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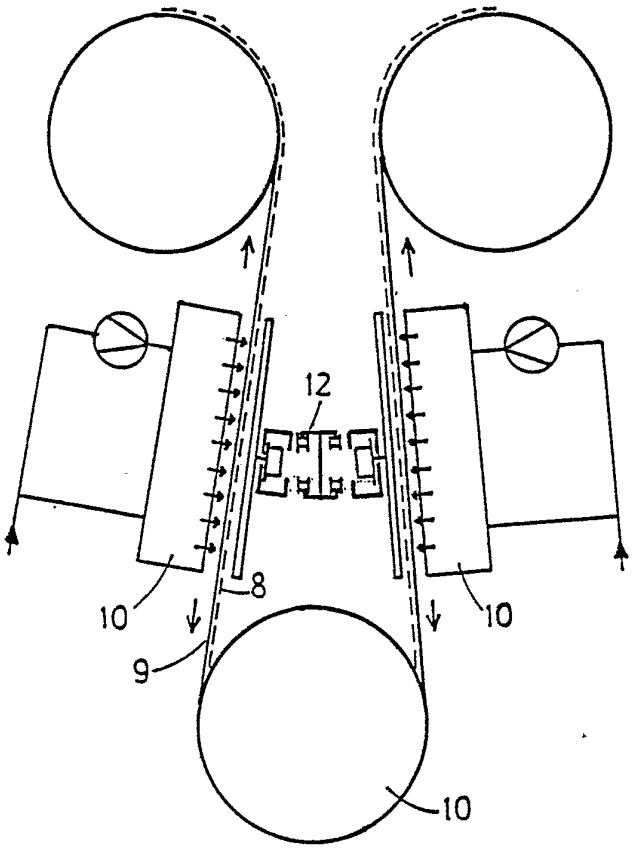
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(54) Title: METHOD AND APPARATUS FOR THE LEVELLING OF THE HUMIDITY PROFILE OF A CONTINUOUS WEB BY DIELECTRIC DRYING

(57) Abstract

Method and apparatus for reducing moisture differentials of a moving web (1), for instance, a paper web, containing longitudinal wet streaks, by applying high-frequency electromagnetic energy to bar-formed electrodes (2), which are located close to the surface of the web (1). In accordance with the invention, the longitudinal axes of the electrodes (2) are aligned approximately parallel to the machine direction of the web (1) and the electrodes (2) are located over each wet streak of the web (1). The apparatus in accordance with the invention comprises a beam (3) extending in the cross direction essentially over the web (1), with each electrode fitted to the beam so as to align the longitudinal axis of the electrode in the home position approximately parallel to the machine direction of the web (1) and provided with a means of transferring each electrode in the aforementioned cross direction onto an assigned wet streak in the web (1). The invention provides an economical and effective solution for reducing moisture differentials in the web (1).



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Method and apparatus for the levelling of the humidity profile of a continuous web by dielectric drying

The present invention relates to a method for the improvement of the moisture profile of a continuous web by means of dielectric drying in accordance with the preamble of claim 1.

The invention also involves an apparatus for the implementation of the method.

The product quality of several continuous web processing machines including, for instance, paper and textile web drying sections, is impaired by the uneven final moisture profile of the web.

The problem is most recognized and quantitatively most important in the paper industry. Users require a product with an even final moisture content in order to ensure non-problematic runnability in printing, as well as to achieve a high dimensional stability of the web for accurate alignment of colours.

The unevenness of the web moisture is caused by different defective functions at the wet end either before the drying section or in the dryer itself. The web defects may be generated by incorrect crowning of the press rolls, unevenness of the pressing felts or their cleaning, or by temperature differentials of the web. Persistent or random defects on the final humidity profile of the web on the dryer are caused by the edge effect related to the low humidity of the drying atmosphere and higher heat transfer factors at the edge of the web as well as by the surface of the drying cylinder extending over the web edge; the nonsymmetrical air circulations, uneven action of the drying felts together with, for instance,

the defects of condensate removal from the cylinders and asymmetrical flows of the condensate.

In order to compensate for these defects, several different auxiliary apparatuses have been developed. Their operation is based on the principle of intentionally providing a functional defect which compensates for a defect of the machine, often originating from an unrecognized cause.

Rather typical examples of these means are different kinds of air blowing units, in which the atmospheres in the drying pockets are sectionally adjusted in a compensatory manner. The effect of one air blowing unit is minimal and, consequently, several units are needed for each machine; generally, as many as possible within the space limitations.

When high-velocity hoods are used, relatively few will suffice because the method of blowing air via nozzles on the paper achieves high characteristic evaporation rates and differential rates. Due to their clumsiness and high power consumption, these solutions are not very popular.

In contrast, infrared radiant heaters heated by gas or electricity with a sectionally controlled effect are very effective and popular.

In some cases, a high-frequency electromagnetic field has been used for profile improvement by locating bar electrodes cross-directionally to the web over a sufficiently large area. The dielectric constant and loss factor that determine the power absorbed as heat by the web are higher at the wetter parts of the web. Consequently, a dielectric dryer drives moisture more effectively out from the wetter parts of the web than from the dry parts when the unit is located at the dry end of the

drying section. However, the disadvantage of crosswise located bar electrodes is the increased power consumption of the dryer due to the unnecessary simultaneous drying of the dry streaks. This leads to the fact that the dryer cannot produce an even final moisture but only reduces the highest absolute and relative humidity differentials. In order to achieve any effective differential drying at all, this kind of moisture profile correcting dryer must be located at the relatively dry section of the web with a correspondingly low dielectric constant and loss factor. Naturally, this is disadvantageous with consideration to the size of the drying section. Compared to the other methods described above, however, this solution provides the advantage of disposing of any control means in the crosswise direction of the web.

The present invention relates to a method in accordance with the preamble of claim 1 for reducing differentials of moisture profile on a web, especially a paper web, by means of high-frequency electromagnetic energy.

The invention is characterized by the use of bar electrodes, energized by a high-frequency electromagnetic power source and aligned approximately in the machine direction, for drying the web.

More specifically, the method in accordance with the invention is characterized by what is stated in the characterizing part of claim 1.

Furthermore, the apparatus in accordance with the invention is characterized by what is stated in the characterizing part of claim 7.

In the following, the invention will be examined in more detail by means of exemplifying embodiments described in the attached figures. For the sake of presentation

simplicity and clarity, the figures omit all equipment unessential to the invention, such as components associated with the generation and feed of the electromagnetic energy; equipment necessary for environmental protection from radiated energy, possible automatic control devices, actuators and their details required for movement, ventilation equipment necessary for humidity removal and advancement of drying, and the like.

Figure 1 shows an apparatus in accordance with the invention in a side elevation view aligned with a plane of a processed web 1.

Figure 2 shows the same apparatus viewed from the direction of arrow B in Figure 1.

Figure 3 shows a preferred location for the apparatus, especially in a high-speed paper web drying section.

The processing of a wet streak in the machine direction of the web requires a drying unit consisting of at least two electrodes 2, which are located parallel to the processed web 1, and approximately aligned in the machine direction of the web (arrow A). Figures 1 and 2 show the mounting of the electrodes in a carriage 4, which can move along a beam 3 by automatic, remote-controlled or manually controlled means with the help of the apparatus not described in the figures, onto a selected wet streak of the web. These kind of units can be located lengthwise to the beam 3, that is, in the cross direction of the web in a number corresponding to the number of the wet streaks.

When a mounting base 7 of the electrodes is mounted pivotable with an actuator 6 around a pin, an angle L can be provided between the direction of the electrodes and the machine direction of the web. In addition,

the mounting base 7 can be complemented with required fixtures and possible actuators that are not shown in the figures, and with which a mutual distance a of the electrodes can be adjusted automatically, by remote-control or manually in accordance with the correction requirements of the web moisture. Thus by varying the orientation of the electrodes, a local energy density P/A imposed on the web can be provided in the direction of the crosswise coordinate x of the web yielding an energy distribution that conforms as accurately as possible with the moisture distribution of the wet streak to be corrected. The lower part of Figure 2 shows the variable P/A as a function of coordinate x for the electrode orientation shown in Figure 2.

The invention offers appreciable benefits.

The power consumption required is decreased and the equipment necessary for generating the high-frequency energy may be smaller. This is produced by the disposal of unnecessary drying which avoids consuming power for processing intermediate areas between the wet streaks, which also reduces power consumption at the wet streaks because less evaporation is required for correcting the moisture profile.

In principle, an evenly distributed moisture content can be achieved. This is not possible with crosswise electrodes extending over the entire web, whose selective drying effect for drying a wet part of the web faster than a dryer part of the web is based on the differentials of the electrical characteristics of the dried substance at different moisture levels. For this reason, although the crosswise electrodes are capable of reducing the moisture differential, they are not capable of fully levelling them off.

In addition to achieving a reduced number of electrodes by disposing of the electrodes at the dry parts of the web, reduction in electrode numbers also achieved by advantageously locating the moisture profile correction units over the wet streaks at the wet end of the machine where the dielectric constant of the web is most suitable for the method.

The described moisture profile correction units are located in a paper machine for drying the web at the web transfer when the web is conveyed from one drying cylinder to another. The suggested location is especially advantageous in modern high-speed machines that tend to employ as a design of the art the single wire transfer at the wet end of the machine immediately after the press section. This means that the web is conveyed, supported by the drying wire, from one cylinder to another, a method which reduces the frequency of paper breaks in a high-speed drying section. The disadvantage of the method is that on every other cylinder, generally on the lower cylinders, the drying wire passes between the paper web and the cylinder.

A special advantage in paper machines is achieved by locating a moisture profile correction unit 12 in a single wire group as shown in Figure 3. When the correction unit 12 is located on the side of a web 9 supported by wire 8, a ventilation equipment 10, e.g. nozzle blowing equipment for drying and profile correction, can be located on the paper side and adapted to blow immediately against the paper. This provides an especially safe arrangement against breaks and an effective location for drying. In addition, Figure 3 shows that the cylinder is preferably positioned lower than normal for easier location and higher efficiency of the correction unit, which also lengthens the free passages of web transfer.

WHAT IS CLAIMED IS:

1. A method for reducing moisture differentials in a moving web (1), for instance, a paper web, containing wet streaks in the machine direction by the application of high-frequency electromagnetic energy fed to bar-formed electrodes (2) which are located close to the surface of the web (1),

c h a r a c t e r i z e d in that

- the longitudinal axes of the electrodes (2) are aligned approximately parallel to the machine direction of the web (1) and
- the electrodes (2) are located over each wet streak of the web (1).

2. A method in accordance with claim 1, c h a r a c t e r i z e d in that each electrode (2) is attached by means of a support base (4 or 7) to a beam (3) extending over the web (1).

3. A method in accordance with claim 1 or 2, c h a r a c t e r i z e d in that the location of the electrodes (2) in a plane parallel with the web (1) and their angle in relation to the machine direction of the web (1) are adjusted either manually or automatically so as to apply as accurately as possible to each streak a proportional drying power in order to minimize the moisture differentials.

4. A method in accordance with claim 1, 2, or 3, c h a r a c t e r i z e d in that a drying unit assembly (2, 4, 3) consisting of the electrode (2), the support base (4) and the beam (3) is fitted into the contact dryer section on the web between two successive cylinders.

5. A method in accordance with claim 1, 2, or 3, c h a r a c t e r i z e d in that the drying unit assembly (2, 4, 3) is fitted into a single-wire section of the web contact dryer on the web and its supporting wire passing from one cylinder to another so that the wire remains between the web (1) and the electrodes (2).

6. A method in accordance with claim 4, c h a r a c t e r i z e d in that an air blowing dryer, for instance, a nozzle dryer, is located at the electrode group (2, 4).

7. An apparatus for reducing moisture differentials in a moving web (1), for instance, a paper web, with the apparatus consisting of

- at least two bar-formed electrodes (2) that are applicable close to the surface of the web (1) and capable of being fed with a high-frequency electromagnetic energy,

c h a r a c t e r i z e d by

- a beam (3), located crosswise essentially over the web (1), to which each electrode is fitted so as to align its longitudinal axis in home position approximately parallel to the machine direction of the web (1) and provided with a means for transferring the electrode in the aforementioned cross direction onto an assigned wet streak in the web (1).

8. An apparatus in accordance with claim 7, c h a r a c t e r i z e d in that the direction of the bar electrodes (2) can be deviated from the machine direction of the web (1) in order to adjust the local energy density.

9. An apparatus in accordance with claim 7 or 8, c h a r a c t e r i z e d by a location near the contact dryer of the web (1) at a point on the web between two cylinders.

10. An apparatus in accordance with claims 7...9, c h a r a c t e r i z e d in that the apparatus is integrated with a single-wire section of the contact dryer of the web (1) and located onto the web and its supporting wire between two successive cylinders so as to make the wire pass between web (1) and the electrodes (2).

11. An apparatus in accordance with claim 10, c h a r a c t e r i z e d in that an air-blowing dryer, for instance, a nozzle dryer, is located close to the paper at the electrode group.

12. An apparatus in accordance with claim 10 or 11, c h a r a c t e r i z e d in that the processing length of the web (1) is lengthened by increasing the mutual center point distances of successive drying cylinders.

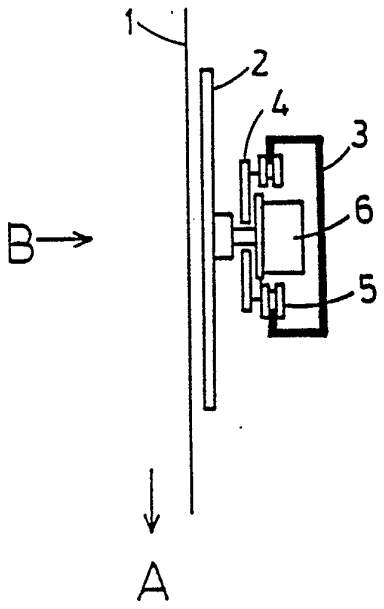


Fig. 1

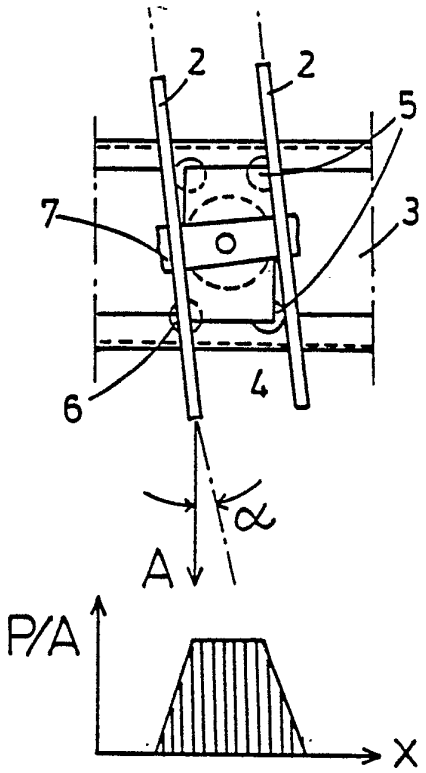


Fig. 2

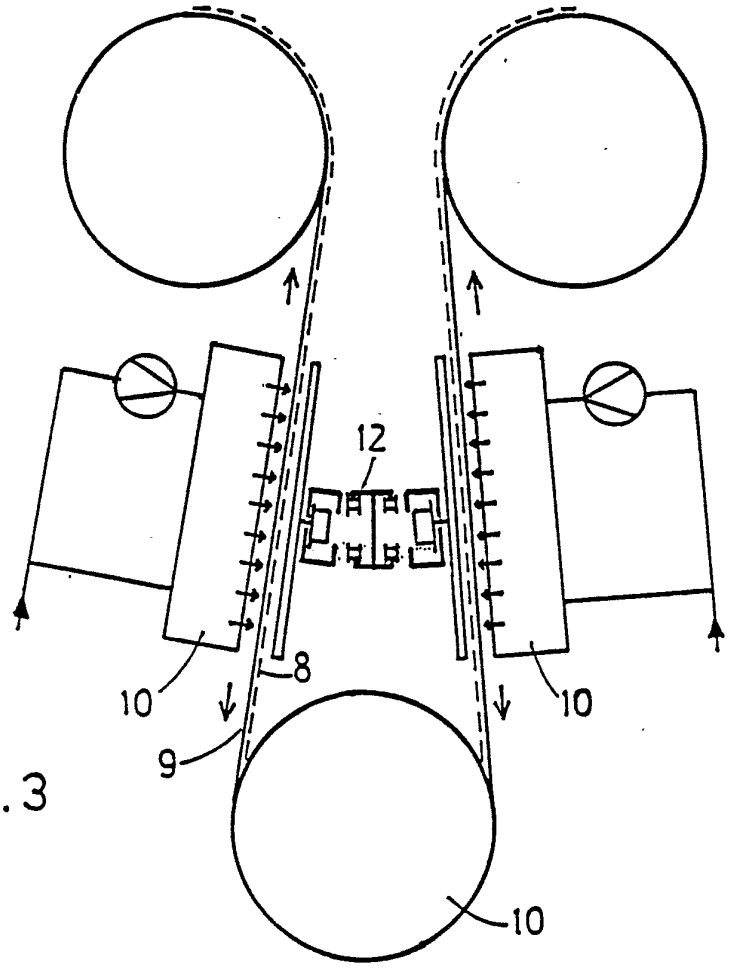


Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI86/00148

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC [4]

D 21 F 5/16

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	D 21 F 5/00, /16; F 26 B 3/34, 23/08
US Cl	34: 1

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	US, A, 3 470 621 (W N BENNETT) 7 October 1969 see column 4, lines 41 to 52	1-6 7-12
Y	US, A, 3 293 765 (R WINKLER ET AL) 27 December 1966 see figure 1a	7-12
A	DE, A, 3 130 358 (AGFA-GEVAERT AG) 17 February 1983	
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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