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METHOD FOR CONTROLLING THE DRYING STEPS ON CONTINUOUS SHEET OF MATERIAL

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Fig.1

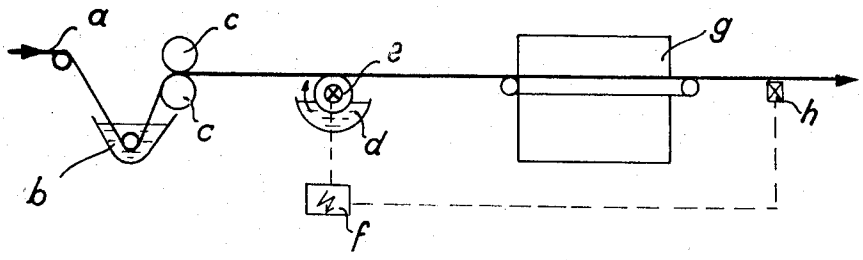


Fig.2

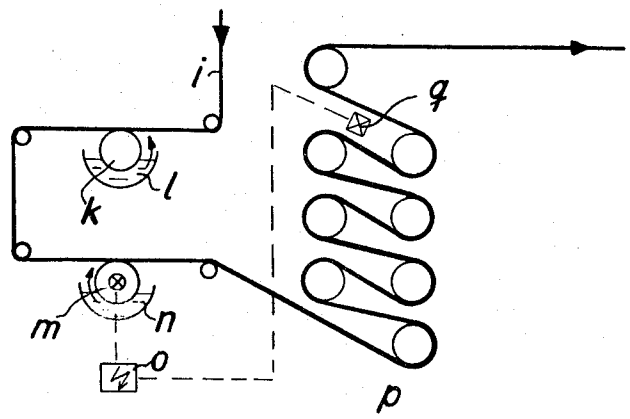
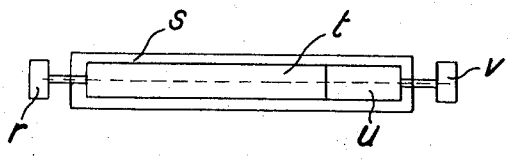


Fig.3



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METHOD FOR CONTROLLING THE DRYING STEPS ON CONTINUOUS SHEET OF MATERIAL

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U.S. Cl. 34—9 5 Claims

ABSTRACT OF THE DISCLOSURE

A method is provided for controlling and maintaining a predetermined residual moisture content and sheets dried in a drying machine. This is accomplished by measuring the value of the residual moisture in the sheet at the discharge end of the drying machine and using this value to control the application of water to the sheet upstream from the drying machine. The water may be provided in two stages, the first of which is constant and which contains additive chemicals, and the second of which is variable and responsive to the measuring device at the discharge end of the drying machine. Furthermore, the device preferably used to apply water involves a rotating roller which is controlled independently of the speed of the sheet moving thereover.

The present invention relates to the measurement and control of definite and pre-defined moisture contents at the end of a drying step on continuous sheets such as fabrics, films, paper and the like. It is an additional feature of the novel method of the invention to maintain and control in an accurate manner the temperature of the continuous sheet within wide limits while drying.

During the course of the last years, a series of production methods has been developed which require maintaining constant moisture and temperature ranges. For instance, new cross-linking treatments of cellulosic textile materials have become known under the term "moist cross-linking." These methods will only yield satisfactory and reproduceable results if the textile materials are dried to a constant residual moisture content after the application of the necessary chemicals. Heretofore, such defined moisture contents have been controlled either by variation of the heat input by means of changing the amount of energy or by variation of the speed of the continuous sheets to be dried, keeping the heat input constant, or by combining in a suitable manner both factors.

In the former case, the slowness of temperature changes has to be considered. Only after relatively large lengths of material have passed through the drying zone will the required temperature adjustment have reached the desired figure. In the second instance, the variation of the production speed will result in unconstant output which is obviously undesirable. In the same way, similar difficulties will be observed in cases where continuous sheets are not to be dried to a definite residual moisture content but are rather dried at a given maximum temperature or have to be subjected to a heat treatment.

In theory, these difficulties could be circumvented by changing the quantity of the treating bath to be applied to the material in accordance with the desired final temperature or residual moisture content, respectively, i.e. by varying the amount of water to be removed in the heat treatment. In order to effect this procedure, the squeezing

pressure in the padding machine could be reduced or the amount of water to be applied could be increased by dilution of the treating liquor. In practice, however, several difficulties will arise: Firstly, it is not possible for mechanical reasons, to alter within wide limits the quantity of liquids to be applied by means of the application equipment employed in the industry, such as padding machines, mangles and the like. Secondly, this mode of operation will yield changes in the concentration of the chemicals to be applied, resulting in an undesired variation in the properties of the final product since a frequent change of the water content according to the required residual moisture or final temperature is necessary.

In accordance with the present invention, an improved method is provided for any type of drying equipment whereby, at a given constant quantity of chemicals applied, at a given constant heat input, and at a given constant production speed, the residual moisture content and the final temperature, respectively, are variable within wide limits and are controlled in a precise and reproduceable manner. These conditions are effected by applying onto the continuous sheet, immediately prior to its entering the drying equipment, a quantity of water which is controlled by the required residual moisture content and final temperature, respectively. According to the present invention, the water required for the temperature and moisture control, respectively, is applied in a separate step in cases where the production method demands the application of aqueous solutions containing chemicals. Thus, the total quantity of water finally contained in the material has been applied in two steps. In the first step, a constant amount of water is applied which depends solely on the type and the necessary concentration of the chemicals as well as of the desired properties of the finished material. The amount of pure water applied in the second step, however, is regulated by the controlling instrument according to the required residual moisture content and final temperature, respectively. The first step will be obsolete in production methods which do not require the application of chemicals but merely drying the material to a given residual moisture content, or which demand a definite final temperature, or in cases where the final temperature must not exceed a certain limit. In such cases, only the amount of water necessary for the control of the residual moisture content and the final temperature, respectively, is applied.

In an embodiment of the present invention, the apparatus for the control and regulation of the residual moisture content and the final temperature, respectively, will consist of a suitable application machine, a drying zone, instruments for measuring the moisture and the temperature, respectively, and instruments to regulate these controlling conditions. In a preferred form of the invention, the application machine consists of a rotating roll, mounted on a trough and partly immersed in water therein contained. If desired, a suitable wetting agent may be added to the water. The continuous sheet of material passes over the surface of the rotating roll. The quantity of water applied to the continuous sheet of material is determined by the ratio of the surface speed of the rotating roll and the speed of the continuous sheet passing over the roll. In accordance with the invention, this ratio is fixed by means of the measuring and regulating instruments, keeping constant the speed of the continuous sheet of material. It is possible to employ the application machine both in the application of the liquid containing the chemicals and the regulating water by combining two application rolls. The first roll will apply the treating liquid, and the second roll will apply the changing quantity of the regulating water. It lies further within the

scope of the present invention to apply the chemicals by known methods such as padding machines, mangles, and the like.

In the processing of continuous sheets of material, such as woven fabrics, cases have become known where it is desirable to obtain in the longitudinal direction of the fabric zones of different contents of humidity adjacent to each other. According to the present invention, different humidity contents of this type are regulated by way of employing a rotating roll constructed of several segments, the speeds of which may be varied, thus leading to different water contents in the individual zones of the fabric. The surface speed of the segments are measured and regulated in the same manner as described hereinbefore.

The nature of the surface of the application roll or the segments thereof depends on the type of continuous sheet whereon the water is to be applied. The surface may be smooth or textured. Further, it is possible to employ sectional application rolls with different surface characteristics.

In accordance with the present invention, the water may be applied by means other than those described hereinbefore, e.g., by spraying, coating, steaming, and the like. When steam is used, the quantity of the water applied is regulated in a simple manner by controlling the amount of steam passing through the steamer. Applying the water in zones is effected in this case following the same principle as in the use of liquid water, e.g., by employing perforated steam pipes divided into sections and regulating the steam pressure in these sections individually and according to the quantity of water required in each zone.

The drying equipment may be of any known type, such as tenter frames, jet dryers, loop dryers, infra-red dryers, cylinder dryers, and the like. The measuring and regulating instruments are composed of known elements. According to the present invention, either the moisture content or the temperature are measured by known methods. The data are fed into the regulating instruments which in turn control the speed of the application machine. In a preferred form of the invention, the required data are measured at the end of the drying machine; however, it is also possible to effect the measurements at a convenient location inside of the drying zone.

The continuous sheet of material, the residual moisture content and final temperature, respectively, of which are regulated according to the scope of the present invention, may consist of a fabric of either a woven or knitted type, a felt, a fleece, a plastic film, a paper, and similar continuous flat materials.

For a better understanding of the invention, reference should be made to the following detailed description and accompanying drawing in which

FIGURE 1 is a simplified schematic representation of the apparatus, using one application machine, constructed in accordance with the invention and used for carrying out the new method;

FIGURE 2 is a similar simplified schematic representation, using two application machines;

FIGURE 3 is an enlarged fragmentary view of a rotating application roll divided into segments.

In FIGURE 1 the continuous sheet of material *a* is immersed in a vessel containing the application liquor *b* and is then squeezed off to a constant water content by means of the padding machine *c*. The sheet of material passes over the application machine consisting of the rotating application roll *e* which applies varying quantities of water *d* onto the sheet of material *a* according to the surface speed of the rotating roll. The material *a* then passes through the drying zone *g* at the exit of which the residual moisture content or the temperature is measured by an instrument *h*. The measuring device *h* controls a regulating instrument *f* which in turn varies the speed of the rotating roll *e* according to the residual moisture content or temperature required.

In FIGURE 2 the rotating application roll *k* is partly immersed in the application liquid *l* which contains the necessary chemicals. This liquid is applied to one side of the continuous sheet of material *i*. As the surface speed of the roll *k* is kept constant, a constant quantity of the application liquid is applied to the sheet of material *i*. The sheet of material *i* is reversed in the usual manner by way of rollers, and passes a second rotating roll *m*. The surface speed of the roll *m* may be varied. Thus, varying quantities of water *n* are applied to the opposite side of the sheet of material *i* which then passes a cylinder drying machine *p* and is dried to a predetermined residual moisture content or at a final temperature. The feeling device *q* feeds the measured data into the regulating instrument *o* which changes the surface speed of the rotating roll *m* according to the quantity of water required for the desired residual moisture content or final temperature.

In FIGURE 3 the rotating roll is evided into two segments *u, t,* which are individually driven by the motors *v, r*. The surface speeds of the two segments are regulated by means of two separate measuring and regulating systems. When the surface speeds of the segments *u, t* differ, different quantities of water *s* are applied to the continuous sheet of material.

What is claimed is:

1. A method for controlling and maintaining within wide limits a predetermined residual moisture content and/or final temperature on continuous sheets of material conveyed through a drying machine comprising providing constant heat input to said drying machine, moving said sheet at constant velocity, determing the value of the residual moisture content and/or temperature of the sheet either immediately at the discharge end of said drying machine or within same, and applying to the sheets prior to their drying a quantity of water in response to said value to obtain said predetermined residual moisture content and/or final temperature in said sheets.

2. The method of claim **1** wherein said quantity further comprising continuously applying a given quantity of water containing chemicals for other treatments in a preliminary stage followed by said aforementioned second application of water, and the amount of water being applied in the second stage corresponding to the difference to make up said quantity of water.

3. The method of claim **1** wherein said quantity of water is applied on said sheets immediately prior to the entering said drying machine.

4. The method of claim **1** wherein said quantity of water is applied in part quantities each covering a different zone across said sheets said zones being contiguous to each other, and wherein each part quantity is determined so as to obtain different values of residual moisture content and/or final temperature on lengthwise running portions of said sheets associated with said zones.

5. The method of claim **1** wherein said quantity of water is applied to said sheet by a continuous rolling-on action of a roller partially dipped in a water supply, said roller rotating at a rate independent from the rate of movement of said sheet thereover.

References Cited

UNITED STATES PATENTS

2,951,007	8/1960	Lippke	34—43 X
3,161,482	12/1964	Gschwind et al.	34—54
3,302,296	2/1967	Holmwood et al.	34—9

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