Oct. 9, 1962 P. LIPPKE 3,057,075

METHOD OF HEATING, DRYING AND EQUALIZING THE DRYING OF ENDLESS WEBS

Filed May 13, 1959

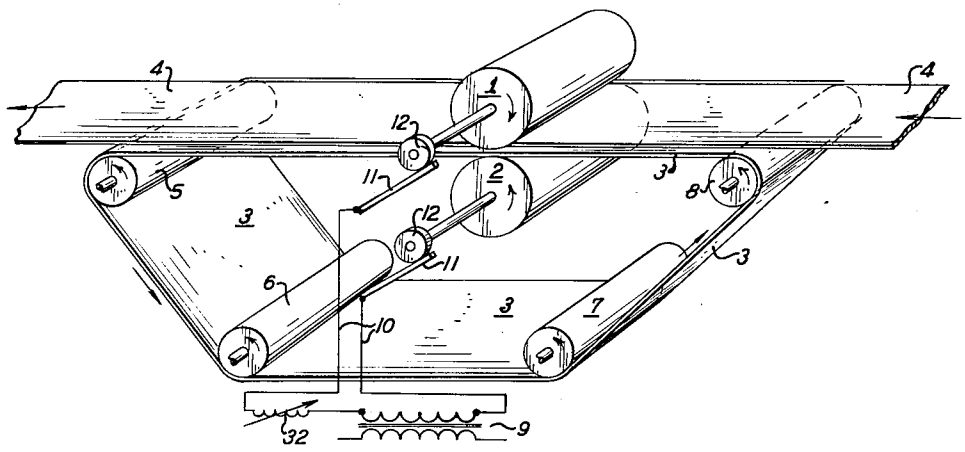


Fig. 1

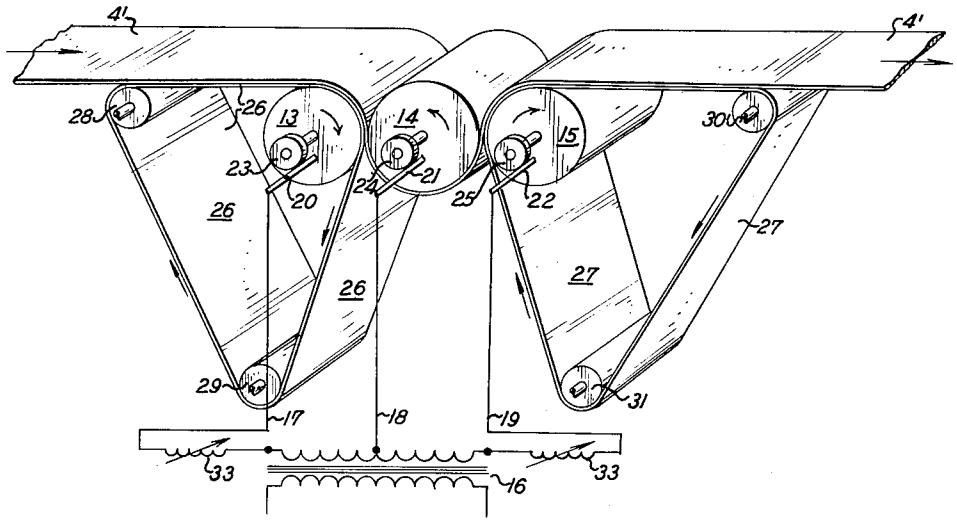


Fig. 2

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United States Patent Office

3,057,075

Patented Oct. 9, 1962

3,057,075
METHOD OF HEATING, DRYING AND EQUALIZING THE DRYING OF ENDLESS WEBS

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Filed May 13, 1959, Ser. No. 812,907
Claims priority, application Germany Jan. 23, 1954
9 Claims. (Cl. 34—1)

The present invention relates to a process for the production of webs of fiber materials and more particularly to a process for the improved drying and equalization of water content during drying of wet webs in such production.

This application is a continuation-in-part of copending U.S. application Serial No. 482,401, filed January 17, 1955.

In the usual production of endless webs of fiber material, particularly paper, cardboard or cellulose webs, the fiber web is formed from an aqueous fiber pulp on an endless flat or circular rotating draining screen or sieve. The wet pulp mass is further reduced in water content by means of one or more roller presses and is finally passed to the drying step wherein the remaining moisture is removed by heating and air drying the web.

A variation on the usual process relates to the use of heating cylinders adjacent the roller presses so that the water in the fiber pulp may be heated to reduce the viscosity thereof as the temperature increases and thereby improve its removal during the pressing step. The heated water more easily emerges from the tight fiber structure than if it were unheated. Such heating cylinders are especially suitable in the production of cellulose products wherein slowly running machines are employed.

Where such pre-heating is employed in the pressing step, a higher degree of water removal is obtained for a given quantity of material, which results in the need for less heat in the final drying step after this pressing step. For example, it is known that the fiber pulp mass need only be heated to a maximum of 60° C. in order to increase the content of dry fibers in the web under otherwise equal conditions from 32% to 40%. At the same time, the content of water remaining in the web to be dried decreases by over 30%. Apart from the saving in heat required for final drying, the drying apparatus may accommodate a correspondingly larger quantity of fiber material in this way since its water content is 30% less than before.

Nevertheless, it has been demonstrated that even in slowly running machines the contact time between the heating cylinders and the web is so short that the web is never totally heated throughout. Instead, only the surface of the web is really heated, with the unfavorable result that the surface becomes drier than the web interior. In fast running machines, such as those used in paper making, it is all but impossible to obtain any advantages by preheating with conventional size heating cylinders. Extra-large size heating cylinders with greater heating surface area would be required to heat the fast running web sufficiently, since only low temperatures may be used in order to avoid caking of the individual fibers or clinging of the fibers to the surface of the heating cylinders. In any case, it is very difficult in practice

to pass a fast running paper web over a large number of cylinders.

Another drawback is the fact that it is usually necessary to use a supporting felt for the purpose of conducting the fiber web through the pressing rollers. The surface weight of the felt is always greater than that of the corresponding fiber material web and, because of the water saturation of the felt, a constant cooling thereof, due to water evaporation, takes place during operation. The felt necessarily becomes saturated with water by direct contact with the wet web before pressing, but while water may tend to emerge from the heated web more easily during the pressing step, this emerging water prevents the water in the comparatively cooler felt from also emerging. Thus, the wet felt loses a certain amount of its water through evaporation during the recycling period, and as a consequence, the felt remains cooler and wetter than the web, so that efficient over-all water removal cannot be obtained.

It has been suggested heretofore to use electric current in the production of endless fiber webs during the drying step. It has been suggested also to heat both the web and the felt by conducting an electric current through them by means of electrodes in contact with the web and the felt. Such techniques, however, have not met with success since considerable heat losses occurred during travel of the web and felt from the heating electrodes to the subsequent roller press, even though sufficient initial heating could be obtained. Additionally, the electrodes had to be urged against the passing web and felt with a certain degree of pressure in order to effect sufficient contact therebetween.

As a result, since the web necessarily expands during heating, it was not possible to transmit the web without wrinkles from the heating electrodes to the press rollers. Besides this undesirable wrinkling, as a consequence of the heating, more water emerged from the web than did occur when no heating was employed, as in the theretofore previous manner. This increased amount of water was not able to flow off quickly enough and instead collected above the felt in the web and eventaully destroyed the web. To overcome this, the pressure of the roller presses had to be decreased, with the result that such heating only led to the same degree of water removal as before.

It is an object of the present invention to overcome the above-mentioned drawbacks and to provide a process for the production of fiber webs in which more efficient and quicker drying of the web may be obtained by simultaneously heating the web by electric current and pressing said web to remove the attendant water therefrom.

Another object of the invention is to carry out such simultaneous heating and pressing in conventional apparatus whereby a comparatively larger quantity of fiber material may be dried during a given period than before and a simultaneous reduction in operating cost may be achieved.

A further object of the invention is the equalization of the moisture content in the various portions of the web, regardless of whether the variations in moisture content occur along the width or length of the running web.

These and other objects of the invention will become apparent from a study of the within specification and accompanying drawings, in which:

FIG. 1 is a perspective view of a heating and pressing roller apparatus, including an energy source, which may be used in accordance with one embodiment of the invention, and

FIG. 2 is a perspective view of a further heating and pressing roller apparatus, including an energy source, which may be used in accordance with another embodiment of the invention.

It has been found, in accordance with the process of the invention, that the web and even the felt as well may be more effectively and efficiently reduced in water content than was heretofore possible, by simultaneously heating by electric current and pressing the web and the felt, if one be present, at the same point in the travelling web. By reason of such simultaneous heating and pressing at one point, the water contained in the web and felt is reduced in viscosity by the heating and readily pressed out by the pressing more completely than in prior methods. An equalization of the moisture content throughout the web is also obtained due to the coacting heat and pressure and the relative degree of moisture at every point in the web.

Briefly, the previous disadvantages of prior methods of fiber production are overcome in accordance with the present invention by the fact that the web and felt are heated at the same time and place. Cooling, wrinkling, stretching, or too slow water flow off are, therefore, not possible. In order to obtain such simultaneous heating and pressing, rollers are employed which, in addition to supplying the required squeezing pressure also serve as heating electrodes.

These electrodes, while insulated from one another, are both connected in an electric circuit with an energy source, such as by means of contact brushes. The source of energy may be a generator, transformer, or the like. The circuit is closed between these pressure rollers by the wet web passing in pressing contact therebetween, the water in the web being sufficiently conductive to conduct the current from one roller to the other. As a consequence of the pressing current, when sufficient voltage is applied, the water itself is heated up instantaneously by the resistance created thereat.

The viscosity of the water is decreased and correspondingly the liquidity of flow of the water is increased, the moment the water is heated, which is, of course, the same moment when increased liquidity of the water is necessary for the simultaneous pressing.

It will be appreciated that the heating of the web may be carried out in one or several presses, in accordance with the invention, which simultaneously press out the contained water so that the least amount of electrical energy need be expended for the heating of the water.

Where a felt is present for supporting the web, the water which is heated and squeezed out of the web and into the felt is counteracted by the air permeating the felt which is also heated. Such heated air expands and thereby squeezes out the water from the felt in a much better manner than is possible in cold pressing techniques or even in the aforementioned electric current preheating and subsequent pressing of the wet web.

Hence, in accordance with the invention, higher pressures may be applied in the pressing step than before to obtain a more efficient water removal free from the drawbacks heretofore encountered. By also increasing the current intensity, even in the tightest pressure zone of the felt, a partial water evaporation occurs due to the increased expansion of the heated air thereat.

By the above described process of the invention, it is possible, even where fine fibers are treated, which in the conventional unheated pressing technique only difficulty give off water to yield a web having only about 25% dry fiber content, to obtain instead webs having up to 35 to 37% dry fiber content under equal pressing pressure.

Referring to the drawing, FIG. 1 illustrates a roller press

apparatus used in the production of endless webs from fiber pulp materials, in accordance with the invention. Cooperating press rollers 1 and 2 are suitably mounted for rotation, together with one another. Fiber web 4, which is, in this case, carried by felt 3, passes between these rollers in the direction of the arrow. Felt 3 is mounted, under slight tension, over several guide rollers 5, 6, 7, 8 suitably arranged. During the passage of the web and felt through the pressing gap between rollers 1 and 2, contained water is passed out of the web into the felt and finally also out of the felt in the usual way.

From current source 9, which is herein shown as a transformer but which may be any suitable source of electric current, electric current is passed to rollers 1 and 2 via wires 10, 10, brushes 11, 11 and brush rings 12, 12. The two rollers are electrically insulated from one another so that the circuit from the source to one roller and from the other roller back to said source can only be closed when web 4 and felt 3 pass in pressing contact between said rollers. The web may be a paper web, cellulose web, cardboard web or any other web containing fiber materials.

In accordance with the known laws of transformation of electrical energy into heat in the flow of electric current, web 4 and felt 3 are heated since these elements comprise the zone of highest resistance in the electric circuit. By such heating, the water in web 4 and felt 3 becomes more liquid and is simultaneously squeezed out of these parts more easily and in greater quantity than was heretofore possible.

In FIG. 2, double press arrangement is provided. The current is conducted to pressing rollers 13, 14, and 15 from the source 16, which, in this case, is a transformer, although any other current source may be used, via wires 17, 18, and 19, brushes 20, 21, and 22, and brush rings 23, 24, and 25 respectively. In this case two felts 26 and 27 are used. Felt 26 is mounted under slight tension over pressing roller 13 and guide rollers 28 and 29 while felt 27 is similarly mounted over pressing roller 15 and guide rollers 30 and 31. Web 4' passes in the direction of the arrow disposed over felt 26 between pressing rollers 13 and 14, thence under roller 14 and finally between rollers 14 and 15 whereupon it is conducted away upon felt 27.

One of the advantages of this multiple pressing roller arrangement is that a lower voltage can be used while a correspondingly greater heating of the web is obtained.

It will be recognized that the intensity of the current conducted to the web should be regulated so as to offer the most favorable heating at the particular speed at which the web travels, the particular thickness of the web and the particular degree of conductibility of the web. Thus, only so much heat should be used as is necessary to cause sufficient water removal during the pressing step. The current required to produce this quantity of heat is dependent upon the weight of the fiber web and the amount of water entering therewith into the pressing rollers per unit time. For efficient water removal, of course, the pressure of the press is also influential, and in view of the heating, in accordance with the invention, more water will be pressed out of the web at a given pressure than was possible by prior techniques. Nevertheless, the pressure of the rollers may be increased even more without fear of detrimental stretching, wrinkling, or too slow water flow off, etc., and, as a result, a correspondingly greater water removal will be effected per unit weight of the fiber web.

In this connection, in FIG. 1 such current regulation may be obtained by providing a variable choke coil 32 while, in FIG. 2, variable choke coil 33 may be used for the same purpose. However, any other suitable means may be used to effect changes in the current conducted to the rollers.

The process, in accordance with the invention, may be

employed for the production of endless webs of all types of fiber materials. Examples of such fiber webs are those used in the production of paper, cardboard, cellulose, insulating, and hard fiber sheets. Moreover, the process of the present invention is particularly applicable to the textile industry for the production of fibrous webs of various materials.

The type of current which may be employed for the heating of the web may be either direct or alternating current. Particularly suitable is alternating current having a typical frequency of 50 to 60 cycles per second, although much higher frequencies may also be used with equally good results.

The amount of water present in the web is not important except that at higher water content more current must be used for a given amount of fibrous material in order to effect the required heating.

It is contemplated, by the process of the invention, that several heating and pressing roller presses be used together with favorable results. Preferably, in such cases, the web may be heated in stages of presses so that only a certain amount of water will be squeezed out at each press so as to entirely avoid any possibility of destroying the web by too great a water removal at any one place.

The speed at which the web is conducted through the press, or where a series of presses are used, through each press, is not unduly critical, as it is only necessary at higher current frequencies where alternating current is used to adjust the current so that the heating of the web is carried out in the desired phase.

In the production of paper and cardboard webs, some irregularities in the thickness of the fibers joined together are unavoidable. In the sieve draining step, the air drying step, as well as in the pressing step, of water removal, the areas in the web which contain more fibers, also retain a higher water content. However, these places are particularly well conductive, and the electric current seeks its way through the fiber web and the felt especially at such areas. Accordingly, these areas are essentially more intensely heated by reason of their high water content. This results in an increased liquidity of the water at such areas as compared to the surrounding thinner areas which thereby causes the water to be expelled more easily. In this way, an equalization of the fiber content and water content of the entire web is attained both in the direction of travel of the web and transversely thereto, as well.

The degree to which this automatically resulting equalization is achieved is so great that even with considerable fluctuations in the surface weight of the fiber web, a very uniform water content is obtained at the end of the drying step.

While, in the conventional manner of operation, the web had to be subjected to subsequent processing, in order to obtain a decrease in variations of moisture content, in accordance with the invention, it is no longer necessary to dry the fiber web more strongly than is necessary for the desired purpose. Yet, the web obtained is more uniform in its hygroscopic characteristics than webs which heretofore had to be subjected to subsequent processing, and is also free from disturbing stretching and wrinkling of the web, particularly where thin papers are concerned.

Preferably, the apparatus used for the process of heating the felt and the web, in accordance with the invention, comprises a roller press, having at least two rollers, wherein the surface of each roller is able to conduct electrical current, the two rollers are electrically insulated from one another, and one of the rollers is also electrically insulated from the mounting frame.

Where three rollers are used, the current may be conducted to the middle roller and thence be carried off by the two outside rollers, or the middle roller, which may be connected with the mounting frame, may carry off the current while the two outside rollers may receive currents of the same or different voltages.

Among the advantages of the invention is the fact that the moisture content may be decreased by 60 to 50%, for instance making possible an increase of one third in production capacity, even where only one heating and pressing roller device is employed.

As a consequence of the extraordinarily superior water removal obtained by the process, in accordance with the invention, it is unnecessary to use suction presses for further dehydration of the web. Hence, a saving in the cost of such suction presses and the energy requirement therefor is made possible.

Example

In a cardboard machine, 70 tons of cardboard are produced daily by cold pressing the web between two suction presses. By using a normal pressing technique, but with simultaneous individual current supply to the press rollers, as shown in FIG. 1, the water content of the web, which is 100 inches in width and which has a density of 200 grams per square meter, is decreased from 71% to 37% water content. For this purpose, an electrical capacity of about 168 kilowatts per hour is needed per ton of cardboard produced and a voltage of about 250 volts between the rollers.

However, also in the drying of pastes and all dried material which is brought for the period of drying into the condition of a continuously moving web, for instance powdered masses which are pressed in a screen, the invention can be used with great advantage. The paste is applied in the form of a coating on a metallic screen between the heating and pressing rollers.

What is claimed is:

1. A process for the improved dehydration and equalization of water content during drying of wet webs formed in the production of webs from fiber materials and the like, which comprises passing the wet web between a pair of cooperating electrically conductive pressing surfaces in pressing contact therewith, said surfaces being electrically insulated from one another, while passing electric current from a source through said wet web by means of said surfaces to heat said web by the electrical resistance created therein by said current and simultaneously to expel and remove substantially all the remaining liquid moisture in said web by said pressing contact whereby an equalization of the fibre content and water content of the entire web is attained both in the direction of travel of the web and transversely thereto.

2. A process for the improved dehydration and equalization of water content during drying of wet webs of irregular thickness formed in the production of webs from fiber materials, which comprises passing the wet web of irregular thickness between two cooperating electrically conductive continuous pressing surfaces in pressing contact therewith, said surfaces being electrically insulated from one another, and said web and the liquid moisture in said web being capable of closing an electrical circuit between said surfaces, while passing electric current from a source through said wet web by means of the closed circuit formed by said web, the liquid moisture in said web and said surfaces, to heat said web by the electrical resistance created therein by said current in direct ratio to the thickness of the web thereat, the thicker portions of the web being heated more intensely, and simultaneously to expel and remove substantially all the remaining liquid moisture in said web by said pressing contact whereby an equalization of the fibre content and water content of the entire web is attained both in the direction of travel of the web and transversely thereto.

3. A process, according to claim 1, wherein said surfaces are defined by a pair of cooperating press rollers.

4. A process, according to claim 3, wherein a plurality of cooperating press rollers are used.

5. A process, according to claim 4, wherein the current supplied to each successive roller is decreasingly adjusted

in increments corresponding to the proportional decrease in moisture content of the web passing thereat.

6. A process, according to claim 1, wherein said wet web is passed between said surfaces disposed on a continuous supporting felt therefor.

7. A process, according to claim 1, wherein said equalization of water content during drying is effected by conducting a particular quantity of current through each portion of the web which is directly proportional to the moisture content thereat.

8. A process, according to claim 1, wherein said equalization of water content during drying is effected by conducting a particular quantity of current through each point of the web which is directly proportional to the moisture content thereat and inversely proportional to the solids content thereat.

9. A process, according to claim 1, wherein an air drying step is provided subsequent to said pressing contact.

References Cited in the file of this patent

UNITED STATES PATENTS

2,209,761	Berry	July 30, 1940
2,824,383	Machalek	Feb. 25, 1958

FOREIGN PATENTS

449,079	Germany	Sept. 1, 1927
327,433	Switzerland	Mar. 15, 1958