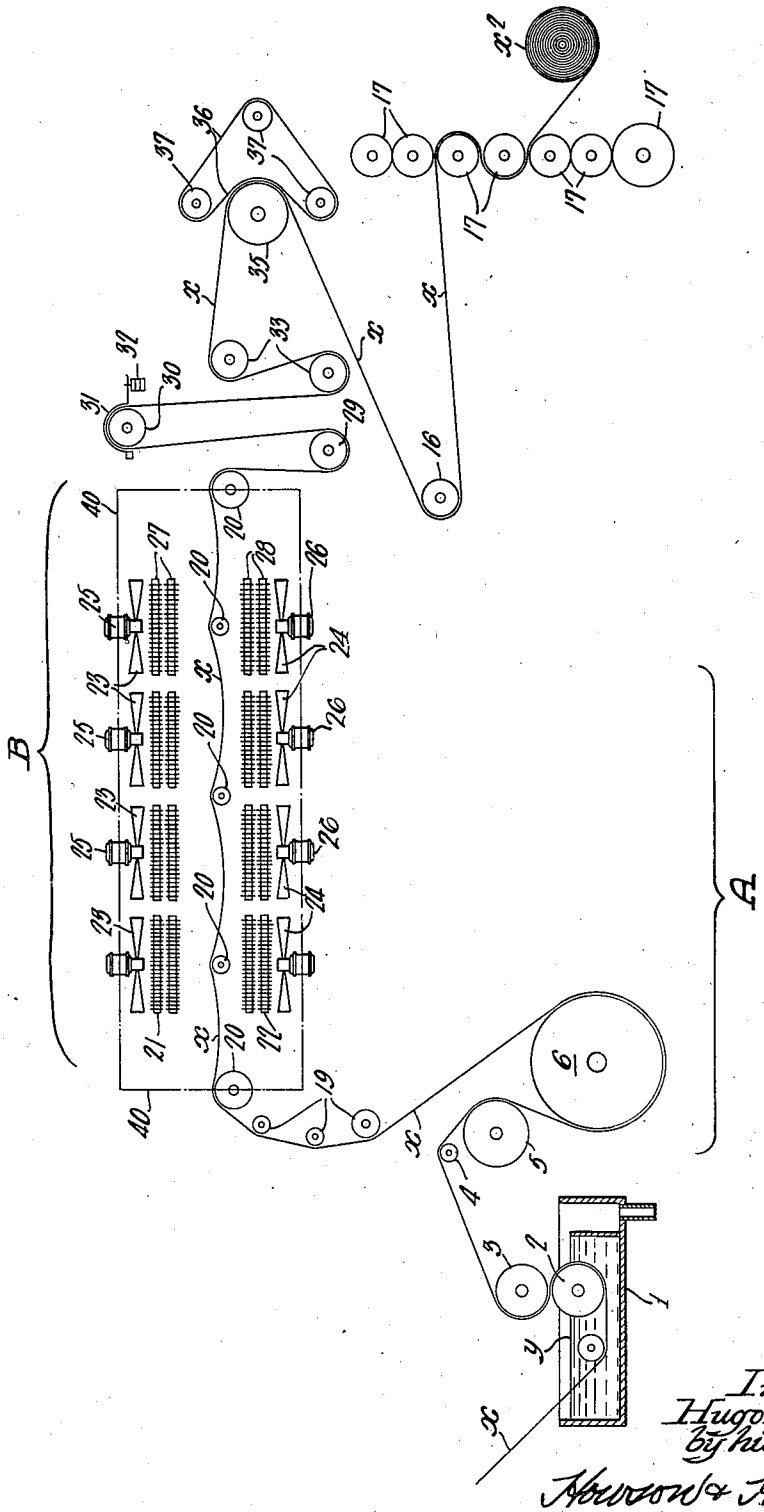
April 28, 1942. H. H. HANSON 2,281,496

AIR DRIER FOR PAPER

Filed April 29, 1940



Patented Apr. 28, 1942

2,281,496

UNITED STATES PATENT OFFICE

2,281,496

AIR DRIER FOR PAPER

Hugo H. Hanson, Philadelphia, Pa., assignor to W. C. Hamilton & Sons, Miquon, Pa., a corporation of Pennsylvania

Application April 29, 1940, Serial No. 332,348

5 Claims. (Cl. 34—155)

This invention relates to the art of finishing paper, and especially to the production of a "cockle" finish which is characteristic of high grade "bond" and similar air-dried stock.

In the paper making and finishing art, the term "air dried" distinguishes that class of papers having a uniformly puckered surface, known as "cockle," from the "machine" dried type wherein the paper has an overall flat level surface.

The distinguishing characteristics between the two processes reside in the air dried paper being dried under minimum restraint while the machine dried paper is dried under relatively great restraint.

In the case of the air dried paper, drying is effected by contact therewith of flowing air while the paper is supported and maintained under the least possible degree of longitudinal and transverse tension; whereas in the case of the machine dried paper, it passes around and is maintained under a high degree of lengthwise and crosswise tension on the peripheral surfaces of heated cylinders. The paper is dried by its direct contact with the heated surfaces of the cylinders.

In either case, the paper web, after it leaves the final press rolls of the web forming machine in a wet condition, passes around a set or nest of primary drying cylinders. From the primary drying cylinders the web passes through a sizing solution in a suitable tub located between the primary drying cylinders and the finishing apparatus.

In the case of the machine finished papers, the initially partly dried web passes from the sizing tub to a finishing "set" composed of a second series of heated cylinders, around which the web passes successively. Throughout a substantial portion of the travel of the web on the face of each heated finishing cylinder the web is pressed firmly against the smooth peripheral surface of the cylinder by a blanket which travels concurrently with the cylinder and holds the web against shrinkage. Drying of the web under the above noted conditions prevents the paper from shrinking naturally, thus the paper dries flat with a more or less smooth surface.

In the case of air dried papers, the web coming from the primary set of drying cylinders and passing through the solution in the sizing tub, passes into a long drying chamber in which the web is loosely supported and through which it is advanced by a series of rotating rolls. Supporting and advancing the web in this manner relieves the web of tension, to the greatest possible extent. The web resting on and sagging between the supporting rolls is therefore under no restraint against natural shrinkage, except that which is produced by its own weight in resting on and hanging loosely between the advancing rolls.

The mechanism at the delivery end of the drying chamber is regulated to take up the web at a rate commensurable with the rate at which the wet sized web is fed into the receiving end of the drying chamber, less the rate at which the web shrinks longitudinally in its drying-transit through the chamber.

Under the air drying processes previously known to the art, the drying rate has been relatively low, therefore an extremely long chamber has been required. The low rate of drying has been due to the fact that the temperature of the drying air considered safe for drying without scorching the web, did not exceed 240° F. and in instances has been known to be as low as 100° F.

Because of the enormous length of the drying chamber heretofore required under prior art practices, air dryers were usually installed in a room separate from that in which the paper making machine and primary set of drying rolls was installed. This necessitated the use of turnover rolls, conveying rolls, and idlers, etc. to support and advance the web along a course deviating from a straight line path in alignment with the travel of the web through the primary set and sizing tub.

One object of the present invention is to provide an air dryer capable of rapidly drying a web, in transit, at such a relatively high rate that the length of the air dryer can be reduced to approximately the overall length of an ordinary set of machine finishing cylinders.

Another object of the invention is to produce an air dryer which can be installed and operated in superposed relation to an ordinary set of machine finishing cylinders, thus eliminating the necessity for any additional floor space to accommodate the air drier.

Another object of the invention is to operate the air drier in conjunction with one or more of the machine finishing cylinders, whereby the web may be heated, by passage around such cylinder or cylinders, up to the point where shrinkage of the web would normally begin and then to pass the preheated web immediately into the feed end of the air drier.

Another object of the invention is to arrange

the air-heating and circulating means of the air drier in such relation to the path of travel of the web that temperatures up to approximately 280° F. or 300° F. may be employed without fear of scorching the web, and by which the evaporation of the moisture from the web is made so rapid that the web is kept relatively cool and safely below scorching temperature. Such extremely fast drying permits the length of the drier to be reduced to the extent noted above.

The single figure of the accompanying drawing diagrammatically illustrates the air drier of the present invention in superposed relation to a conventional set of machine drying cylinders commonly employed to produce the smooth finished paper noted above.

In the drawing, a web x in an initially dried state as it comes from the primary drying set (not shown) is illustrated as passing into a sizing solution y contained in a conventional type of size-tub 1. The tub 1 is provided with the usual squeeze rolls 2 and 3 for removing excess sizing solution from the web.

From the squeeze rolls 2 and 3 the web x passes around carrying rolls 4 and 5 to a normal set, A, of finishing cylinders, one only of which is shown at 6.

Normally, in the above noted machine drying of paper the endless belt or blanket composed of felt or other suitable material is associated with the upper row of cylinders of the finishing set, and bears against segmental portions of the upper sides of the peripheral surfaces of these cylinders, said blanket or belt being held in contact with the cylinders and otherwise supported by a series of rolls.

A similar belt is associated with the lower row of cylinders of the finishing set and bears against the under segmental portions of these cylinders, under control of suitable guide rolls.

Normally the above noted belts travel concurrently with the peripheral surfaces of the heated cylinders, with the paper being held between the belts and the peripheral surfaces of the cylinders, as the web of paper travels around the cylinders.

Normally the web passes from the last cylinder of the finishing set around a guide or spring roll 16 to a stack of calendering rolls 17, 17, and from there to suitable reeling mechanism adapted to convert the web into a roll $x2$.

The calendering rolls 17, 17 are power driven and serve as a means for drawing the web through the finishing set A, the cylinders 6, etc. of which may also be driven by any suitable means, not shown, this being common practice in the art.

In accordance with the principles of the present invention the air drier B is superposed above the finishing set of cylinders A, as indicated in the drawing. Under the principles of the present invention the web x passes around one or more of the heated cylinders of the finishing set A, employed in this instance merely to heat or preheat the web x prior to its entrance into the air drier B.

In the present instance the web x is shown as passing around only the first cylinder 6, it being found that usually the heat applied to the paper by this one cylinder is sufficient to bring the paper to a stage of moisture evaporation wherein the paper is about to begin normal shrinkage, upon further evaporation of the moisture therefrom.

The preheated web x passes from the heating cylinder 6 to and around a series of guide rolls 19, 19, onto a series of supporting rolls 20, 20. The rolls 20, 20 support the web in a substantially horizontal plane between upper and lower air heating and impinging units 21 and 22 respectively, the upper series 21 being designed to drive air downwardly into impinging contact with the upper surface of the web x as it travels along horizontally over the rolls 20, 20, while the lower series 22 drives air upwardly into impinging contact with the under surface of the web x.

Between and as a result of the opposed currents of air the web x is maintained in a more or less floating condition, free of restraint opposing its natural tendencies to shrink in all directions simultaneously.

In the units 21 and 22, the air is driven downwardly and upwardly by high capacity impellers in the form of fans 23 and 24 respectively. These fans are driven individually by electric motors 25 and 26 respectively, or by any other suitable means. The fans 23 and 24 are adapted to move large volumes of air at relatively high velocity into impingement with the opposite surfaces of the web x.

Intermediate the air impellers 23 and 24 and the opposite surfaces respectively of the web x, air heaters 27 and 28 are provided. The air heaters 27 and 28 are preferably of the high heat transfer type such, for example, as the honeycomb type of radiator employed in automobiles and in other heating equipment.

Preferably the construction of the heaters 27 and 28 is such as to withstand an internal steam pressure of approximately 185 pounds per square inch, by which high temperatures upward to about 300° F. may be readily obtained in the air driven through the honeycomb construction by the impellers 23 and 24.

Under the above conditions, the evaporation of moisture from the web x is so rapid that the opposite surfaces of the web are maintained relatively cool and the web x, traveling at the rate of approximately 130 to 150 feet per minute, does not remain in contact with the high temperature air currents for a sufficient length of time to scorch or otherwise damage the web. However, even at such relatively high rate of travel of the paper the air currents by impinging upon substantially all points on both surfaces of the web from side to side thereof and from end to end of the unit B, simultaneously, effects complete drying of the web. During this drying, with the web in an unrestricted condition, said web attains the all-over puckered condition commonly known as "cockle."

From the last of the supporting rolls 20, at the delivery end of the unit B, the web passes around a guide roll 29 to and around a drag roll 30 to which friction is applied by a shoe 31 under the influence of a weight 32 or other friction producing means.

From the roll 30 the web passes around additional drag rolls 33 to and around a retarding roll 35. At spaced intervals across the face of the roll 35, narrow endless belts or straps 36 pass around guide rolls 37, 37 which engage and press the web into firm contact with the peripheral surface of the roll 35 at laterally spaced intervals across the width of the paper throughout its travel around a segmental portion of the peripheral surface of the roll 35.

From the retarding roll 35 the web x passes to the roll 16 previously mentioned and from there to the calendering rolls 17. The rolls 29,

30, 33 and 35, with the friction device 31 and spaced straps 36, act as a brake to permit the calender rolls 17 to place the web under tension after it leaves the air drying unit B, at which time it has attained its full amount of natural shrinkage, said tension being placed on the web in order that it may be properly calendered and wound into the roll x2 without wrinkling.

The web x, as it leaves the size-tub 1, is of approximately 25 to 30% moisture content. The web is heated on the cylinder 6 up to the point where evaporation of moisture and shrinkage of the web begins, after which the moisture is evaporated from the web during its travel through the unit B.

The velocity and temperature of the impinging air may be regulated to deliver the web from the unit B in any state desired from a bone dry condition to a condition having any percentage of moisture content that may be desired.

From the time the web x leaves the heating cylinder 6, until it arrives at the brake roll 30, or at least the roll 20 at the delivery end of the unit B, it is under no tension except that produced by its own weight in passing around the various rolls and this lack of restraint is controlled by providing a differential in the speeds of the driven rolls 6 and 35 which will compensate for the reduction in the over-all length of the web by shrinkage as it dries in transit in passing through the unit B.

If desired, the air heating and impelling units of the air dryer B may be confined within any suitable casing with or without insulated walls and with a slot adjacent each end roller 20 for the ingress and egress of the paper relative to the chamber formed within the casing, such casing being diagrammatically illustrated in broken lines and indicated at 40.

From the foregoing it will be clear that by creating a zone of relatively high temperature adjacent each of the opposite faces of the unrestrained paper simultaneously, rapid evaporation of moisture from the paper can be effected, and because of the paper being free to shrink in all directions simultaneously the entire area of the paper within the zone will assume an all-over substantially uniform puckered condition providing the desired "cockle" finish on the paper.

It will be further noted that the rapid evaporation of the moisture from the paper will maintain the surface of the paper relatively cool, thereby permitting the use of high temperatures heretofore considered unsafe in the drying of paper.

It will be further noted that by preheating the wet paper to a point where shrinkage of the paper would normally begin, the time necessary to keep the paper in the high temperature zone to evaporate the moisture from the paper to the point where the puckering has advanced to the desired extent can be reduced to a minimum, thus requiring a relatively short air dryer. As an example, with the temperatures noted above, i. e. from 280° F. to 300° F. or better, rather complete evaporation of moisture from the paper may be effected in 5 seconds, thus with the paper traveling at approximately 130 to 150 feet per minute the length of the air dryer need only be approximately 12 feet long, the average length of a finishing set of machine drying cylinders.

I claim:

1. In a paper-finishing apparatus, a pair of naked foraminous air-heaters each having a large number of air passages, said air-heaters being arranged in opposed spaced and substantially parallel relationship providing a paper-receiving channel therebetween, means for advancing a continuous web of paper longitudinally through said channel, and means for driving air through the air passages of said heaters directly into contact with the opposite faces respectively of the moving web, said air normally maintaining said web in spaced relation to said heaters.

2. In a paper-finishing apparatus, a pair of naked foraminous air-heaters each having a large number of air passages, said air-heaters being arranged in opposed spaced and substantially parallel relationship providing a paper-receiving channel therebetween, means for advancing a continuous web of paper longitudinally through said channel, and means distributed over the areas of said heaters which define said channel and disposed adjacent the faces of said heaters lying opposite those between which said channel is formed for driving air through the air passages of said heaters directly into contact with the opposite faces respectively of the moving web, said air normally maintaining said web in spaced relation to said heaters.

3. In a paper-finishing apparatus, a pair of horizontally disposed naked foraminous air-heaters each having a large number of vertical air passages, said air-heaters being arranged in opposed vertically spaced and substantially parallel relationship providing a horizontal paper-receiving channel therebetween, means for advancing a continuous web of paper longitudinally through said channel, and means distributed over the areas of said heaters which define said channel and disposed adjacent the faces of said heaters lying opposite those between which said channel is formed for driving air through the air passages of said heaters directly into contact with the opposite faces respectively of the moving web, said air normally maintaining said web in spaced relation to said heaters.

4. In a paper-finishing apparatus, a pair of horizontally disposed naked foraminous air-heaters each having a large number of vertical air passages, said air-heaters being arranged in opposed vertically spaced and substantially parallel relationship providing a horizontal paper-receiving channel therebetween, means for advancing a continuous web of paper longitudinally through said channel, means distributed over the areas of said heaters which define said channel and disposed adjacent the faces of said heaters lying opposite those between which said channel is formed for driving air through the air passages of said heaters directly into contact with the opposite faces respectively of the moving web, said air normally maintaining said web in spaced relation to said heaters, and means within said channel to maintain the web out of contact with the heaters.

5. In a paper-finishing apparatus, a pair of naked foraminous air-heaters of predetermined length and breadth respectively operating at a temperature having a minimum of 280° F., each air-heater having a large number of air passages uniformly distributed over its area, said air-heaters being arranged in opposed spaced substantially parallel relationship to provide a paper-receiving channel of predetermined length therebetween, means for advancing a continuous web of paper containing a maximum of 30% moisture through said channel lengthwise thereof at a rate of speed having a minimum of 130 feet per

minute to effect travel of the web from end to end of the channel within a period of time having a maximum of substantially 5 seconds, and means for driving air through the air passages of said heaters directly into contact with the opposite faces respectively of the moving web at a velocity predetermined to reduce the moisture content of the paper to substantially 0% in a single passage of the web through said channel, said air normally maintaining the web in spaced relation to the heaters within said channel.

HUGO H. HANSON.