# United States Patent

[11] 3,576,078


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[21] Appl. No. **7,815**
[22] Filed **Feb. 2, 1970**
[45] Patented **Apr. 27, 1971**



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[54] **PAPER DRYING PROCESS AND APPARATUS**
**4 Claims, 1 Drawing Fig.**


[52] **U.S. Cl.** ..... **34/23,** 34/114, 34/159
[51] **Int. Cl.** ..... **F26b 3/00**
[50] **Field of Search** ..... 34/23, 114, 159



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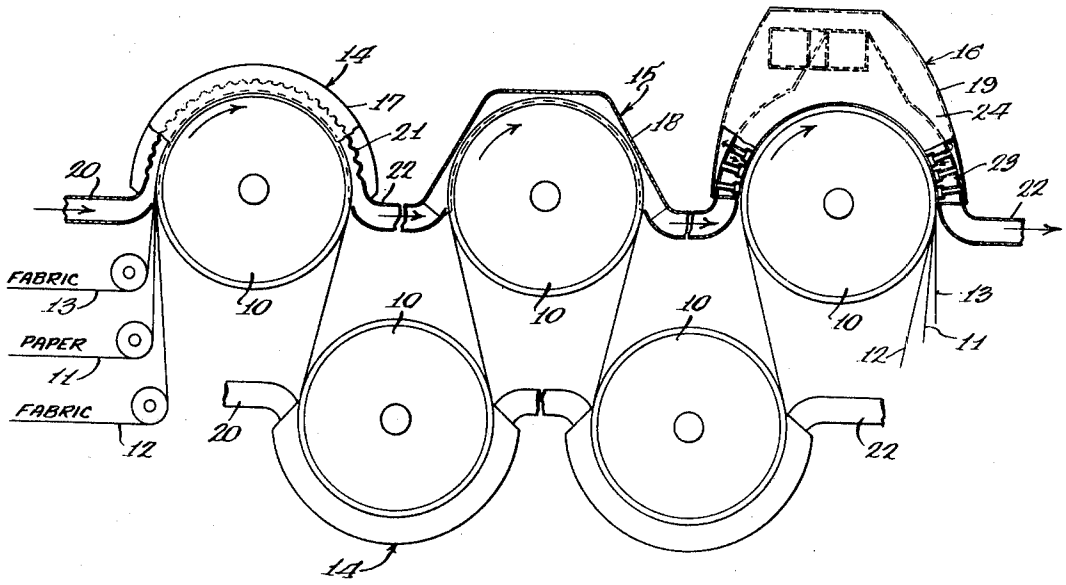
**ABSTRACT:** A process and apparatus for drying webs of newly formed paper material in the dryer section of a paper making machine having a plurality of rotatable dryer drums over which the paper web is guided in seriatim in heat exchange relationship while the web is disposed between open mesh dryer fabric endless belting and the web is scrubbed by air circulated through the meshes of the fabric while moving beneath hoods embracing the dryer drums.

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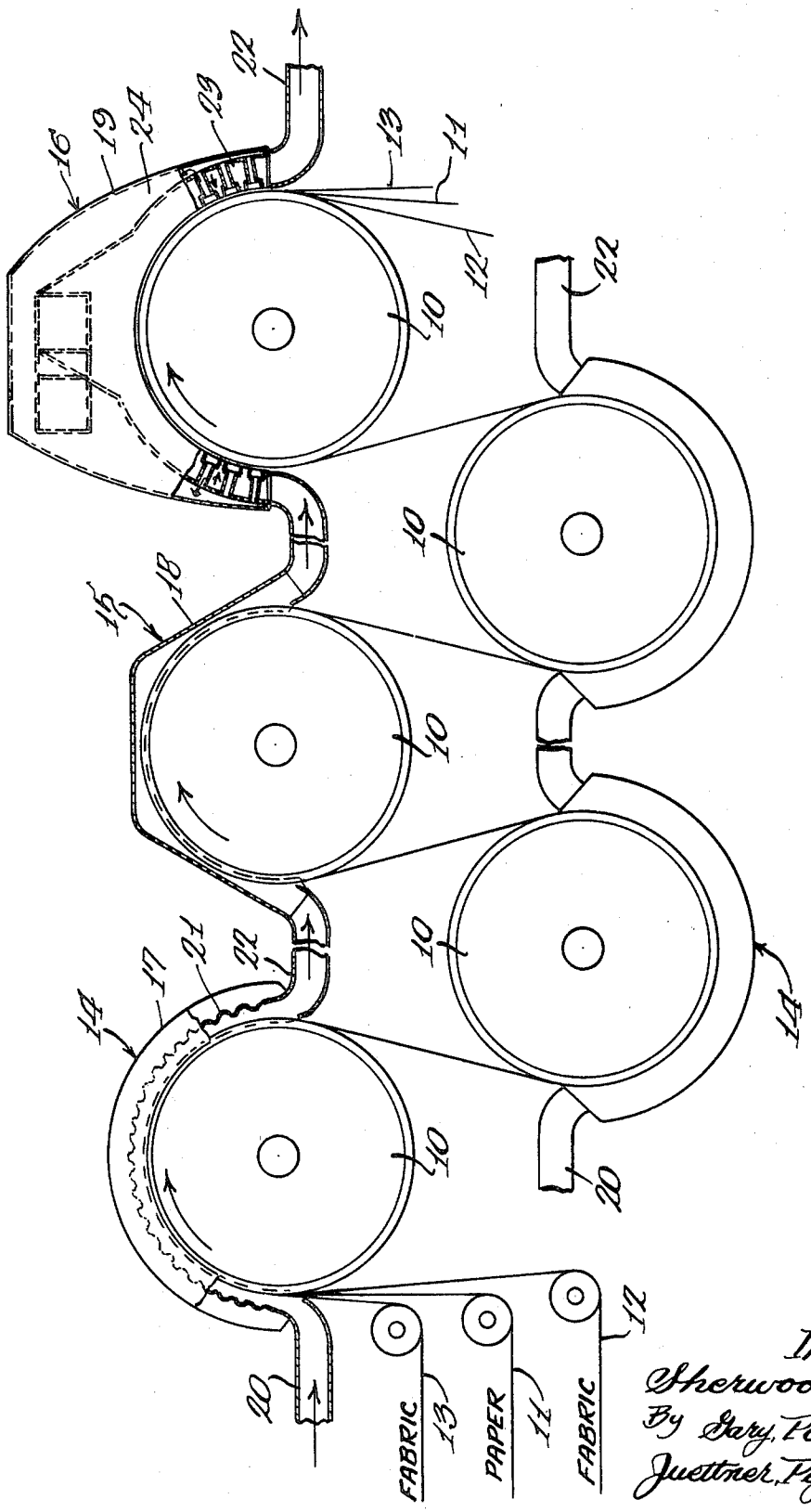


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# PAPER DRYING PROCESS AND APPARATUS

This invention relates to improvements in the process and apparatus for drying paper webs in the drying section of a paper making machine having a plurality of drums rotating about horizontal axes over which the paper web is guided seriatim in heat exchange relationship.

In the typical dryer section of a paper making machine, heated drying drums are arranged in horizontally disposed upper and staggered lower series and the web is conducted sequentially into contact with the drum in one of the series to a drum in the other of the series and back to the first series and so on. An endwise flexible woven fabric belt or dryer felt has heretofore been conventionally associated with each of the series of dryer drums, that is, a dryer belt is arranged to press the web into heat exchange relationship with a peripheral portion of each of the dryer drums with the opposed sides of the paper web alternately embracing the drums in the respective upper and lower series.

The evaporation rates obtained with present-day "Can" type dryers or drying drums of the aforesaid class is about 1 to 2 pounds per hour per square foot. This can be contrasted with drying rates of from about 20 to about 40 pounds per hour per square foot obtained with the relatively large diameter "Yankee" drums, the latter being characterized by a diameter of from about 9 to about 15 feet. This higher rate for the Yankee dryers is partially due to better conduction of heat from the dryer shell to the adhering paper, but is mostly due to employment therewith of high velocity types of hoods which reduces the boundary layer film of moist air to a minimum which thus increases mass surfaces. A considerable amount of heat is also transmitted to the sheet from this "scrubbing" air.

In the arrangement of the present invention, the paper sheet to be dried is carried over the surfaces of the dryer drums between an opposed pair of open mesh dryer fabrics and subjected to scrubbing action through the meshes of the fabric by means of air caused to flow in a turbulent manner through hoods which embrace approximately one-half of the periphery of said drying drums at the area where the paper web is caused to pass over said drums.

Although the presence of this fabric tends to retard evaporation, the thickness of the boundary layer film can be reduced to approximately 0.020 inch In contrast to this, in a conventional system employing dense conveyor felts where almost no evaporation takes place over the dryer surface, the boundary layer in the open sheet draws in the neighborhood of 0.25 inch. With the arrangement of the present invention the drying rate can be in the neighborhood of 8 pounds per hour per square foot representing a four-fold increase. Although no increase in heat transfer from the cylinder to the sheet would be expected, this can also be increased by heating the scrubbing air in the hoods.

The present invention is particularly useful in overcoming problems encountered in dryer sections as speeds are increased above 2,000 feet per minute and basis weight of paper is less than 26 pounds per 3,000 square feet. Thus, in the present invention where the sheet is essentially sandwiched between two porous fabrics which follow the normal sheet run through the dryer section, the arrangement is self-threading and avoids the problem of sheet flutter and windage which are becoming problems for high weight paper grades.

With the present arrangement the sheet is separated from the dryer surfaces by a porous fabric at all times. While this will decrease the transfer of heat from the drying drum to the sheet, this decrease can be compensated for by the scrubbing air. Moreover, in the drying of lightweight paper, overall drying ability is not critical.

Perhaps one of the most valuable benefits from such a system is the tendency of the dryer section to level out cross machine nonuniformities of moisture. While the present "Can" dryers have this same tendency, however, this will be greatly increased by the high velocity air impingement employed in the present invention. Wetter spots, having better conductivity and better opportunity for vapor transfer, will dry more rapidly than the drier spots.



Although drying hoods of conventional character can be employed in the present invention, the use of porous dryer fabrics of varying permeability in a cross direction have been found particularly useful, such drying fabrics consisting of endless belts of flexible woven fabric whereof the warp threads are greater in number per linear inch adjacent the longitudinal edges of the belts and decrease in number therefrom in a crosswise direction towards the longitudinal center of the belt, whereby the humidity profile, during drying, is flattened to produce a more uniform drying across the paper machine width. The porous fabric between which the paper web is confined and carried about the drying drums can be composed of either conventional cotton or asbestos or synthetic fabric such as polyester fiber or nylon and wherein the cross threads may be monofilaments and the warp threads of spun fibers.

The process and apparatus of the present invention, its details and arrangements will be apparent from a consideration of the following specification and accompanying drawings, wherein the drawing diagrammatically illustrates the dryer section of a paper making machine embodying the present invention.

Referring to the drawings, a fragmentary portion of the dryer section of a paper making machine is illustrated and comprises a plurality of heated drying cylinders, drums or cans **10** arranged in horizontally disposed upper and staggered lower series with the paper web **11** conducted sequentially into contact with a drum in one of the series to a drum in the other of the series and then back to the first series and so on, as is conventional so that heat is passed to the paper web from the drum in alternate directions a plurality of times until the web is dried to the desired extent.

While the paper web **11** is being carried over the drying drums in the manner aforesaid, it is conducted thereover between the porous fabrics **12** and **13** which are in the form of endless belts usually in separate pairs, which eliminate sheet marking due to the fabric contour or a series of pairs of fabrics operating as separate sections, the speeds of which can be adjusted to allow for stretch or shrinkage, one going about the upper cylinders and one going about the lower cylinders, with conventional tensioning by intermediate pocket rolls (not shown) which guide the fabrics **12** and **13** in its passage about the drying cylinders **10**.

As the paper sheet **11** is guided about the cylinder **10**, it is further enveloped by a driving hood such as that shown at either **14**, **15** or **16** of FIG. **1**. While three different types of drying hoods are illustrated, it will be understood that generally one type of drying hood will be employed in a single dryer section and that hoods are similarly provided for the lower row of drying drums in inverted position. These dryer hoods embrace about one-half of the periphery of the drying cylinders and have an arcuate top wall **17** as shown in the dryer **14**, or the angular wall **18** for the dryer **15**, or the composite wall **19** for the dryer **16**. An air supply, either room temperature or preferably heated air, is introduced at a high velocity to the various drying hoods such as for example into the supply conduit **20** and through the hood **14** wherein a turbulent flow is induced to the air supply be means of the undulating member **21** and exhausted through the conduit **22**. Air may be supplied to and exhausted from each air hood individually or two or more adjacent hoods may be connected to each other so that the air supply flows through a plurality of hoods.

In the hood **15** air turbulence is provided by means of a convergent-divergent channel defined by the convergent and divergent components of the wall or or enclosure **18**, and in the hood **16** a turbulent flow of air is provided to the supply plenum **23** and emitted through the exhaust plenum **24**. The foregoing various types of hood designs per se are conventional and known to have the general effect of reducing boundary layer thickness.

Although I have shown and described the preferred embodiment of my invention, it will be understood by those skilled in the art that changes may be made in the details thereof

without departing from its scope as comprehended by the following claims.

I claim:

1. In apparatus for drying a paper web in the dryer section of a paper making machine, a plurality of drums rotating about horizontal axes arranged in upper and staggered lower series, a pair of porous fabric belts for embracing engagement with the opposed faces of said paper web and for conveying the web in spaced relationship to and alternately about said dryer drums, and dryer hood means embracing a plurality of said dryer drums in substantially the area where the paper web is carried thereover, said hoods including dryer air supply inlets and exhausts and means for causing turbulence of the air while passing said hoods and for subjecting the paper web to air scrubbing action through the meshes of said porous fabric.



2. The apparatus of claim 1 wherein each of said drying drums include an embracing dryer hood.

3. The apparatus of claim 1 wherein said dryer fabric belts are of varying permeability in the cross direction, the permeability being greatest adjacent its longitudinal center.

4. In a method for drying a paper web in the dryer section of a paper making machine comprising a plurality of horizontally disposed rotatable dryer drums arranged in upper and staggered lower series the steps which comprise moving the paper web between a pair of porous fabric belts alternately about said dryer drums, and simultaneously subjecting the paper web to air scrubbing action through the meshes of said porous fabric by impinging and flowing air thereover in a turbulent manner while being conveyed about said dryer drums.