Oct. 20, 1942. H. G. CHATAIN 2,299,459

PAPER MANUFACTURE

Filed March 15, 1940 4 Sheets-Sheet 1

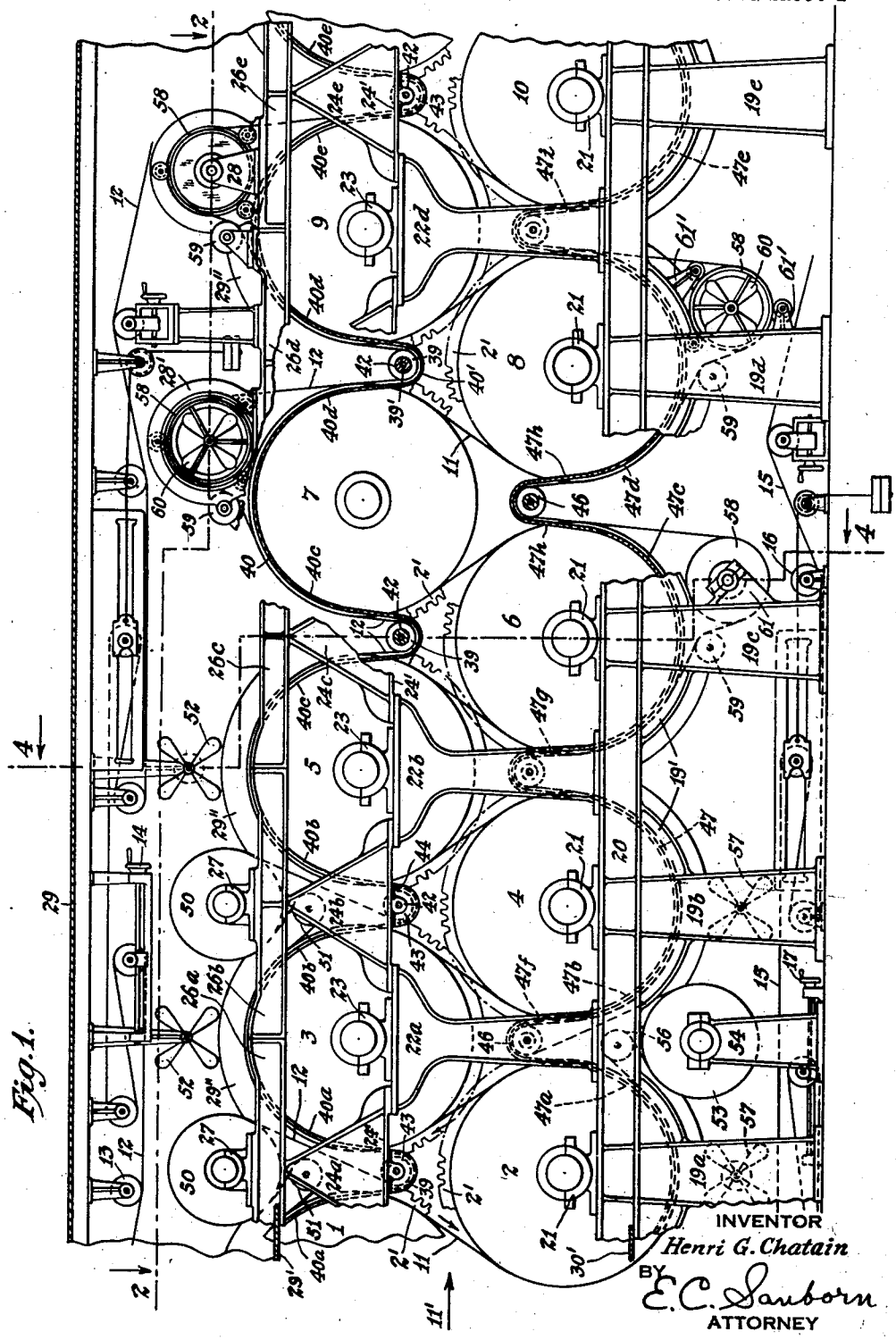


Fig. 1.

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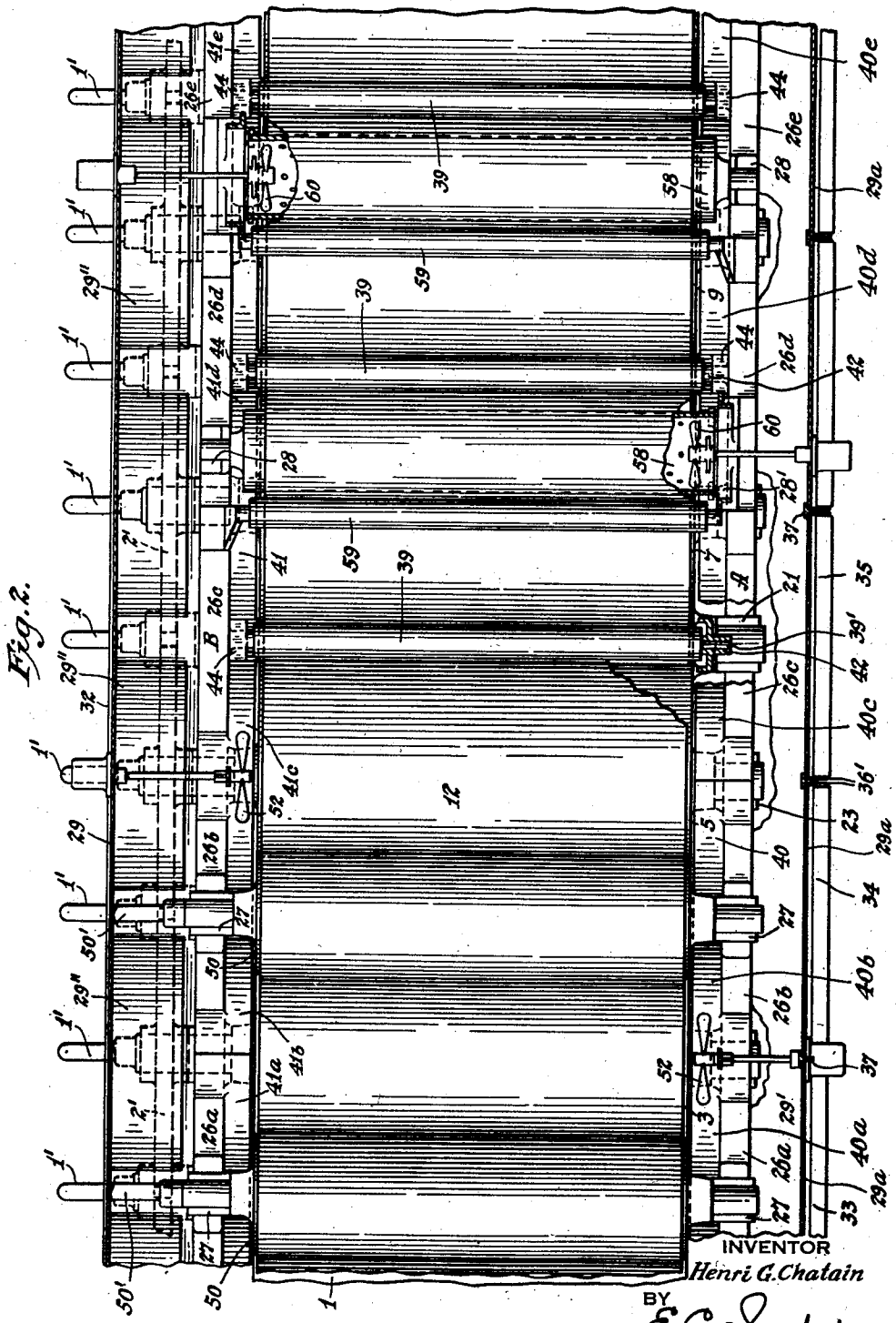


Fig. 2.

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Fig. 4.

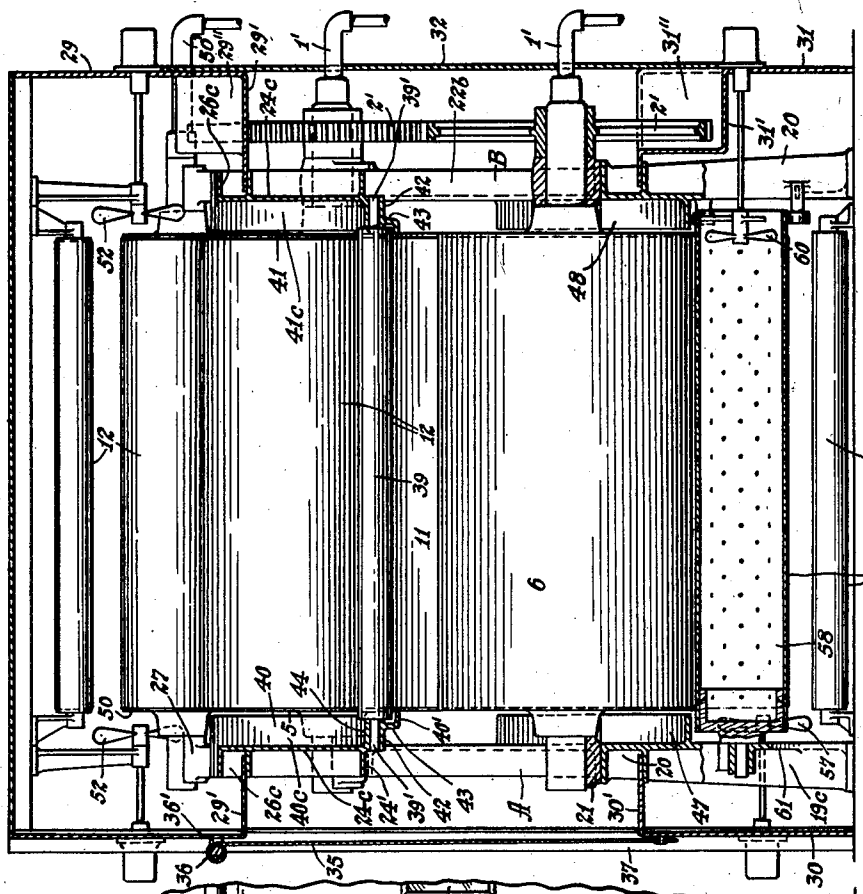
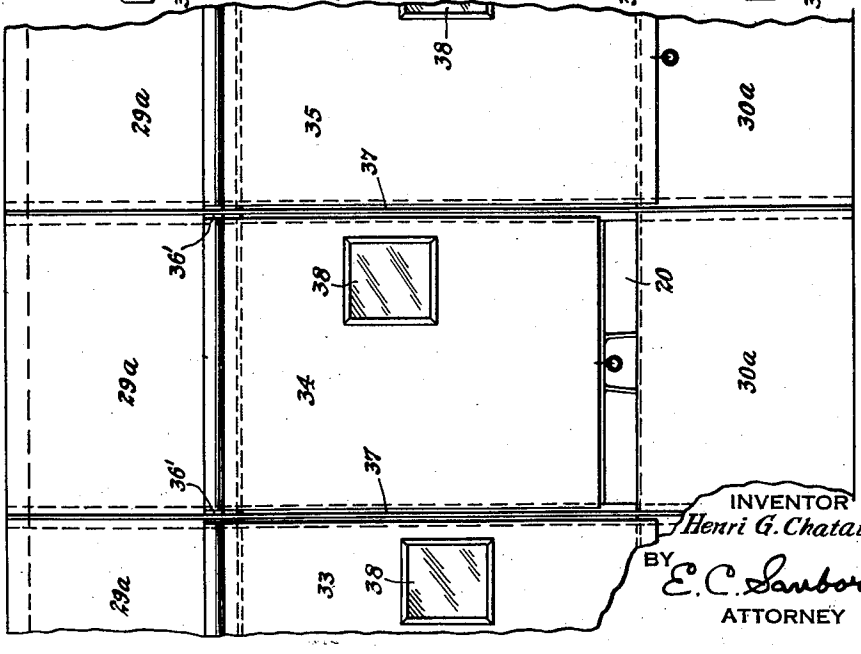


Fig. 3.



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Filed March 15, 1940 4 Sheets-Sheet 4

Fig: 5.

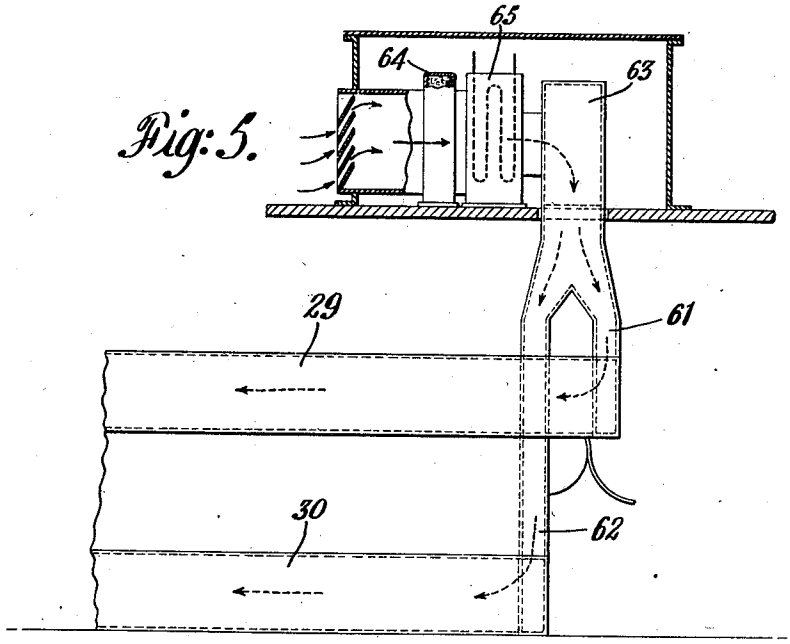
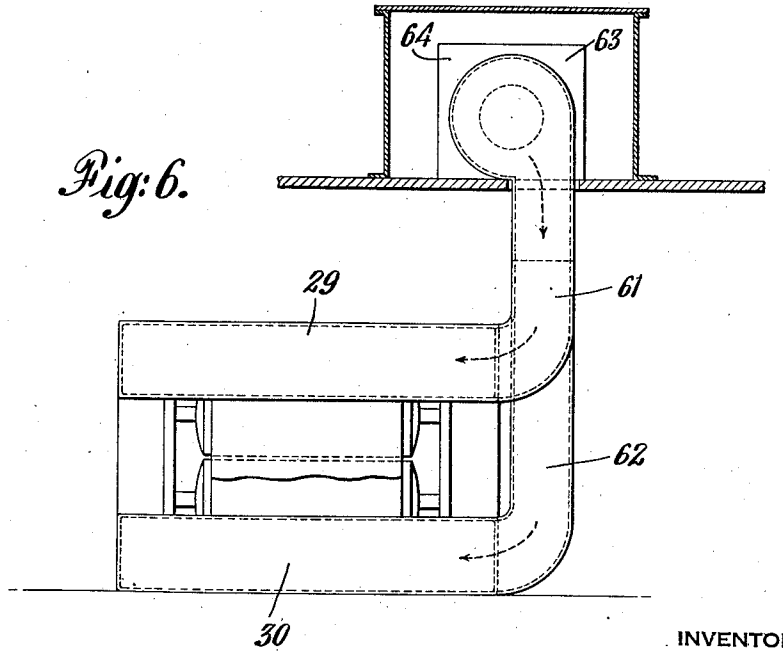


Fig: 6.



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UNITED STATES PATENT OFFICE

2,299,459

PAPER MANUFACTURE

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Application March 15, 1940, Serial No. 324,021

14 Claims. (Cl. 34—41)

This invention relates to the manufacture of paper and is more particularly concerned with preventing objectionable shrinking of paper during its passage through the dryer section of a paper machine. In the customary operations, the paper emerging from the dryer rolls usually has "rough edges," or, in other words, the edges are grainy or corrugated, sometimes for a distance of six inches or so into the width of the sheet. The portions of the sheet involving the grainy edges are not salable as a first-class product and must be trimmed from the sheet, with substantial manufacturing loss. Also the sheet after passage through the dryers is frequently prone to curl.

I have found that these difficulties can be overcome by preventing or diminishing the admission of air to the central zone of the dryer section, i. e., the zone between the upper and lower sets of dryer rolls, so that the air in that section will be saturated, or nearly so, thus preventing water from escaping to said air from the portions of the sheet which are passing through the spaces between the dryer rolls. As a result the paper is subjected to a drying action practically entirely on the dryer rolls, where it is held from shrinking, and the production of "rough edges" is avoided. Furthermore, the air with its water vapor in the aforementioned central zone becomes thoroughly diffused to thereby cause evenness of such small amount of drying as may occur in said zone, with consequent elimination of strains set up in the paper as it is being dried, thus obviating the conditions which cause curling, and resulting in a sheet of paper which will lie flat.

The invention further achieves these results without sacrifices of the desired extent of drying of the paper and without diminishing the speed of operation of the paper machine.

The invention also comprises the provision of novel and efficient means, of simple and economical construction, for attaining the above-noted results, and which may be applied to the dryer sections of standard paper machines.

Other objects and advantages of the invention will be hereinafter described and claimed.

In the accompanying drawings:

Fig. 1 is a vertical sectional view, with parts in elevation, illustrating an embodiment of my invention.

Fig. 2 is a horizontal sectional view taken approximately on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary elevation of a detail.

Fig. 4 is a transverse vertical section, taken approximately on line 4—4, of Fig. 1.

Fig. 5 is a diagrammatic view in side elevation illustrating provisions for supplying heated and conditioned air to the housings 29 and 30 for the upper and lower zones of the drier section.

Fig. 6 is a diagrammatic end view of the arrangement illustrated in Fig. 5.

Referring to the drawings, there is shown a dryer section of a paper machine, said dryer section including the usual upper and lower sets of dryer rolls. The numerals 1, 3, 5, 7, and 9 designate dryer rolls in the upper set, while numerals 2, 4, 6, 8, and 10 refer to dryer rolls in the lower set. Said rolls may be supplied with steam in the customary way through pipes 1' and may be driven through gears 2' in any suitable or conventional manner to advance the web of paper 11 through the dryer section in the direction indicated by the arrow 11'. Overlying the paper in its passage over the upper rollers is the usual endless felt band 12 which passes over suitable rollers, such as are indicated at 13 and the lower course of which travels in the same direction as the paper and presses the latter firmly against said upper dryer rolls. Conventional tension regulating apparatus for the felt band 12 is indicated at 14.

Similarly an endless felt band 15 passes over the usual rollers 16 and tension regulating means 17 in the lower part of the dryer section, the upper course of which band travels in the same direction as the paper and maintains the latter pressed firmly against the lower drying rolls.

The various rolls may be mounted in suitable main side frames A and B (Fig. 4), each of which side frames may comprise a series of lower pedestals, such as indicated at 19*a*, 19*b*, 19*c*, 19*d* and 19*e*, which pedestals are connected by beam 20. The lower dryer rolls may be journaled in bearings 21 on the beams 20. Supported on each of said beams is a series of upwardly extending pedestals, such as 22*a*—22*d*, carrying bearings 23 at their upper ends, in which bearings the upper dryer rolls are journaled. The pedestals, such as 22*a*—22*d* of each series, may be interconnected by frame elements, as indicated at 24*a*—24*e*, which frame elements are joined at their upper ends by beam sections such as shown at 26*a*—26*e*. The last mentioned beam sections are suitably joined together and may carry bearings 27 and pedestals or supports 28 and 28' for various other rolls later to be described. It will be understood that the various pedestals and beams may be secured together in any suitable way, as by bolts or welding.

A housing 29 of sheet metal or other material

is mounted, through inwardly projecting extensions 29', on flanges of the beams 26a—26e, as shown in Fig. 4, and serves to enclose the top portion of the dryer section. At the front and rear sides of the lower portion of said dryer section there are provided suitable plates or frames 30 and 31, respectively, each having a flange 30', 31' projecting into engagement with a flange of the adjacent beam 20, said frames extending to the bottom of said section. The flanged portion 31' of frame 31 may be pocketed as shown at 31'' in Fig. 4 to accommodate the gears for driving the respective lower dryer rolls. Similarly, the flanged rear portion of housing 29 may be pocketed, as indicated at 29'', to accommodate the gears for driving the respective upper dryer rolls.

As above noted, my invention provides for maintaining the air in the central zone of the dryer section (i. e., the zone wherein the paper passes between the upper and lower drying rolls) in sufficiently humid condition to prevent any substantial drying of the paper in said zone. To this end I provide for isolating the air in said zone from the air exterior to the dryer section, as well as from the air in the upper and lower portions of said section.

At the rear side of the machine the entrance of exterior air to said central zone may be excluded by a frame or plate 32 extending along said rear side and suitably secured at its top to the housing 29 and at its bottom to the plate 31. At the front, the exterior air may be excluded in any desired manner, but I prefer to provide a series of curtains, such as illustrated at 33, 34, and 35 (Figures 3 and 4) which may be mounted on rollers 36 journaled in suitable brackets 36'.

As illustrated in Figures 3 and 4, each curtain may be mounted between adjacent beam elements 37, of T-shaped cross section, which elements extend from top to bottom of the machine, and to which elements said brackets 36' are welded or otherwise suitably secured. Said beam elements 37 also serve as reinforcing members, in which connection it will be noted that the frame or plate 30 may consist of sections 30a secured to said beam elements, as by bolts or through welding, and extending therebetween. Similarly the front wall of the housing 29 may comprise sections 29a extending between said beam elements 37 and suitably fastened thereto.

Each curtain may contain a window 38 of flexible, transparent material so that the operator may look into the interior of the dryer section without raising the curtain. In Fig. 3, the curtain 34 is shown in slightly raised position, simply to show more clearly its relation to certain associated parts. In normal operation, all of the curtains will be in their lowermost positions, as illustrated in conjunction with curtain 35.

It has been previously noted that the lower course of the felt band 12 travels in the same direction as the paper through the dryer section, i. e., in the direction of the arrow 11', and presses the paper firmly against the upper dryer rolls. As shown in Figures 1 and 2, said felt passes around the upper half of the circumference of each of said rolls and also passes under guide rolls 39 positioned between said dryer rolls. Said felt also is of such width as to extend over substantially the entire length of each of the aforesaid rolls.

Between the ends of the upper dryer rolls and the respective side frames A and B, I provide means in the form of shields 40, 41, for blocking substantially any interchange of air between the aforementioned central and upper zones around the ends of said rolls. Since said shields 40 and 41 may be substantial duplicates, a description of shield 40 will suffice.

Said shield 40 may be of metal and, as shown, may be curved to conform with the curvature of the dryer rolls. Said shield may conveniently be formed in sections 40a—40e each of which may be formed integrally with a corresponding one of the beam sections 26a—26e, and also with a corresponding one of the frame elements 24a—24e. Between adjacent dryer rolls, each of the shield sections comprises a portion 40' which passes under the corresponding guide roller 39 and is provided with a bearing portion 42 for the adjacent journal 39' of said roller, as shown in Figures 1 and 4. Each of the frame sections 24a—24e may have a flange 44 projecting from the bottom web 24' thereof and merging with the associated bearing portion 42 to impart additional rigidity thereto. Each of the shield sections may be also provided with a web 43 extending upwardly from the aforementioned portion 40' and merging with the lower flange 44 of the corresponding one of the frame elements 24a—24e, and also merging with the aforesaid bearing portion 42. If desired, each of the beam sections 26a—26e may be cast integrally with its associated frame element 24a—24e, and the corresponding shield section may be cast integrally with said beam section and associated frame element, or the corresponding sections and elements may be formed separately and welded or otherwise secured together.

It will be seen that the above mentioned shield sections follow substantially the course of the lower run of the felt 12 and extend between the adjacent edge of said felt and the frame A. As above noted, the shield 41 between the opposite edge of the felt and the frame B may be constructed of sections arranged in the same manner as described in connection with the shield 40. In the drawings, the sections of shield 41 are designated 41a—41e, respectively.

Since the air in the above mentioned central zone cannot pass upwardly through the dryer and guide rolls aforementioned, or through the felt 12 which extends over substantially the entire lengths of said rolls and passes between the dryer rolls, and since said air also cannot pass upwardly through the shields 40 and 41 interposed between said rolls and the side frames, it will be apparent that the air in said central zone is substantially isolated from that in the upper portion of the machine.

The upper course of the felt 15, as previously observed, runs in the same direction as that in which the paper travels through the machine and presses the paper firmly against the lower dryer rolls. Said felt passes around the lower half of the circumference of each of said lower dryer rolls and also over guide rolls 46 journaled in the pedestals 22a—22d of the side frames. In addition, said felt is of such width as to extend substantially across the full length of said dryer and guide rolls. Shields 47 and 48, similar to the shields 40 and 41, are interposed between the ends of the lower dryer rolls and the respective side frames A and B for blocking substantial interchange of air between the cen-

tral and lower zones around the ends of said rolls.

Referring to Figures 1 and 4, it will be seen that the shield 47 may be formed in sections cast integrally with or otherwise united to the side frame A. As shown, said shield comprises sections 47*a*, 47*b*, 47*c*, 47*d*, and 47*e*, united to the beam 20 and to the respective pedestals 19*a*—19*e*, as well as to reinforcing webs 19' integral with said beams and pedestals. Said shield also comprises intermediate sections 47*f*, 47*g*, 47*h*, and 47*i*, cast integrally with or otherwise secured to the respective pedestals 22*a*—22*d*. The shield 48 may be formed in like manner.

The guide rollers 46 for the upper run of the felt band 15 may be journalled for rotation in the pedestals 22*a*—22*d* as previously noted; and the shields 47, 48 are arranged as shown, to follow the course of the felt and to pass above said rollers. The air in the central zone aforesaid cannot pass downwardly through the lower dryer and guide rollers or through the felt into the lower zone of the machine, nor can it pass through the shields into said lower zone.

It will thus be evident that I have provided for substantially isolating the air in the central zone of the dryer section of a paper machine from the air in the upper and lower zones of said section, as well as from the outside air. As a result, when the machine is set into operation, said air in the central zone will speedily become saturated with moisture to such extent as to be unable to absorb any substantial amount of moisture from the paper passing between the upper and lower sets of drying rolls, and drying of the paper will be substantially prevented in said central zone. Thus, the drying of the paper will be practically entirely restricted to the dryer rolls, on which the paper is held from shrinking or curling, and the conditions which give rise to curling and shrinking are obviated.

While a slight interchange of air may take place between said central zone and the zones above and below the same, since a small space exists between the edges of the shields and the ends of the dryer rolls, no more than a small interchange of air can take place between said zones, so that the central zone is substantially isolated from said upper and lower zones. I prefer not to obtain a complete elimination of drying in said central zone, because some small shrinkage is desirable to prevent slack of the paper from manifesting itself at some point. My invention enables the prevention of drying in said central zone to the extent desired and without preventing some slight drying therein sufficient for preventing the occurrence of slack. The space between said shields and the ends of the drier rolls may be so chosen as to achieve the desired extent of prevention of drying in the central zone. I prefer to eliminate all drying in that zone except for the very small amount desirable for preventing slack.

In starting the machine, or in case of a "break," the operator may raise one or more of the curtains 33, 34, or 35, to obtain greater accessibility.

The above noted prevention of curling and shrinking of the paper is furthermore accomplished without impairment of the speed of operation of the machine despite the fact that no substantial drying of the paper takes place in the aforementioned central zone. To this end, the felt may pass over any desired number of steam-heated drying rolls in the upper and lower portions of the dryer section, which are open at opposite ends, and fans may be provided in said sections for directing air currents on to said felt, thus expediting the drying of the latter as well as of the paper from which the felt absorbs moisture.

Specifically, I prefer to pass the upper felt band 12 over a series of dryer rolls 50, which may be supplied with steam, through pipes 50', in the same manner as the upper and lower sets of dryer rolls for the paper. Said dryer rolls 50 may, as shown, be mounted in bearings 27 on the beam sections 26*a*, 26*b*, etc. The aforementioned rollers 39, as well as other guide rollers 51, may be provided to guide the felt in its passage to and from the rolls 50. Thus, as shown in Fig. 1, the felt, after passing over the paper on the dryer roll 1, passes around the adjacent guide roller 51, thence over the felt dryer roll 50, then around a guide roller 39, and then over the paper on the succeeding dryer roll 3. The guide rolls 51 may be mounted in various ones of the frame elements 24*a*, 24*b*, etc.

The housing 29 for the upper zone of the dryer section above noted, is preferably connected at the dry end to a system of ducts and pressure fans such as to receive a measured supply of heated air under a slight pressure. The capacity of the zone is such as to contain a sufficient amount of air for drying purposes so that the said air will under all conditions be exhausted at the opposite or wet end of the zone with the saturation desired. The air travels through said zone, counter-current to the travel of the paper and felt, toward the wet end of the drier section. Fans 52, mounted at convenient points in said housing, may be provided to direct currents of air back and forth across the machine and over exposed surfaces of the felt 12 to assist in removing water vapor therefrom. Thus the air in said housing not only travels counter-current toward the wet end of the machine but is furthermore circulated back and forth across the machine by the fans 52, as the result of which the air becomes progressively wetter until, at the wet end of the machine it becomes saturated to a desired extent, preferably to such extent as to be no longer suitable for drying purposes. The wet air may then be exhausted to atmosphere or conducted to a suitable heat reclamation system. In addition to being heated, the air supplied to said housing 29 may be conditioned in any suitable manner to lower its moisture content to a desired value prior to its introduction into said housing.

Likewise, in the lower zone of the dryer section there are provided steam-heated dryer rolls for the felt band 15, one of which dryer rolls is indicated at 53, mounted in bearings on pedestals 54. The previously mentioned guide rollers 46, as well as other guide rollers 56, guide the felt band 15 to and from the respective dryer rolls 53.

Thus, for example, the felt passing from the paper on the roll 2 passes around the adjacent guide roller 56, thence around the associated dryer roll 53, and then around a guide roll 46 from which it passes on to the paper on the succeeding paper dryer roll 4. Guide rollers 56 may be journaled in the side-frame beams 20, as indicated in Fig. 1.

The housing for the lower zone of the dryer section, like that heretofore described for the upper zone, is preferably connected at the dry end to a system of ducts and pressure fans for receiving a measured quantity of heated and humidity-conditioned air under slight pressure.

and fans 57 may be provided in said lower zone to direct currents of said air back and forth across the machine and over exposed portions of the felt 15 to promote the drying thereof. In the lower, as in the upper, housing the air travels counter-current to the paper and felt, and becomes progressively wetter, emerging at the wet end either to atmosphere or to a heat reclamation system.

As shown in Figures 5 and 6, the housings 29 and 30 for the respective upper and lower zones above mentioned may, for example, be connected by ducts 61, 62, respectively, to an air supply fan 63, which draws air through a suitable air conditioner 64 and heater 65, and passes said air into said upper and lower zones in a direction counter-current to the travel of the paper.

It may be observed that while the central zone of the dryer section is, of course, open at opposite ends, exterior air cannot enter said central zone from either end to any substantial extent, since the web of paper passes across said central zone between the upper and lower sets of paper dryer rolls, and said web is of such width as to extend over substantially the entire lengths of said rolls.

The aforementioned provisions for drying the felt bands 12 and 15 also, of course, facilitate the drying of the paper in contact with the felt. As many dryer rolls 50 and 53 may be provided as desired.

In the upper and lower zones above referred to, there may also be included supplemental paper drying rolls 58, of the type illustrated in the application of H. G. Chatain and H. L. Dyer, Serial Number 324,284, filed March 16, 1940. Where such rolls are provided, the felt is raised from a portion of the adjacent main dryer roll and passes under a guide roller 59 and thence over the supplemental dryer roll, as indicated, the supplemental dryer roll being perforated and associated with a fan 60 for blowing air through the perforations and on to the paper, as fully described in the above-mentioned application. Any desired number of said supplemental paper dryer rolls may be provided. The rolls 58 in the upper portion of said section may be mounted in bearings on suitable pedestals or supports 28, 28' on various ones of the beam sections 26*a*—26*e*, while those in the lower portion may be mounted in supports 61, 61' mounted on various ones of the pedestals 19*a*—19*d* and on the associated reinforcing webs 19'.

When the paper first comes into the dryer section it is quite cool and wet, and paper making technique demands that the sheet temperature be raised gradually to minimize tendencies to cockle. Evaporation at this stage is quite limited with the conventional arrangement of felts and dryer cylinders. The felt dryer rolls 50, 53 are preferably located in the region adjacent the forward or wet end of the dryer section, in which region the dryer felts are capable of blotting up considerable moisture from the damp paper sheet. This moisture is immediately driven out of the felt by means of the felt dryer rolls, whereby the subsequent paper drying rolls may be used for the sole purpose of drying the paper without the necessity of also having to dry the felt. It is preferred that the felt dryer rolls be maintained at a temperature considerably higher than that of the first few paper dryer rolls, to expedite the driving of moisture from the felts.

The supplemental drying rolls 58 are preferably provided in the region following that in which the combined blotting and felt-drying action above described can be employed to good advantage. At the end of the felt-drying region the paper sheet has been brought up to its normal drying temperature, and it is in the succeeding region that the aforementioned supplemental drying rolls 58 are preferably located. The air directed on to the paper from said supplemental rolls subjects the paper to a uniform drying action across the full width of its surface.

While, when said supplemental dryer rolls 58 are provided, the paper opposite said rolls is not engaged by the felt, said paper is held against shrinkage by its adhesion to the main dryer rolls. When said supplemental dryer rolls are employed it is preferred that they be discontinued at the point in the dryer section where the paper surface has become dried to such extent that the influence of air currents across said surface has no substantial effect on the drying rate. Furthermore, the discontinuance of said supplemental rolls at that point is desirable since when that stage of drying is reached the ability of the paper sheet to cling to the surface of the main dryer rolls has been materially lessened. From that point on to the end of the dryer section the drying is primarily a question of the rate at which moisture in the interior of the sheet can be driven to the surface. The agent best suited for this purpose is heat. Hence, in the portion of the dryer section following said supplemental rolls 58 the drying can be effectively accomplished by the main dryer rolls against which the paper is firmly pressed by the felts. In the drawings, only a portion of the dryer section is shown, for purposes of illustration, but it will be understood that the rolls 58, when employed, are preferably not provided beyond the point above indicated, and that from said point on to the dry or rearward end of the dryer section the sheet is held on the main dryer rolls by the felts, and is dried by said rolls in the customary manner.

My invention, in substantially eliminating drying of the paper in the spaces between the main dryer rolls and in restricting the drying practically entirely to the portions of the paper on said dryer rolls, not only results in the production of a paper having superior characteristics and in overcoming the objectionable rough edges and curling tendencies heretofore encountered, but furthermore enables increased production rates to be obtained. In previous practice the speed at which particular grades of paper were run through the machine were frequently held down in endeavors to curtail the severity of rough edges. Through my invention it is unnecessary to sacrific speed of operation, and rough edges are at the same time effectively prevented. In addition, a sheet of paper which is dried substantially entirely on the dryer rolls, as in my invention, is found to result in a superior product having minimum reactivity to humidity changes and a strikingly reduced tendency to curl, as well as a paper which behaves considerably better in printing presses.

The absence of rough edges, moreover, provides a sheet of uniform appearance and characteristics from deckle to deckle. It also enables a substantial increase in available production to be achieved since the full deckle width is available at all times, and the difference between reel width and finished roll width is markedly reduced owing to pronounced decrease in crosswise shrinkage of the sheet throughout the dryers.

The invention furthermore decreases the cost of manufacture because the machine will make less broke, thereby saving considerable time as well as effecting substantial saving of steam heretofore required to dry the broke, which has to be remanufactured.

The particular arrangement of felt dryers and supplemental dryer rolls above described is not claimed herein, since such arrangement is the joint invention of H. G. Chatain and H. L. Dyer, and is claimed in the above mentioned application.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

I claim:

1. The method of controlling the drying of paper passing through upper and lower sets of dryer rolls in a paper machine, said method comprising preventing substantial escape of air from the zone intermediate said sets of rolls to thereby maintain in contact with the paper between said sets of rolls a substantially isolated mass of humid air to prevent substantial drying of the paper in said zone.

2. The method of controlling the drying of paper passing through upper and lower sets of dryer rolls in the dryer section of a paper machine, said method comprising excluding substantial entrance of air from the exterior of the machine and from the upper and lower portions of said section into the zone between said sets of dryer rolls and preventing substantial escape of vapor from the last mentioned zone to thereby prevent substantial drying of said paper in said zone.

3. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, side frames in which said sets of rolls are mounted, a pair of endless flexible bands engaging the paper on the respective upper and lower sets of drying rolls, means at the sides of said apparatus for preventing entrance of exterior air into the zone between said sets of drying rolls, and means between said flexible bands and said side frames for substantially preventing air from zones above and below the first-mentioned zone from entering said first-mentioned zone.

4. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, side frames in which said rolls are mounted, and means for preventing substantial escape of air from the zone wherein said paper passes between said sets of rolls to thereby prevent substantial drying of said paper in said zone, said means comprising shielding means between said side frames and the ends of the rolls of said sets for substantially preventing air in said zone from passing into zones above and below the first-mentioned zone.

5. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, side frames in which said rolls are mounted, flexible bands passing around the rolls of the respective sets and engaging portions of the paper thereon, and means for preventing substantial escape of air from the zone wherein said paper passes between said sets of rolls to thereby prevent substantial drying of said paper in said zone, said means comprising shielding means between the ends of said rolls and the side frames and extending along substantially the courses of said bands in engagement with said rolls for substantially preventing air in said zone from passing into zones above and below the first-mentioned zone.

6. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, side frames in which said rolls are mounted, an upper endless flexible band the lower course of which passes over the rolls of the upper set and engages portions of the paper thereon, a lower endless flexible band the upper course of which passes over the rolls of the lower set and engages portions of the paper thereon, shielding means between the ends of the upper rolls and said side frames for substantially preventing air in the zone between said sets of rolls from passing into the zone thereabove, shielding means between the ends of the lower rolls and said side frames for substantially preventing air from said first-mentioned zone from passing into the zone therebelow, means substantially preventing escape of air laterally from said first-mentioned zone, each of said side frames comprising a plurality of contacting sections secured together, and each of said shielding means comprising a plurality of contacting sections joined with corresponding side frame sections.

7. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, side frames in which said rolls are mounted, an upper endless flexible band the lower course of which passes over the rolls of the upper set and engages portions of the paper thereon, a lower endless flexible band the upper course of which passes over the rolls of the lower set and engages portions of the paper thereon, shielding means between the ends of the upper rolls and said side frames for substantially preventing air in the zone between said sets of rolls from passing into the zone thereabove, shielding means between the ends of the lower rolls and said side frames for substantially preventing air from said first-mentioned zone from passing into the zone therebelow, means substantially preventing escape of air laterally from said first-mentioned zone, guide rollers for said flexible bands between the dryer rolls of the respective sets, and bearing means on the respective shielding means for supporting said guide rollers.

8. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, flexible bands engaging portions of the paper on the respective sets of rolls, and means for preventing substantial escape of air from the zone between said bands to thereby maintain in contact with the paper in said zone a substantially isolated mass of humid air to prevent substantial drying of the paper in said zone.

9. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, flexible bands engaging portions of the paper on the respective sets of rolls, means for preventing substantial escape of air from the zone between said bands to thereby maintain in contact with the paper in said zone a substantially isolated mass of humid air to prevent substantial drying of the

paper in said zone, and means supplemental to said rolls of one of said sets and engaging a portion of the corresponding flexible band in its passage from one of said rolls to the next for accelerating the drying of the paper.

10. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, means for substantially confining the air in the zone wherein the paper passes between said sets to prevent substantial drying of the paper in said zone, said means including a curtain at one side of said apparatus together with means at the opposite side substantially preventing lateral escape of air from said zone.

11. The method of controlling the drying of paper passing through upper and lower sets of dryer rolls in a paper machine and pressed against said rolls by moisture absorbing felts, said method comprising preventing substantial exchange of air between the zone intermediate said sets of rolls and the zones above and below said rolls, causing air to flow through the last mentioned zones counter-current to the direction of travel of the paper through said machine in contact with said felts, and simultaneously directing currents of said air back and forth across said felts in contact therewith.

12. The method of controlling the drying of paper passing through upper and lower sets of dryer rolls in a paper machine and pressed against said rolls by moisture absorbing felts, said method comprising passing air streams in contact with said felts in a direction counter-current to the travel of the paper through said machine and simultaneously directing currents of said air streams back and forth transversely of said felts in contact therewith.

13. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, side frames in which said rolls are mounted, means between said side frames and the ends of the rolls of said sets for substantially preventing air in the zone wherein the paper is out of contact with said rolls from passing into zones above and below the first-mentioned zone, means substantially preventing escape of air laterally from said first mentioned zone, and housings for the zones above and below said first-mentioned zone, said housings being open at their ends for the passage of air streams therethrough.

14. Paper drying apparatus comprising a set of upper drying rolls and a set of lower drying rolls around which a web of paper passes, side frames in which said rolls are mounted, means between said side frames and the ends of the rolls of said sets for substantially preventing air in the zone wherein the paper is out of contact with said rolls from passing into zones above and below the first-mentioned zone, means substantially preventing escape of air laterally from said first mentioned zone, housings for the zones above and below said first-mentioned zone, said housings being open at their ends for the passage of air streams therethrough, and means in said housings for directing air currents back and forth across said housings.

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