which it can turn and a change in thickness of the fabrics may be detected by a sensor that measures the change in position of the arm.

[0024] The one or more sensors of said sensing means may measure, sense or detect at least one property of the workpieces such as electric conductivity or dielectric constant. For instance, the sensors are arranged to measure values of capacitance or resistance of a portion of said workpiece. For example, humidity detectors may measure the dielectric value of the fabrics workpiece by means of capacitive electrodes or may use conductive electrodes to measure the conductivity of the workpiece from which a humidity value may be derived. The capacitive or conductive detector can be a separate capacitive or conductive detector with a dc or mAmp output, a separate capacitive or conductive detector with integrated Signal Converter Interface (SCI), or just separate electrodes with a cable to an SCI or another analogue-digital control circuit, integrated or not in an electronic control system of the ironing machine.

[0025] In the case of a capacitive detector, the detector should preferably be electrically insulated from the fabrics. The fabric functions as the dielectric of the capacitive electrodes. The electrodes can be mounted in such a way that the fabrics workpiece passes in between or not in between the electrodes. The electrodes can be concentric, mounted next to each other (which means the fabrics workpiece doesn't pass in between the electrodes), above each other (which means the fabrics workpiece passes in between the electrodes) and can have many shapes or sizes. The electrodes can be big enough to substantially cover the surface of the ironing cylinder or so small that they are mounted in an Integrated Circuit (IC). They can be mounted inside or outside an enclosure which houses the ironing cylinder. The fabrics workpiece can make any angle with the electrodes. The capacitive detectors may be provided with a protective coating or insulation that resists ironing temperature and is resistive to chemicals that can be expected at the laundry/ironing process. The capacitive detectors may be provided with electrodes that touch the fabrics and are substantially insensitive to static electricity caused by the friction of dry or drying fabrics, or with electrodes that do not touch the fabrics and are also substantially insensitive to static electricity.

[0026] Said ironing machine may further comprise sensing means arranged in use to supply to said control means a signal indicative of a level of static electrical charge on at least a portion of said workpiece. The detection system for static electricity may be positioned in the region of an exit table of the ironing machine and used to prevent the fabrics from being charged with static electricity during the ironing process. This helps prevent the residual humidity of the fabrics getting below an acceptable level. The detection system for static electricity may comprise an electrical insulation material that causes static electricity by friction and a sensing system that measures the static electricity. The detection system for static electricity may operate without making contact with the fabrics and with a sensing element that measures the change and occurrence of electric charge at a close distance to the fabrics.

[0027] Said ironing machine may further comprise a fabrics sensing means arranged in use to supply to said control means a signal indicative of the nature of at least a portion of said workpiece, such as for example a structural feature, material, width, classification, type or labeling thereof. The nature of the fabrics may be detected by an identification system to read a barcode or RF-responsive label or other identification element. By this ID-code the ironing control system can directly or indirectly by means of a central database system obtain the ironing properties of the material and set the related optimal ironing speed and temperature automatically. The identification system allows also the total laundering process to be followed up and the calculation of the related costs (like ironing energy) involved in the ironing process.

[0028] A said sensing means may comprise a light based detection system arranged to generate a signal on the basis of at least one of reflective or translucent properties of said workpiece. In the event that the fabrics detection system is based on the reflective characteristics of fabrics, it may comprise a light emitter and a light sensing element. The light source can be mono phase like a laser or can send a light spectrum between infrared up to ultraviolet or can even be invisible for the human eye.

[0029] The light based system may extend across the whole width or only part of the workpiece. The system may be provided with multiple capacitive and/or conductive detectors to cover the whole width of the ironing table to measure the humidity and presence or absence of the fabrics, e.g. with the purpose of measuring the width of the fabrics and getting an average value of the total humidity of the fabrics.

[0030] In the event that the fabrics detection system is based on the translucent properties of fabrics, light may be projected on the fabrics and, at the other side, a photosensitive element may be used for measuring the light that passes through the fabrics. The detector may comprise a light emitter and a light sensing element. The light source can be mono phase like a laser or can send a light spectrum between infrared up to ultraviolet or can even be invisible for the human eye.

[0031] A control operation by said control means of said at least one operating parameter may be adaptive in accordance with one or more signals from one or more sensing means. Said adaptive control may be arranged to modulate heating of said ironing means such that a predetermined residual humidity is achieved without an ironing speed falling below a predetermined level and only allowing said ironing speed to fall below said predetermined level when a maximum level of modulation has been employed for said heating temperature.

[0032] Said adaptive control may be arranged to take account of a propagation delay of said workpiece through said ironing machine. This may be achieved using adaptive control to compensate for a time delay between measuring a said parameter of substantially the same part of the fabrics moving through the ironing machine from the inlet to the outlet (e.g. entry/exit tables). The values measured may be stored in a volatile memory of a control means.

[0033] The capacitive or conductive detector can be a separate capacitive or conductive detector with a dc or mA output, a separate capacitive or conductive detector with integrated SCI, or just separate electrodes with a cable to the SCI or another analogue-digital control circuit integrated or not in the electronic control system of the ironer. The sensing means may include a reference electrode to compensate disturbing factors like those that might be caused by an enclosure. The sensing means may use an oscillating detection frequency within the frequency range of 1 kHz up to 750 MHz.

[0034] The ironing machine may further comprise a display and/or manual input means (e.g. keypad) e.g. so as to allow monitoring of actual values and adjustment of settings. The ironing machine may further comprise mechanical parts, such as distance pieces, adapted to keep the fabrics workpiece at a substantially constant distance from a said sensing means such as a humidity detector.

[0035] The present invention also provides a control means for an ironing machine, said control means being arranged in use to control at least one operating parameter of said ironing machine in dependence on one or more signals from sensing means, a said signal being indicative of a humidity of at least part of a laundry workpiece upstream and/or downstream of an ironing means of said ironing machine. A said operating parameter may comprise at least one of an ironing temperature or an ironing speed. The ironing temperature may be variable by providing variable control of heating power of the ironing means. The ironing speed may be variable, e.g. by varying the speed of a drive motor. The control means may comprise a micro-controller or microprocessor system with at least one memory element that allows the averaging and processing of the averaged and filtered signals of the different detectors taking part in the ironing process.

[0036] Control of a said parameter may be adaptive in accordance with one or more signals from said sensing means. The adaptive control may, for example, adjust ironing speed values as a feedback system. If, at the end of an ironing operation, the residual humidity does not fall within predefined limits, the speed value may be adjusted in small steps until the residual humidity is the optimal value for the ironing process in relation to the preselected and actual ironing temperatures. These new optimal values may replace or supplement originally stored or programmed values and may be kept in a non-volatile memory of the control means. The control means may comprise a signal converter interface (SCI), e.g. for measuring/processing conductivity, capacitive or temperature values.

[0037] The present invention also provides a method of controlling an ironing machine, the method including:

a) direct sensing of a value related to in situ humidity in at least part of a laundry workpiece upstream and/or downstream of an ironing means; and
b) controlling an operating parameter of said ironing machine in proportion to a sensed level of said humidity.

[0038] The method detects/senses a value related to the in situ humidity of the fabric workpiece itself and not that of its environment. A said operating parameter controlled may comprise at least one of ironing temperature or ironing speed.

[0039] Said ironing temperature may comprise a reference ironing temperature and said method may include varying said ironing speed such that said workpiece approaches a target residual humidity set with respect to said reference ironing temperature.

[0040] Said ironing speed may comprise a reference ironing speed and said method may include varying said ironing temperature such that said workpiece approaches a target residual humidity set with respect to said reference ironing speed. The method may include controlling a said parameter adaptively in accordance with one or more signals from sensing means. The method may include modulating heating power applied to the ironing means in such a way that a desired ironing temperature and desired residual humidity will be reached without the need for decreasing ironing speed. Preferably only if maximum modulation for a certain ironing temperature is reached, will the ironing speed be decreased. Modulation may be achieved by regulating switch on/off time or by partial switching of the heating power.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041]

Figure 1 is a schematic side elevation of an ironing-folding machine according to the invention;
Figure 2 is a basic block diagram of the main control functions;
Figure 3 is a schematic overview of the ironing process;
Figure 4 is a time table of the ironing process; and
Figure 5 is a graph that shows the relationship between ironing speed and humidity measured using a capacitive detector.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0042] The present invention will now be described with reference to certain embodiments and with reference to the above mentioned drawings. Such description is by way of example only and the invention is not limited thereto.

[0043] Referring to the drawings and for the moment in particular to Figure 1, an ironing machine 100 comprises an outer casing that houses an ironing means that includes a heated ironing cylinder 7. The cylinder 7 is adapted for rotation and its surface is kept to a specific and preferably predetermined temperature by means of a heating system. The heating system is not shown separately and may take a variety of forms, e.g. electrical, gas or steam heating. The cylinder 7 is driven for rotation by a suitable variable speed motor and transmission (not shown). A feed means is provided in the form of a pressure cylinder 6, which rests substantially parallel to and on the ironing cylinder 7, and a plurality of continuous/endless textile belts 3, which are trained around the pressure cylinder 6 and around a series of belt cylinders 8. In at least one point of their path, the belts 3 are trapped between cylinders 6, 7, 8 in such a way that movement is imparted to the belts 3 and they feed a fabrics workpiece into the machine 100 and drive it through, keeping the fabric 1 in contact with the heating cylinder 7. At the end of the ironing process, the feed means is adapted to return the fabrics workpiece 1, via an outlet comprising an exit table roller 9, to an operator in an ironed condition.

[0044] The ironing machine 100 may include a surface temperature detector device 14 for measuring the temperature of the surface of the heated ironing cylinder 7. Humidity measuring devices 15, 16 for measuring the humidity of the fabrics work piece 1 are mounted at the entry table/top fabrics holder 2 and/or at the exit table/bottom fabrics holder 11 of the ironing machine 100. The humidity measuring devices preferably measure directly a value related to the humidity within the fabric rather than in air surrounding the fabric. The measurement is preferably of a material property of the fabric which is affected by humidity content.

[0045] The operation of the ironing of the invention is essentially as follows: once an ironing temperature has been achieved at the surface of the heated ironing cylinder 7 that is suitable for the type of fabric 1 (e.g. cotton, linen, synthetics) to be ironed, the fabrics work piece 1 is put in the top fabrics holder 2. The top fabrics holder 2 acts as an input of the machine 100 and is used for receipt of fabrics workpieces upstream of the ironing cylinder 7. The operator then shifts the fabrics 1 over transportation belts 3 and initiates a machine ironing cycle, e.g. by means of a user device such as a pedal 21 if part of the ironer 100. Initiating an ironing cycle starts the belts 3 and cylinders 8 turning at the entry table 2. By friction, the fabrics 1 are transported automatically by the belts 3 into the machine 100 between the pressure cylinder 6 and the heated ironing cylinder 7. Finger protection 4 is provided to protect an operator from injury and is adapted to put the drive motor in reverse if something goes wrong at the entry table 2, e.g. if an operator body part passes beyond a finger protection trip switch 4.

[0046] Next, the inserted piece of fabric 1 passes the entry table humidity detector 15 at the entry table 2. Mechanical parts in the form of distance pieces 5 keep the fabrics 1 at a constant distance from the head of the humidity detector 15 and its capacitive electrodes. The information gathered by the humidity detector 15 is sent to a electronic control means/system 20 and, as a consequence, the control system 20 starts modulating the heating of the heated cylinder 7 so as to obtain the necessary power output according the desired/reference ironing temperature and also, if necessary, sets the ironing speed to a predefined (reference) value according the desired residual humidity.

[0047] As the fabrics 1 are heated by the main cylinder 7, vapours 12 will appear and are sucked away by means of a ventilator 13. As the fabrics 1 leave the ironing process at the exit table 11, passing over an exit cylinder 9, the fabrics 1 are kept by means of mechanical distance pieces 10 at a constant distance from the head of the exit table humidity detector 16 and its capacitive electrodes at the exit table. Next, the fabrics 1 fall into the bottom fabrics holder 11, which acts as an output for return of fabrics workpieces downstream of the ironing cylinder 7. In a case where the ironing machine 100 is provided with a folding mechanism (not illustrated), the fabrics 1 will be folded automatically when leaving the exit table.

[0048] By means of the second humidity detection device 16, the control system 20 obtains feedback of the residual humidity of the fabrics 1 after the ironing process has been performed, i.e. downstream of the ironing means. The control system 20 is adaptive, by which is meant that it will actively vary or alter stored or calculated values so as to optimise modulation, in real time or in future cycles, of at least one and preferably both of the ironing cylinder temperature and ironing speed to reflect the substantially instantaneous measured temperature and/or humidity values of the processed fabrics 11. The feedback ensures that the ironing process is more automated than some existing arrangements and therefore more uniform and reliable. In addition, the process may not need intervention of the operator for quality control, e.g. to check and see if the fabrics must be put through the ironing machine 100 again. This can be assessed instead by the control system 20 on the basis of the feedback from at least the exit table humidity detection device 16.

[0049] It should be noted that the modulation of cylinder heater power and any subsequent adaptation of control strategy is preferably performed in a first step, while modulation and/or adaptation of the ironing speed is performed in a second step. This has as a consequence that the speed of ironing should always be regulated to the maximum possible in accordance with the desired temperature of ironing, desired residual humidity and having the modulation of power exploited to the maximum according to the desired temperature of ironing unless otherwise wanted by the operator. Modulation of power can be arranged by switching a certain percentage of the power (this is especially the case for electrical or gas heated ironers) or can be done through modulation of the power in time (this is the preferred case for gas or steam heated ironers).

[0050] Referring now also to Figure 2, the control apparatus 20 operates as follows. Pre-set values can be entered by a keypad and may include one or more of the desired ironing temperature, the desired ironing speed, the desired residual humidity and the maximal acceptable electrostatic charge. A display may be provided to help in checking and/or setting ironing or other machine parameters.

[0051] By measuring the humidity of the fabric material itself at the exit table 16, the electronic control system 20 is able to obtain a downstream humidity feedback signal indicative of the actual residual humidity of the fabrics workpiece itself. This feedback alone may be used to control at least one operating parameter of the ironing machine. Alternatively or additionally, an inlet humidity signal indicative of the humidity of the fabrics at the entry table may be used to control operation. Further feedback, e.g. of the temperature of the surface of the ironing cylinder 14 may further assist in automatically setting parameters such as optimal power modulation and heated cylinder rotational speed values.

[0052] The ironing temperature may be set as a reference temperature, e.g. on the basis of heat required for a given input humidity. In that case, the ironing speed may be a parameter under control on the basis of feedback of residual humidity. The control system 20 would then be set to control the ironing speed in such a manner that the workpiece approaches a target residual humidity set with respect to that reference ironing temperature. In the event that the ironing speed comprises a reference ironing speed and a controlled parameter comprises an ironing temperature, the control system 20 may control the ironing temperature such that the fabrics workpiece 1 approaches a target residual humidity set with respect to the reference ironing speed. In either of these cases, in the event that a maximum level of modulation is reached without achieving a desired temperature or speed as the case may be, then the reference parameter itself may be varied. Thus, by adaptive control, the control system 20 may be arranged to modulate heating of the ironing cylinder 7 such that a predetermined residual humidity is achieved without an ironing speed falling below a predetermined level and only allowing the ironing speed to fall below that predetermined level when a maximum level of modulation has been employed for the heating temperature.

[0053] By means of an electrostatic charge detector 17 at the exit table and an optical fabrics detector 18 at the entry table, excessive ironing of some delicate fabrics is prevented and the chances of damage can thus be reduced. By means of a thickness detector 19 at the entry table, the ironing process can be optimised to the actual thickness of the fabrics 1 being processed.

[0054] In Figure 3, a partial schematic view is provided of the arrangement of Figure 1, in which the belts 3 that make the fabrics 1 travel are omitted. The fabrics 1 travel from the entry table rollers 6, 8 to the exit table roller 9 and are heated when they have contact with the heated ironing cylinder 7. The active heating surface that heats the fabrics is preferably about ¾ of the total surface of the heating cylinder 7.

[0055] When the fabrics 1 are inserted, the humidity detector 15 at the entry table 2 starts measuring the moisture of the fabrics 1. As the measured value may not be constant, in the software of the control system 20 the average value can be taken. The control system 20 may take a sample at a constant time interval, e.g. each 100 mS. As regards filtering the values of the samples, a simple solution is to filter the humidity values for a fixed length of the fabrics 1.

[0056] Depending on the ironing speed, for the same surface the number of samples for this constant measurement distance may be small, e.g. if the speed is high. If the speed is low, the number of samples for this distance may be high. The benefit of this sampling is that the control system 20 can more easily relate the measured humidity value to the actual ironed fabrics. As the speed goes up and down, the time counting may become more complex. Positions 1 to 17 are seventeen succeeding distances with the same length d. The first position P1 starts just after the humidity detector 15 at the entry table 2.

[0057] Referring now also to Figure 4, a time table of the ironing process is illustrated. The fabric processing speed value depends on the average humidity value of the fabrics 1. As the ironing speed value is set at a default value when there is no fabric 1 to be ironed, the control system 20 must only control the ironing speed for the part of the fabrics 1 that makes contact with the heating cylinder 7.

[0058] Fig. 4 shows examples of cases A to F in which fabrics 1 are processed. For each distance "d" the average value is taken and saved in the array of elements P1 to Pn. Each time the fabrics 1 has been transported for a distance "d", the values are copied into the next memory element; P1 into P2, P2 into P3, etc. Once the fabrics 1 has reached position P5, the control system 20 will set the ironing speed in relation to the humidity value in P5.

[0059] The relationship between ironing speed and humidity value is illustrated in Figure 5, the humidity value being measured by the capacitive humidity detector 15. When the fabrics 1 has been transported over a distance "d", the control system 20 will set a new speed that corresponds with the average of the humidity values in P5 and P6.

[0060] The speed value may be presented in meter/min. The minimum speed may then be 0.5 meter/minute and the maximum speed 8 meter/minute. When the fabric 1 is almost dry, it can be ironed quickly at the maximal speed of the ironer 100. If the fabrics 1 are still very humid, it has to be ironed at the minimum speed.

[0061] The capacitive value obtained by the humidity detector 15 at the entry table 2 may be represented by a percentage. The smallest value that can be detected is for example 1% and the max value that can be detected is for example 100%. "Dry" fabrics 1 should have a value below 15 %.

[0062] If the ironing temperature is low, the ironing speed must be lower to obtain the same ironing result as for a high temperature. In the graph of Figure 5 there are a few particular characteristics that correspond with typical ironing temperatures. For example, in the graph there are two grey zones that show the area for which the fabrics 1 is too dry or too wet to be ironed to obtain fabrics 1 with an optimal residual humidity. On a display of the ironing control system 20, the operator can be warned that the fabrics 1 are too dry or too wet to be ironed. For the case that the fabrics 1 is too dry, next time before ironing fabrics 1 the operator can reduce the drying time at a dryer. When the humidity level is too high, the operator can decide to put the fabrics 1 once more in an extractor or dry it longer in the dryer.

Capacitive Sensors as Humidity detectors 15, 16

[0063] The provision of humidity detectors 15, 16 will now be discussed, embodied in the form of capacitive sensors.

[0064] Such sensors are adapted to produce an electrostatic field and are able to sense metallic as we!! as non-metallic materials such as liquids and cloth. The sensing surface of a capacitive detector is formed by two metal electrodes. The electrodes can have many shapes and sizes. The electrodes can be flat, concentric and may be small enough to fit on an integrated circuit (IC) or big enough to cover the width of the ironing surface and can be mounted in or outside an enclosure. For measurement purposes, the only requirement is that the fabrics 1 pass in the electrostatic field of both plates. The shape of the electrodes depends of the place where they are mounted and of the measurement results that must be obtained. Also the angle that the fabrics 1 make with the capacitive electrodes depends on the optimal measurement requirements of the capacitive detectors 15, 16.

[0065] When an object nears the sensing surface, it enters the electrostatic field of the electrodes and changes the capacitance in an oscillator circuit. As a result, the oscillator begins oscillating. The trigger circuit reads the oscillator's amplitude and when it reaches a specific level the output state of the sensor 15, 16 changes. The oscillator can have an oscillating frequency from the kHz range up to the MHz range.

[0066] Capacitive sensors depend on the dielectric constant of the target. The larger the dielectric number of a material the easier it is to detect. As water has a high Dielectric Constant value related to some other materials that fabrics consist of, the humidity of the fabrics can be detected quite accurately by such a kind of sensor.

[0067] Overview Dielectric Constant of some materials.

Air, Vacuum	1
Paper	2.3
Polyamide	5
Dry Fabrics	1-2
Water	80 at 20°C, 55 at 100°C

[0068] In the present embodiment, the capacitive electrodes should be protected against water. To avoid a leakage current between the mutual metal electrodes or between the metal electrodes and the chassis (ground), a protective insulation layer is required. Another solution may comprise encapsulation. The protective layer must have a negligible dielectric value and must not influence the measurements. The protective layer must be resistant against ironing temperatures and chemicals that can be expected at the laundering and drying process.

[0069] The capacitive electrodes are mounted and designed in such a way that the measured value of the transport belts 3 is as low as possible, so that these belts 3 do not disturb the measurements.

[0070] As water has different dielectric constants related to its temperature, temperature has an influence on the humidity measurements. Depending on the particular form of ironing apparatus 100, it is also possible for the detector temperature to increase, e.g. caused by hot vapours passing the detector 16 concerned. To compensate for the influence of the increased temperature value of the fabrics 1 and the possible increased temperature of the humidity detector, extra temperature sensors can be added to measure the temperature of the fabrics 1 and the capacitive sensor 15, 16 itself. It is recommended that the distance between the subject and the electrodes is fixed as this will result in a more reliable measurement.

[0071] To get an accurate measurement, by placing sensors next to each other with a small difference in distance to the fabrics, it is possible to detect if the increased humidity is caused by the distance of the fabrics to the head of the detector (capacitive electrodes) or is caused by the difference in moisture in the fabrics 1. It can also give some estimation about the thickness of the fabrics 1.

[0072] As a result, a system exists to determine if the ironing machine 100 is ironing one, two, three or more sheets of fabrics 1. Ironing two sheets is more difficult to get a good result then ironing 1 sheet, so the ironing speed should be lower when ironing two sheets instead of one sheet. Similar considerations apply for larger numbers of sheets. This is especially the case in ironing pillow cases or table clothes were the operator folds the latter in two twice to have the split in the middle of the table cloth. The air between sheets or layers of fabric being processed reduces the heat transportation so it takes longer to heat up multiple sheets or folded over sheets and to vaporise the inner water.

[0073] Capacitive reference electrodes can be added to the capacitive detector, e.g. for disturbing factors a reference electrode can be added to compensate for parasitic capacitance like those possibly caused by a particular enclosure used.

Electrostatic Detection

[0074] A further feature of the invention lies in the provision of means to detect static electricity on dry fabrics, i.e. the optional electcrostatic detector 17 for static electricity on fabrics 1 at the exit table. Some fabrics, e.g. those that contain synthetics, are sensitive to static electricity at the ironing process. This static electricity increases by further removing the moisture while the fabrics are almost completely dry (example: less then 6% residual humidity). The electrostatic charges are caused by the friction of the fabrics that are transported on the belts and by the ironer cylinders. At the ironing process it is preferable to prevent, eliminate or compensate for this electrostatic charge. This electrostatic charge can be taken account of by measuring the electrostatic charge by means of a detector. When the value measured by this detector gets too high this means that the moisture in the fabrics is getting, or has got, too low. As a result, the ironing speed must be increased or the ironing temperature must be reduced. But as synthetics require rather a low ironing temperature, the ironing speed is increased and as a result the residual humidity will increase. As the electrostatic phenomena only occurs when the fabrics get dry, the detector has to be mounted at the exit table.

[0075] At the ironing process, the electrostatic charge can also be produced by means of an electrically insulating material. When this material slides over the fabrics, by frictional contact the charge is generated. By means of an electrostatic voltmeter the amount of electrostatic charge is measured. The electrostatic voltmeter gives a signal to the controller board. The information is processed and if the electrostatic charge gets above or below a predefined level, the ironing speed will be adjusted.

[0076] It is recommended that the electrostatic charge detector is of a type that doesn't require the making of direct contact with the fabrics, i.e. non-contact, so that the fabrics can avoid getting stuck or damaged during transportation.

Conductive Detection

[0077] A further optional feature of the invention is a conductive detection system to measure the moisture of the fabrics. When the fabrics are wet, the electrical resistance of the fabrics is low and when the fabrics are dry, the electrical resistance of the fabrics is high.

[0078] The electrodes have to be mounted electrically insulated from their supports. A current of 1-100μAmp is measured through the fabrics. As water is evaporated and the fabrics get dry, the resistance of the fabrics to the flow of electricity rises. The current detector will measure the change of the humidity value and the output value of the sensor will be processed by the control system.

Fabrics Detection

[0079] Fabrics 1 in most cases are translucent to a greater or lesser extent. As an optional extra source of information, a light emitting element can be provided in a position adapted to shine onto the fabrics. A part of the light will be reflected, a part will be absorbed and a part will shine through the fabrics. An optical sensor can measure the light that is reflected and another one can measure the remaining light at the other side of the fabrics. The light sensor will send an analogue output signal to the ironing control system and the information will be processed. The determination of the fabrics translucence can be useful to set temperature and speed. The detector can be a phototransistor and the light emitting source can be a light emitting diode. This light beam can be a single frequency such as a laser light or a light beam that covers a range of frequencies, e.g. from infrared to ultraviolet. It could be embodied in a form invisible to the human eye.

Width Detection

[0080] The width of the fabrics 1 can be detected with an array of optical or capacitive detectors, using for example a test for presence or absence of the fabrics.

From the results, the control system 20 can get information about the width of the fabrics and can compensate the speed or heating power in relation to the size of the fabrics.

Thickness Detection

[0081] Still another feature of the present invention is the provision to the control system 20 of a measurement of the thickness of the fabrics 1, provided by the thickness detector 19 at the entry table. The purpose of measuring the thickness is to adjust the ironing or heating power as ironing 1 sheet requires less effort then ironing 2 sheets. In addition, such information may prove useful to a folding mechanism if provided.

[0082] The thickness of the fabrics can be measured by a contact or non-contact method. A non-contact method can be the detection by multiple capacitive electrodes. As a contact method, a metal part that moves in a coil when the lever moves depending on the thickness of the fabrics 1 may be provided. The non-contact method is preferred as there are then no moving parts and less risk of marking the fabrics 1 being processed.

[0083] Another solution for measuring the thickness of the fabrics 1 is by means of a light signal sent at a fixed angle and captured at different positions on a light sensitive transistor, caused by reflection on fabrics with a different thickness.

Signal Converter Interface (SCI)

[0084] A Signal Converter Interface (SCI) is a sensor-to-time signal based on a period-modulated oscillator or on a sensor-to-output voltage/current converter. Sensing elements can be directly connected to the (SCI) without the need for extra electronics to interface all different sensor types.

[0085] The use the of the Signal Converter Interface greatly simplifies electronic measurement of almost all kind of electronic sensors (capacitors, platinum resistors, thermistors, resistive bridges and potentiometers).

[0086] The use of SCI greatly simplifies the interfacing of a sensor with the microcontroller, such an interface between a sensor 14-19 used herein and a microcontroller or processor of the control system 20. It reduces the total system cost by eliminating the expensive analogue components without degrading the sensors' precision. The SCI converts low-level signals from a sensor to period modulated microcontroller-compatible signal, voltage or current level microcontroller-compatible signal. Combined with an external multiplexer, the SCI can measure multiple capacitive detectors.

[0087] For the current invention the advantage of the SCI means a low cost solution can be implemented, as capacitive electrodes can have many shapes while still providing accurate measurement and the facility to use more than one capacitive detector at the same time. Also the cylinder temperature sensor 14 can be connected with the SCI and the conductivity of the fabrics can be measured by means of the SCI.

[0088] It can be seen that the present invention concerns several features that improve the quality of ironing by means of an ironing control system in such a way that it is able to control the residual humidity of the fabrics in a much better way than currently exists. The present invention provides an ironing machine with a control system with real residual moisture control at the ironing process itself, rather than by interpolation and indirect measurement as used in some prior art arrangements. The operator can therefore focus on his main task, inserting fabrics at the entry table and is not disturbed each time again by setting the ironing speed. This will result in an increased productivity and reduced energy consumption and better ironing results.

[0089] By controlling the residual humidity at the ironing process itself, the present invention reduces the chances of residual wet spots at the finished fabrics. By substantially eliminating the wet spots, the present invention has also eliminated the risk that bacteria and mould will grow at such wet spots later on when the garments have been stored. To achieve this, the residual humidity of the fabrics after ironing should be less then 8%. As a direct result of the invention it is possible to monitor and prevent the occurrence of such wet spots.

[0090] This can be achieved by measuring the humidity of the fabrics at the start and/or at the end of the ironing process and by setting the predicted ironing speed by a control system 20 in function of a pre-selected temperature and in function of the measured humidity values.

[0091] It has to be understood that at room temperature for stable fabrics, the fabrics still contain moisture (absorbed water from the environmental air). In the present embodiment, however, a level of 0 has been set for convenience of description for residual humidity as the moisture level for stabilised fabrics at room temperature. As a result, if the fabrics are dried heavily it can occur that the remaining moisture is less than in normal stabilised fabrics at room temperature.

[0092] For ironed fabrics the desired residual humidity level is about 2 to 6%. For fabrics that contain synthetics, static electricity occurs if the garments get too dry, so a residual humidity of 6% is recommendable. For fabrics like cotton this should be less then 5%.

[0093] The operator can set the desired temperature and residual humidity and cylinder speed by the operation panel of the control system 20. Temperature and residual humidity will be selected in function of the fabrics to be ironed. If desired the ironing speed can also be set in relation to the expected humidity level of the fabrics. The heating power will be adjusted to keep stable values.

[0094] The operator inserts the fabrics 1 at the entry table 2 of the ironer 100. The fabrics 1 passes first the humidity detector 15 at the entry table. When the fabrics 1 leaves the ironer 100 at the exit table 11, the moisture of the fabrics 1 is measured a second time by means of another humidity detector 16. A temperature sensor 14 measures the temperature of the cylinder 7.

[0095] By means of an electronic control system 20 the measured values are processed. Once the humidity detector 15 at the entry table 2 starts measuring the moisture of the fabrics 1, the control system 20 will use the values of this detector 15 together with those of the temperature sensor 14 to set the speed of the ironer cylinder 7. The speed value is kept in a non-volatile memory part of the control device 20.

[0096] The values of the humidity detector at the exit table 11 are used as a feedback of the ironing process. Due to this feedback the control system 20 can optimise the speed value of the ironer cylinder 7. If the residual humidity of the fabrics 1 is above or below the predefined limits, the control system 20 will update the speed value in its memory and adjust the actual speed. As a result the optimal speed setting in function of the desired residual humidity value will be obtained.

[0097] Another improvement of the invention is that the level of humidity of the fabrics 1 can be displayed on the control panel. As a result the operator can see if the fabrics are still very wet. If the fabrics are very wet, ironing results in a high energy consumption. This can be noticed by an important temperature drop of the heating cylinder 7. As the operator gets a warning, he can avoid ironing very wet fabrics and he can decide to put the fabrics once more in a extractor and/or dryer.

[0098] It is recommended that both humidity detectors 15, 16 are mounted in the same vertical plane, so that the same part of the fabrics 1 passes both detectors 15, 16. In the present invention, multiple detectors can also be used so that the whole operating width of the machine 100 is covered. For the ironing process two detectors may be sufficient, preferably as long as the same part of the fabrics 1 passes both humidity detectors 15, 16.

[0099] In the present invention, it is also possible to mount an extra humidity detector close to the ironing cylinder 7 to get a second feedback signal at the ironing process itself. An exemplary position may be in the middle of the heating surface of the main cylinder.

[0100] Another object of the invention is that the power of the heating is adapted according the measured value of the humidity detector 16 at the exit table 11 and the actual heating temperature. If the temperature drops for a given speed, the power of the heating can be increased to obtain the same residual humidity. The advantage is that the same productivity is kept at the ironing process.

Adaptive Control System with Feedback.

[0101] In carrying the invention into effect, the control system 20 sets the ironing speed value depending the selected temperature and residual humidity of the fabrics 1. The electronic control system 20 compares the values of the capacitive analogue humidity sensor(s) 15 (or conductive sensors) at the entry table 2 and at the output table 11. As a result, it obtains feedback of the ironing process. The Adaptive Ironing Control System 20 is capable of evaluating the measured humidity values and of adjusting the predictive speed value in relation with the actual temperature.

[0102] If the control system 20 detects a small difference between the residual humidity of the fabrics 1 set by the operator and the measured value of humidity, the adaptive control system 20 will adjust in small steps the cylinder speed value until an optimised speed value is reached. This means that, by speed control, the measured residual humidity value will be adjusted until it reaches the desired value, e.g. as set by the operator.

[0103] The adaptive control system 20 has to memorise the measured values of the humidity detector 15 at the entry table 2. After X seconds time delay, the fabric 1 will pass through the ironer 100 and reach another humidity detector 16 at the exit table 11. After X seconds time delay the values of the humidity detector 16 at the exit table 11 will be used to evaluate the speed value in relation with the values of the humidity detector 15 at the entry table 2. The data of the one or each detector is kept in a volatile memory, e.g. RAM. As a part of the invention, the control system 20 is able to the compensate the time delay between the two measured humidity values at the entry 2 and exit 11 table of the ironer 100.

[0104] The Adaptive Control System 20 will still measure a value even when no fabrics 1 is passing the detectors 15, 16. The measured value is caused by the belts 3 that transport the fabrics 1. The Adaptive Control System 20 will compensate the capacitive value of the belts 3 to the humidity value of the fabrics 1.

[0105] Among the improvements provided by the invention is increased reliability of the ironing process by making use of such an adaptive control system 20. Another advantage of the invention is that no operation time is lost through the operator having to check again and again to see if the fabrics 1 has been ironed properly.

[0106] The adaptive system 20 takes also in account that the edges of the fabrics 1 are most of the time more humid compared to the total fabrics surface. Sometimes spots can be found that are drier or wetter than average. The control system 20 responds in such a way that it is averaging and filtering small variations of the humidity in the fabrics 1. Small peaks in the measured values, e. g. due to metal parts in the fabrics, are ignored by the Adaptive Control System 20.

[0107] To avoid wet spots that are not well ironed, the highest humidity values get a bigger weight at the averaging process. Example: If the difference between the biggest humidity spots is 20% above the average value, the average speed will be reduced by 10%. If the difference between the biggest humidity spots is 40% above the average value, the average speed will be reduced by 20%.

[0108] The feedback system is important in this way in that by for example replacing the humidity detectors or by repositioning them, small changes in distance between the detector electrodes and the fabrics 1 will occur. With the feedback system, these differences in distance can be compensated so that the operation of the ironing control system 20 will not be disturbed.

[0109] The control system 20 may also adjust the ironing speed and heating power by processing the measurement values of the width, thickness, fabrics type/labelling, and electrostatic charge detectors.

Mechanical Requirements

[0110] With the improved apparatus 100, to obtain repetitive and reliable measurement results of the humidity detectors 15, 16, it is recommended to keep the fabrics at a constant distance away from the head of the detectors 15, 16. Mechanical parts, such as the distance pieces 5, 10 should preferably keep/guide the fabrics 1 as close as possible to the transportation belts 3. These mechanical parts 5, 10 make sure that the fabrics 1 slide in such a way that it doesn't make direct contact with the detectors 15, 16, otherwise the fabrics may be crushed against the sensor 15. Under such circumstances, the fabrics workpiece 1 may not be transported to the exit table 11 and may even be damaged by, or itself damage, one or more detectors. These mechanical parts 5, 10 should therefore be mounted in such a way that they do not disturb the measurements of the different kinds of detectors 15, 16. By keeping the fabrics 1 at a fixed distance, signal values with peaks are avoided or reduced, which might not be the case if the humid fabrics 1 get too close to the head of one of the detectors.

Fabrics Identification

[0111] As big sheets are ironed one by one, they can be identified by a fabrics identification system. The identification system informs the ironing control system about the ID-number of the fabrics, the kind of material, maximal ironing temperature, weight/surface, thickness and other characteristics that are helpful at the ironing process. This identification system can also be used to locate the fabrics 1 at the laundering process and to follow up if the fabrics 1 have been passed to or through the ironing machine 100. A cost evaluation can be made about the ironing time and energy consumption for each individual piece of fabrics. All this information can be stored in a central database and the ironing control system 20 will interchange this kind of information with a central database by means of an external communication channel. There exist different kinds of identification systems that can be integrated with the ironing control system like barcode, RF-label and I-button by which the fabrics is marked visible or not.

[0112] While the present invention has been particularly shown and described with respect to a preferred embodiment, it will be understood by those skilled in the art that changes in form and detail may be made without departing from the scope and spirit of the invention.

Claims

1. An ironing machine having an ironing means comprising an input and an output for receipt and discharge respectively of laundry workpieces and a feed means arranged in use to feed a said workpiece into said inlet and to feed said workpiece out of said outlet, said ironing machine further comprising sensing means connected to a control means for direct in situ measurement of a value related to humidity in a workpiece, said sensing means being arranged in use to supply to said control means a signal indicative of the humidity of at least the portion of said workpiece and said control means being arranged in use to control at least one operating parameter of said ironing machine in response to said signal.

2. An ironing machine according to claim 1, wherein the sensing means is located upstream and/or downstream of said ironing means.

3. An ironing machine according to claim 1 or 2, wherein a said operating parameter comprises an ironing temperature.

4. An ironing machine according to claim 3, wherein said ironing temperature comprises a reference ironing temperature and a further said operating parameter comprises an ironing speed, said control means being arranged to control said ironing speed in such a manner that said workpiece approaches a target residual humidity set with respect to said reference ironing temperature.

5. An ironing machine according to any preceding claim, wherein a said operating parameter comprises an ironing speed.

6. An ironing machine according to claim 5, wherein said ironing speed comprises a reference ironing speed and a further said parameter comprises an ironing temperature, said control means being arranged in use to control said ironing temperature such that said workpiece approaches a target residual humidity set with respect to said reference ironing speed.

7. An ironing machine according to any preceding claim, further comprising sensing means arranged in use to supply to said control means an inlet and an outlet humidity signal indicative of the humidity of at least a portion of said workpiece upstream of

said ironing means, said upstream and downstream sensing means preferably being arranged to sense the humidity of said workpiece in a region having a portion at least partially common to both said sensing means.

8. An ironing machine according to any preceding claim, further comprising sensing means arranged in use to supply to said control means a signal indicative of the thickness of at least a portion of said workpiece.

9. An ironing machine according to any preceding claim, wherein one or more sensors of said sensing means measure at least one of capacitance or resistance of a portion of said workpiece.

10. An ironing machine according to any preceding claim, further comprising sensing means arranged in use to supply to said control means a signal indicative of a level of static electrical charge on at least a portion of said workpiece.

11. An ironing machine according to any preceding claim, further comprising a fabrics sensing means arranged in use to supply to said control means a signal indicative of the nature of at least a portion of said workpiece, such as for example a structural feature, material, width, classification, type or labeling thereof.

12. An ironing machine according to any preceding claim, wherein a said sensing means comprises a light based detection system arranged to generate a signal on the basis of at least one of reflective or translucent properties of said workpiece.

13. An ironing machine according to any preceding claim, wherein control by said control means of said at least one operating parameter is adaptive in accordance with one or more signals from one or more sensing means.

14. An ironing machine according to claim 13, wherein said adaptive control is arranged to modulate heating of said ironing means such that a predetermined residual humidity is achieved without an ironing speed falling below a predetermined level and only allowing said ironing speed to fall below said predetermined level when a maximum level of modulation has been employed for said heating temperature.

15. An ironing machine according to claim 13 or claim 14, wherein said adaptive control is arranged to take account of a propagation delay of said workpiece through said ironing machine.

16. A method of controlling an ironing machine, the method including:

a) direct in situ sensing of a value related to a residual humidity of at least part of a laundry workpiece upstream and/or downstream of an ironing means; and
b) controlling an operating parameter of said ironing machine in proportion to a sensed level of said humidity.

17. A method according to claim 16, wherein a said operating parameter comprises at least one of ironing temperature or ironing speed.

18. A method according to claim 17, wherein said ironing temperature comprises a reference ironing temperature and said method includes varying said ironing speed such that said workpiece approaches a target residual humidity set with respect to said reference ironing temperature.

19. A method according to claim 17 or claim 18, wherein said ironing speed comprises a reference ironing speed and said method includes varying said ironing temperature such that said workpiece approaches a target residual humidity set with respect to said reference ironing speed.

20. A method according to any one of claims 16 to 19, including controlling a said parameter adaptively in accordance with one or more signals from sensing means.

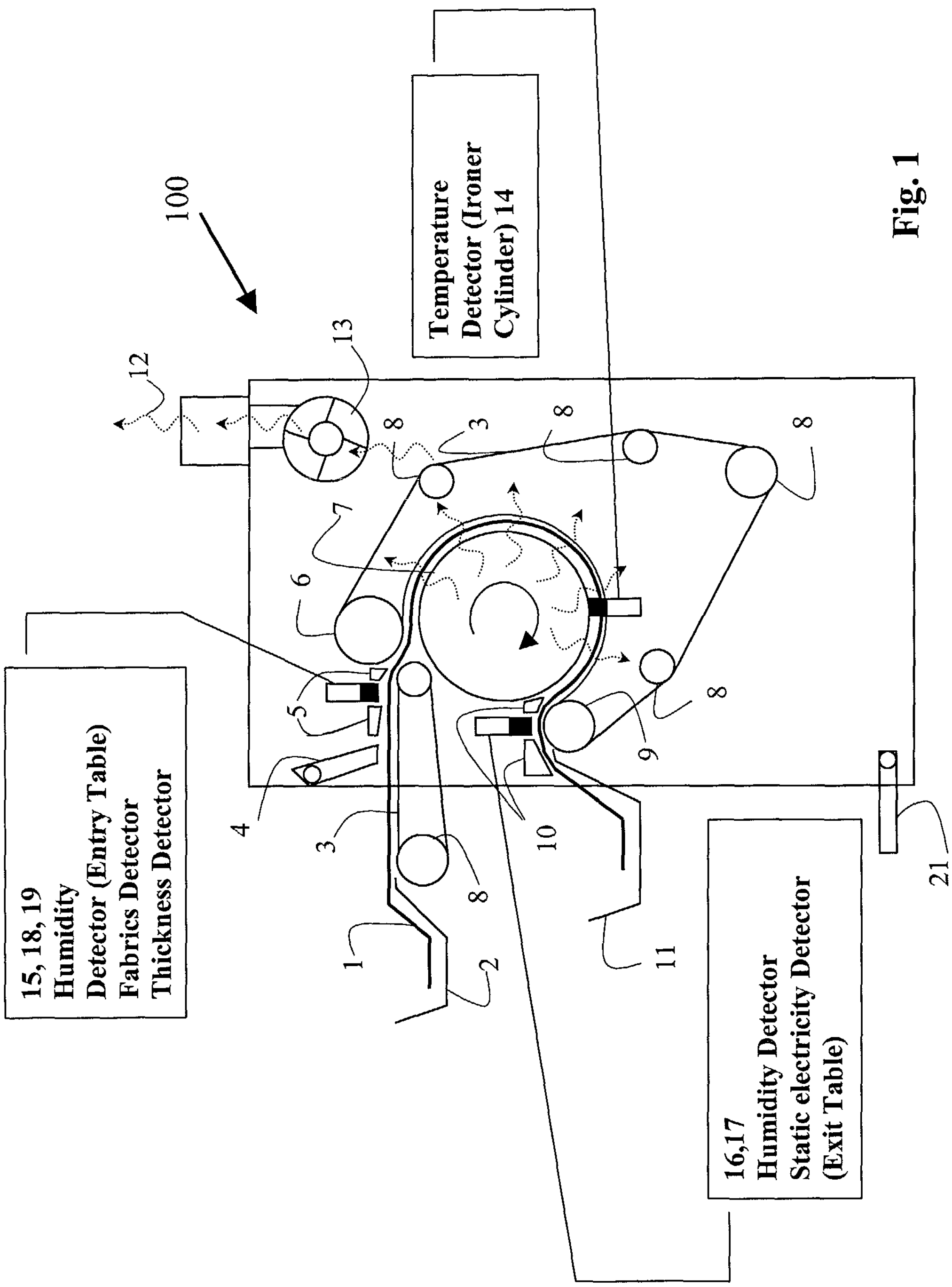
100
Temperature
Detector (Ironer
Cylinder) 14
15, 18, 19
Humidity
Detector (Entry Table)
Fabrics Detector
Thickness Detector
16,17
Humidity Detector
Static electricity Detector
(Exit Table)
1
2
3
4
5
6
7
8
9
10
11
12
13
21

Fig. 1

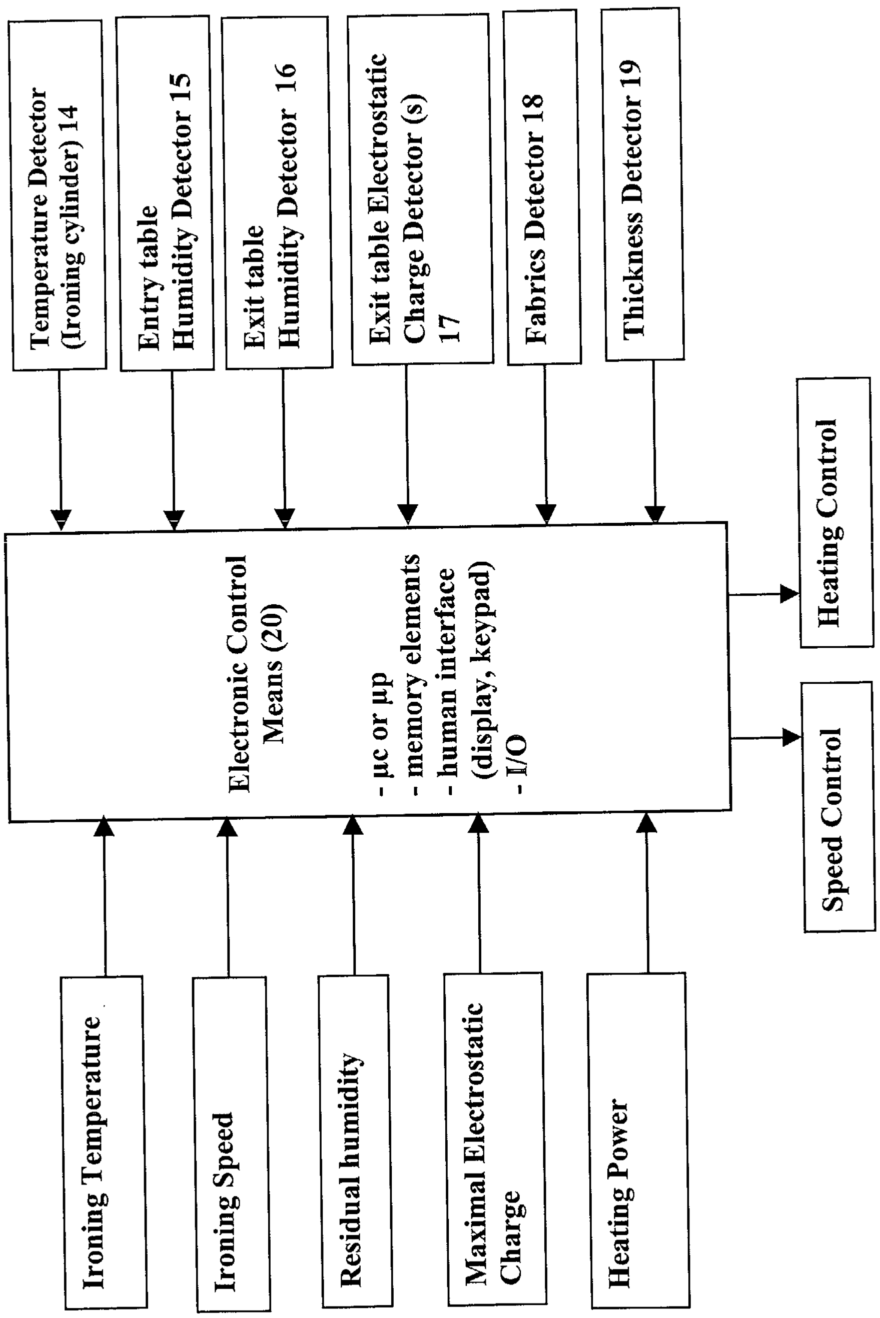
Temperature Detector (Ironing cylinder) 14
Entry table Humidity Detector 15
Exit table Humidity Detector 16
Exit table Electrostatic Charge Detector (s) 17
Fabrics Detector 18
Thickness Detector 19
Electronic Control Means (20)
- µc or µp
- memory elements
- human interface (display, keypad)
- I/O
Heating Control
Speed Control
Ironing Temperature
Ironing Speed
Residual humidity
Maximal Electrostatic Charge
Heating Power

Fig. 2

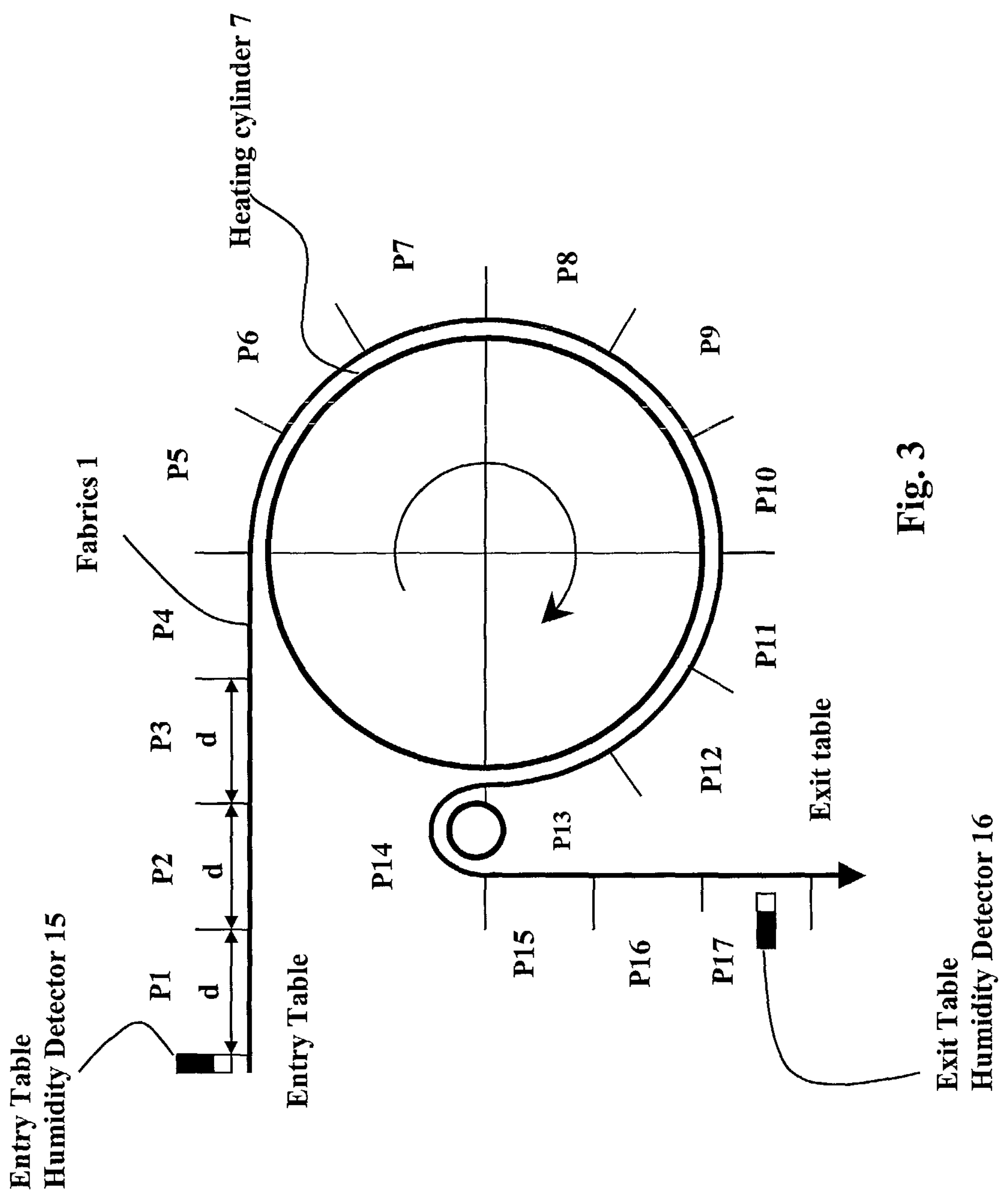
Heating cylinder 7
Fabrics 1
Entry Table
Humidity Detector 15
Entry Table
Exit table
Exit Table
Humidity Detector 16
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
P17
d
d
d

Fig. 3

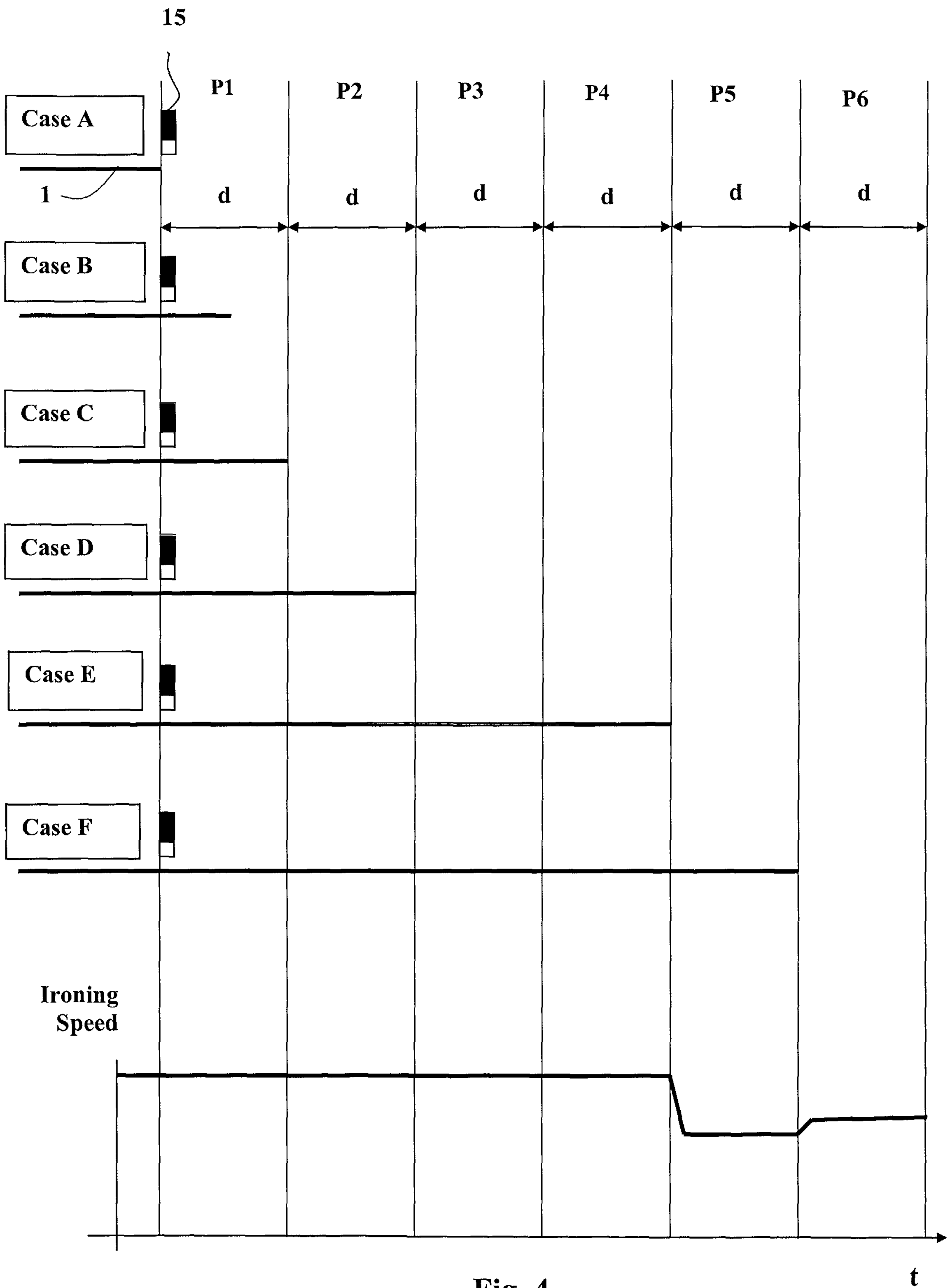
15
P1
P2
P3
P4
P5
P6
Case A
1
d
d
d
d
d
d
Case B
Case C
Case D
Case E
Case F
Ironing Speed
t

Fig. 4

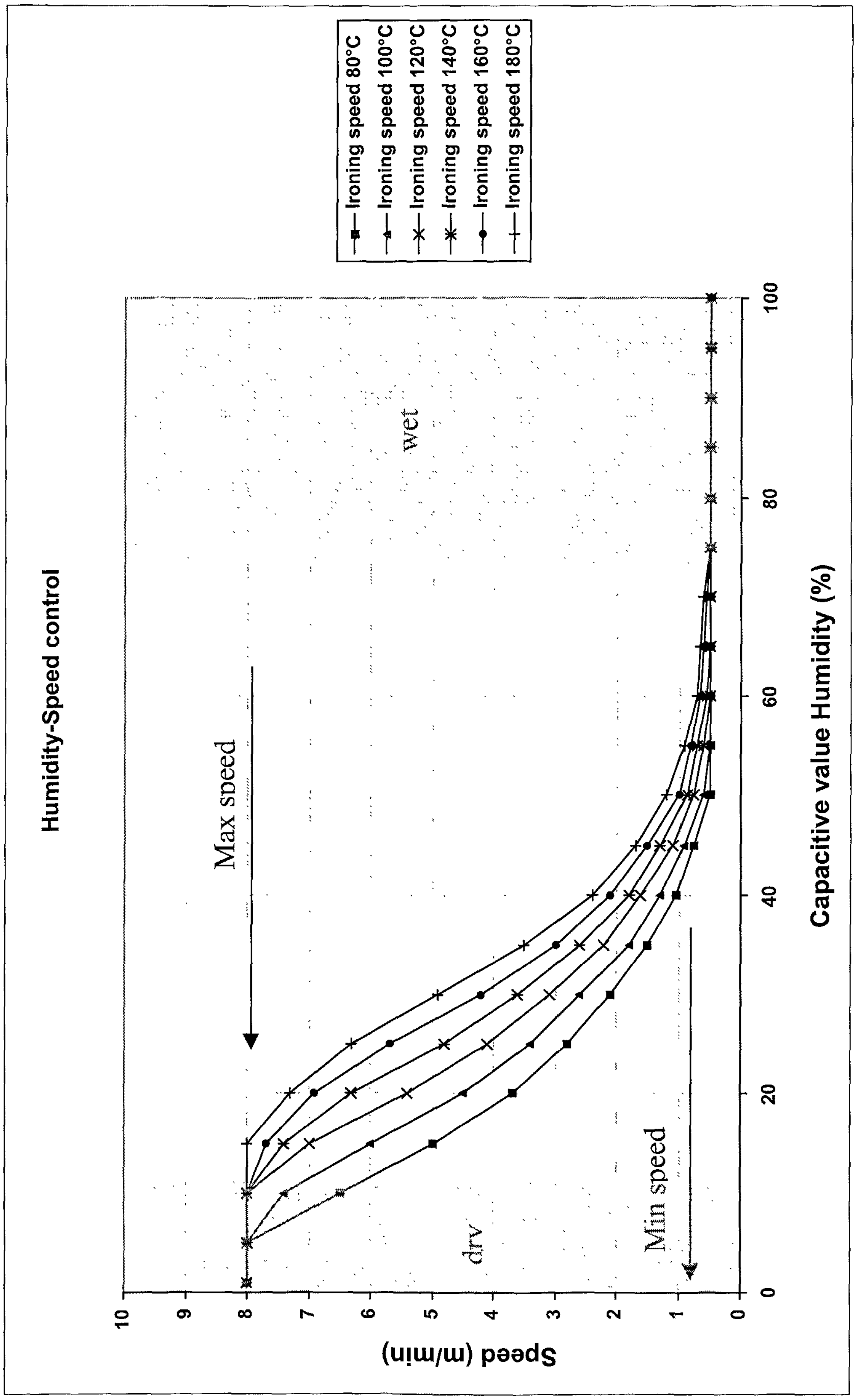
Humidity-Speed control
Ironing speed 80°C
Ironing speed 100°C
Ironing speed 120°C
Ironing speed 140°C
Ironing speed 160°C
Ironing speed 180°C
Max speed
Min speed
wet
dry
Speed (m/min)
Capacitive value Humidity (%)

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 07 8981

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 February 2003	Courrier, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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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
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07-02-2003

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			DK	528745	T3	08-09-1997
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82