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WEB DRYING APPARATUS

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Fig. 1

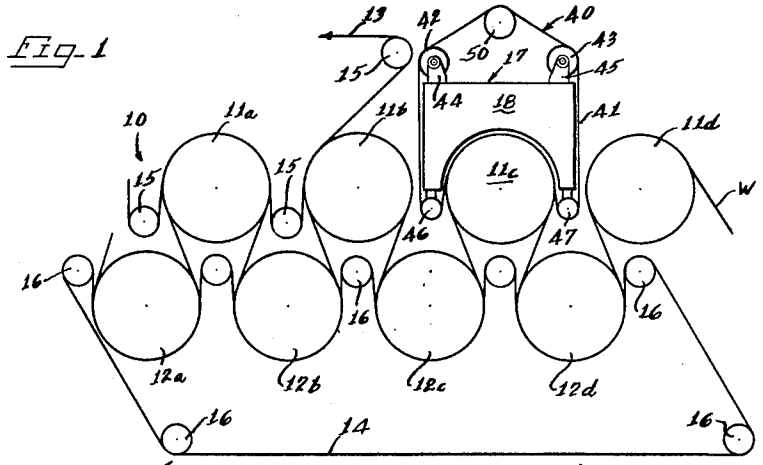


Fig. 2

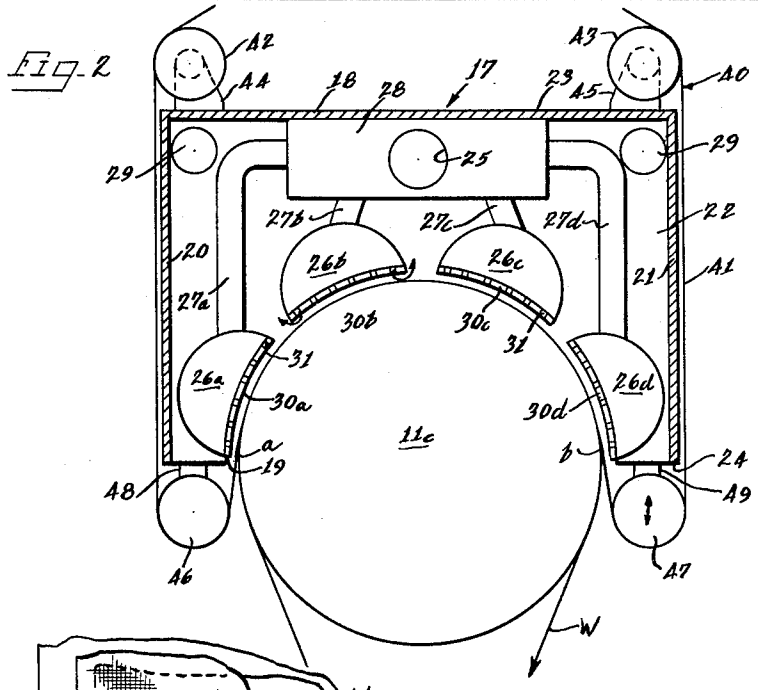
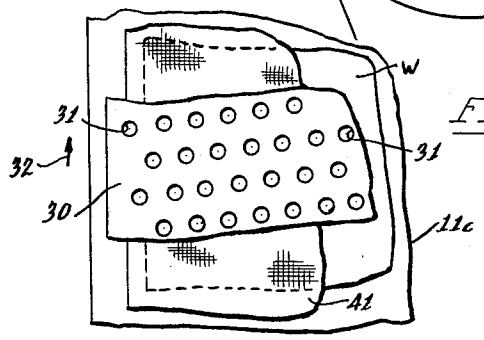


Fig. 3



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WEB DRYING APPARATUS

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The present invention relates broadly to moisture removal means, and is more particularly concerned with web drying apparatus of the high velocity air type featuring the provision therein of a traveling air permeable band overlying the web and urging the same into intimate contact with a heated drying surface, whereby the moisture removal effectiveness of the drying apparatus is markedly enhanced.

It is now known in the art of paper and related web manufacture to direct the moisture bearing sheet along a serpentine path in wrapping relation with a plurality of heated drying cylinders. In this arrangement a hood is positioned in partially enveloping relation with one or more of the drying cylinders and heated high velocity air jets are impinged against the traveling web from the hood to scrub away the boundary layer of fluid thereon.

The structure briefly described in the preceding paragraph represents a marked advance in the art of paper manufacture, and as contrasted with the earlier technique wherein the web was dried solely by being urged against the cylinders by felts, has resulted in reductions in the overall size of the drying section by reason of the increased rate of drying. The high velocity air hoods possess other important advantages; however, a difficulty experienced therewith is a lifting or rising of the web as it travels in wrapping relation with the heated drying cylinders. To explain, the impinging air streams have a velocity of the order of between 10,000 and 20,000 feet per minute, and particularly with the lightweight webs as exemplified by tissues, the air velocities are sufficient to actually lift the substantially impervious web from the heated drying surface. It naturally follows that the drying action is impeded and the overall drying time increased. As well, various portions of the traveling web may be lifted different distances away from the heated cylinder, with the further disadvantage that the web moisture content is not uniform throughout.

The described problem is particularly present at the last drying cylinder in a dryer section where the web is not under close tension control. The prior art has offered token solutions to the web lifting problem in the form of rolls or felts contacting the web upon its entry into and exit from the hood. It is theorized that by so urging the web against the cylinder at the entry and exit ends of the hood that intimate contact of the web with the cylinder is assured throughout the entire angle of wrap. However, this is clearly not the case since the velocity of the impinging air streams is sufficient to lift or raise the web as it travels between the suggested rolls or felts.

It is accordingly an important aim of the present invention to provide an improved dryer arrangement wherein the traveling web is continuously contacted as it wraps a drying cylinder so that lifting the web from the cylinder is prevented and the moitsure removal effectiveness of the dryer is markedly increased.

Another object of this invention lies in the provision of web drying apparatus of the character which includes a drying cylinder and a hood supported closely thereto, and in which the traveling web is urged against the drying cylinder by an air permeable band wrapping the web and moving continuously therewith.

Still another object of this invention is to provide web drying aparatus comprising a heated drying cylinder receiving a traveling web in wrapping relation thereon, hood

means supported adjacent the cylinder and directing substantially normal to the web a plurality of high velocity air streams, and a traveling air permeable or reticulated band wrapping the web and urging the same into intimate contact with the cylinder to increase the moisture removal effectiveness of the drying apparatus.

Other objects and advantages of the invention will become more apparent during the course of the following description, particularly when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals designate like parts throughout the same:

FIGURE 1 is a somewhat diagrammatic view of a dryer section of a paper machine illustrative of an exemplary environment for the present invention;

FIGURE 2 is a vertical sectional view of drying means constructed in accordance with the principles of this invention and showing in further detail the web urging means herein provided; and

FIGURE 3 is a fragmentary plan view showing the paper web and overlying air permeable band impinged by air streams directed by an illustrative form of nozzle means.

Referring to the drawings, there is shown more or less diagrammatically in FIGURE 1 a dry end section **10** of drying apparatus of a paper machine with which the instant invention is of important application. However, it will be readily apparent during the course of the description now to follow that the drying means and method herein disclosed have numerous applications other than for paper machine dryers, and are productive of advantageous results in the heating or cooling of any surface by means of air. Exemplary of such additional applications are the drying of textiles and plastic films and related sheet materials. Further, while drying cylinders are herein illustrated, the heated drying surface could as well be of a generally flat plate-like configuration over which the sheet or web is progressively advanced.

The dry end section **10** shown in FIGURE 1 comprises a first row of horizontally aligned drying chambers or drums **11***a–d* of which four are shown in the exemplary embodiment illustrated, and a second row of horizontally aligned drying cylinders **12***a–d* staggered with respect to the drying drums **11** of the first row. A web of paper W passes in a serpentine path alternately about the drying cylinders **11** and **12**, and is maintained in contact with the surfaces of the drying cylinders **11***a* and **11***b* by a felt **13**, and against the surface of the drying drums **12***a–d* by a felt **14**. A suitable number of rollers **15** are arranged to guide the felt **13**, and rollers **16** guide the felt **14**.

It will further be observed from FIGURE 1 that the drying cylinder **11***c* is partially wrapped or enveloped by hood means generally designated by the reference numeral **17**. The hood means **17** could as well be positioned over the drying cylinder **11***d*, and in many applications may be so located since at this position the web W is normally not under close tension control, which gives rise to the noted problem of web lifting and consequent impairment of the moisture removal effectiveness of the drying apparatus.

The hood means or impingement air drying means **17** comprises a housing or insulated hood cover **18** having a length preferably coextensive with the width of the web W and provided with a bottom opening **19** therein, so that when the housing **18** is suitably supported it overhangs the cylinder **11***c* approximately to the distance shown or about one-half of the roll circumference. Stated otherwise, the housing **18** extends a sufficient distance about the cylinder or drum **11***c* to be coextensive with the wrap of the web W during travel along the circumferential portion of the rotatable drum **11***c*.

The housing 18 may be shaped to provide a pair of generally upright opposed side walls 20 and 21, a pair of opposed end walls 22 (one of which is shown), a generally flat top wall 23, and a bottom wall 24.

The housing 18 supports therewithin in any suitable manner a plurality of circumferentially spaced blower heads 26*a–d*, four of which are shown in the exemplary form illustrated, and which define interiorly a plurality of supply plenums. Each supply plenum 26 may be of generally semi-cylindrical shape, and the plenum means 26*a–d* communicate, respectively, with conduit means 27*a–d* leading to a supply duct 28, which in turn connects with a suitable source of heated or cooled air. For this purpose, one or both of the opposed end walls 22 of the housing 18 may be apertured or passaged at 25 to communicate the header 28 with the air source.

To exhaust moisture-bearing air from the housing 18, a plurality of exhaust openings 29 are provided, these openings being shown somewhat diagrammatically and communicating with an exhaust fan or the like (not shown). The details of the hood means or air impingement means 17 thus far described form no part of the instant invention, and other hood structures can be utilized in the practice of the instant invention.

Each supply plenum 26 supports nozzle means 30*a–d*, which may take the form of a plate having a plurality or array of spaced holes or perforations 31 therein. Desirably, the holes or openings 31 have rounded entrance portions, and investigations conducted to date have demonstrated that maximum drying efficiency is obtained when the openings 31 have a diameter of between one-quarter and five-eighths inch and that the plates 30 be approximately one-quarter inch thick and be spaced from the web W by about one inch. The perforated plates 30 are generally arcuate when viewed in end to thereby generally conform to the curvature of the drying cylinder 11*c*. As appears in FIGURE 3, the openings 31 in the plate 30 and the parameters given provide a construction is viewed in plan, and each group of three openings forms an equilateral triangle which is slightly askew from the sheet travel direction indicated by the arrow 32 applied to FIGURE 3. The described configuration of perforate plate 30 and the perameters given provide a construction which has performed particularly well in practice, although variations may of course be practiced therein without departing from the novel aspects of this invention.

The impinging air streams issue from the nozzle openings 31 at velocities of the order of 10,000 to 20,000 feet per minute, and are highly effective to scrub from the moisture-bearing web W the boundary layer of liquid carried by the traveling web W. Air streams or jets of this velocity, however, create a pressure differential between opposite surfaces of the traveling web W which has the effect of bodily lifting or raising the web from the heated drying surface provided by the drum or cylinder 11*c*. This lifting or departure of the web from close hugging contact with the rotatable cylinder 11*c* may not under particular circumstances be of great magnitude, and in fact may be difficult to detect by the human eye. However, optimum moisture removal effectiveness of the drying apparatus requires that the web at all times run in skin-tight relation against the heated drying surface, and any departures therefrom result in unduly long drying times. This detracts from the drying efficiency, and it may even be found that the web or sheet rises or is lifted different amounts at various locations across the sheet width. This can result in a sheet having a non-uniform moisture content therein and the production of a finished article having blotches or other imperfections therein.

Applicant has effectively overcome this problem by the provision of web urging means generally identified in the drawings by the numeral 40. Such means for maintaining the web W in close hugging contact with the drum or cylinder 11*c* during entrainment thereon comprises an endless air permeable band 41 trained over a first pair of rolls 42 and 43 rotatably supported by bracket means 44 and 45 mounted by the top wall 23 of the hood housing 18. The endless band 41 further wraps a second pair of rolls 46 and 47 carried by bracket means 48 and 49 attached in any suitable manner to the bottom wall 24 of the hood. As appears in FIGURE 1, the endless band 41 may also wrap roll means 50 and which may be structurally constituted to perform a guiding function on the band 41. As well, one of the rolls 42, 43, 46 or 48 may be adjustable to control the tension in the band 41, as is illustrated in FIGURE 2 by the double arrows applied to the roll 47.

The endless band 41 may be provided by any foraminous or reticulated material of sufficient porosity or air permeability to permit the passage therethrough of the impinging air streams. The endless band 41 may accordingly be of wire mesh, or may be provided by woven glass or woven plastic sheeting. Of course, the band 41 must be designed to withstand temperatures of the order of about 300° F., and at present wire mesh is preferred.

The air permeable band desirably is coextensive in width with the paper web W, and may in fact as appears in FIGURE 3 have a slightly greater width than the web. The endless band 41 thereby overlies the paper web in width, although it may be found under particular circumstances that the web is adequately urged into hugging contact with the cylinder 11*c* when only relatively narrow bands are employed along the marginal portions of the web. Under the majority of circumstances, however, the endless band 41 and web W are coextensive one with the other.

It will be noted from FIGURE 2 that the paper web W is wrapped by the endless band 41 to generally the same circumferential extent as the web W wraps the drum or cylinder 11*c*. There is of course a slight gap along the entry and exit sides of the hood whereat the endless band 41 does not overlie the web as the latter wraps the cylinder 11*c*, however, the important point that the web W be wrapped by the endless band 41 continuously while the web is exposed to the high velocity impinging air streams. This is shown in FIGURE 2, and it may be noted therein that the endless band 41 overlies the web W from the points identified at *"a"* and *"b,"* the arcuate distance therebetween corresponding essentially to the arcuate distance between the leading edge of the blower head 2*a* and the trailing edge of the blower head 26*d*.

One or more of the rolls 42, 43, 46 or 47 may be positively driven to impart travel to the endless band 41, or said band may be moved by the rotative force applied to the drum or cylinder 11*c*. Of course, the speed of travel of the paper web W is related to the speed of movement of the endless band 41 so that no substantial friction forces are applied by the band to the web and which could cause damage to the web.

By provision of the air permeable traveling band 41 the paper web W is contacted immediately after it begins wrapping the drum or cylinder 11*c* and immediately upon entry into the hood means 18 and beneath the first blower hood or plenum 26*a*. Continuously then during its travel upon the rotatable drum 11*c* the paper web W is pressed or forced into close hugging or intimate contact with the heated surface of the drum 11*c*, so that there is essentially no likelihood of the web rising or lifting from the drum as it travels thereabout. In this manner, maximum benefit is obtained from the heated surface, while at the same time and importantly there is no interference with the scrubbing action of the heated air streams in removing the boundary layer liquid on the fibrous web.

It has been noted that the endless band 41 may be constituted of various types of materials, and that the invention is not restricted to the particular hood structure illustrated. It is accordingly believed quite apparent that various changes and modifications can be made in the ap-

paratus disclosed without departing from the novel concepts of this invention.

We claim as our invention:

1. In a drying apparatus particularly adapted for drying webs of fibrous material, a rotatable drying cylinder, means guiding a traveling web of fibrous material to said drying cylinder and partially wrapping the web about said cylinder, a hood supported to extend about the portion of the periphery of said cylinder having the web wrapped thereabout, at least one plenum chamber in said hood having nozzles leading therefrom and opening closely adjacent said cylinder and leading from said plenum chamber perpendicular to the periphery thereof and covering a substantial portion of the area of the web wrapped about said cylinder, means supplying heated air to said plenum chamber to direct a plurality of high velocity heated air streams through said nozzles onto said cylinder for the width thereof, and means holding the web to said cylinder upon the impingement of air thereon and thereby increasing the moisture removal effectiveness of said nozzles, comprising a traveling mesh screen selected from a class consisting of wire mesh, woven glass, or woven plastic sheeting of substantially the width of said cylinder and guided at the incoming and outgoing sides of said hood to be partially wrapped about said cylinder and press the web into intimate contact with said cylinder and accommodate the air from said nozzles to freely pass therethrough to dry and web passing about said cylinder.

2. In a drying apparatus particularly adapted for drying webs of fibrous material, a rotatable drying cylinder, means guiding a traveling web of fibrous material to said drying cylinder and partially wrapping the web about said cylinder, a hood supported to extend about the portion of the periphery of said cylinder about which the web is wrapped, at least one plenum chamber in said

hood having nozzles leading therefrom and opening closely adjacent said cylinder and extending perpendicular to the periphery thereof and covering a substantial portion of the area of the web wrapped about said cylinder, means supplying heated air to said plenum chamber and effecting the directing of a plurality of high velocity heated air streams through said nozzles onto said cylinder, means preventing the lifting of the web from said cylinder upon the impingement of air thereon and thereby increasing the moisture removal effectiveness of said nozzles, comprising an endless traveling mesh screen selected from a class consisting of wire mesh, woven glass, or woven plastic sheeting guided to travel about said hood and along the space between said nozzles and the web wrapped about said cylinder, guide rolls at the incoming and outgoing sides of said hood pressing said screen into intimate contact with said web throughout the entire area of said web covered by said hood, and means adjustably moving at least one of said rolls and holding said roll in position to vary the tension of said wire mesh screen and the degree of contact of said web on said drying cylinder.

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