

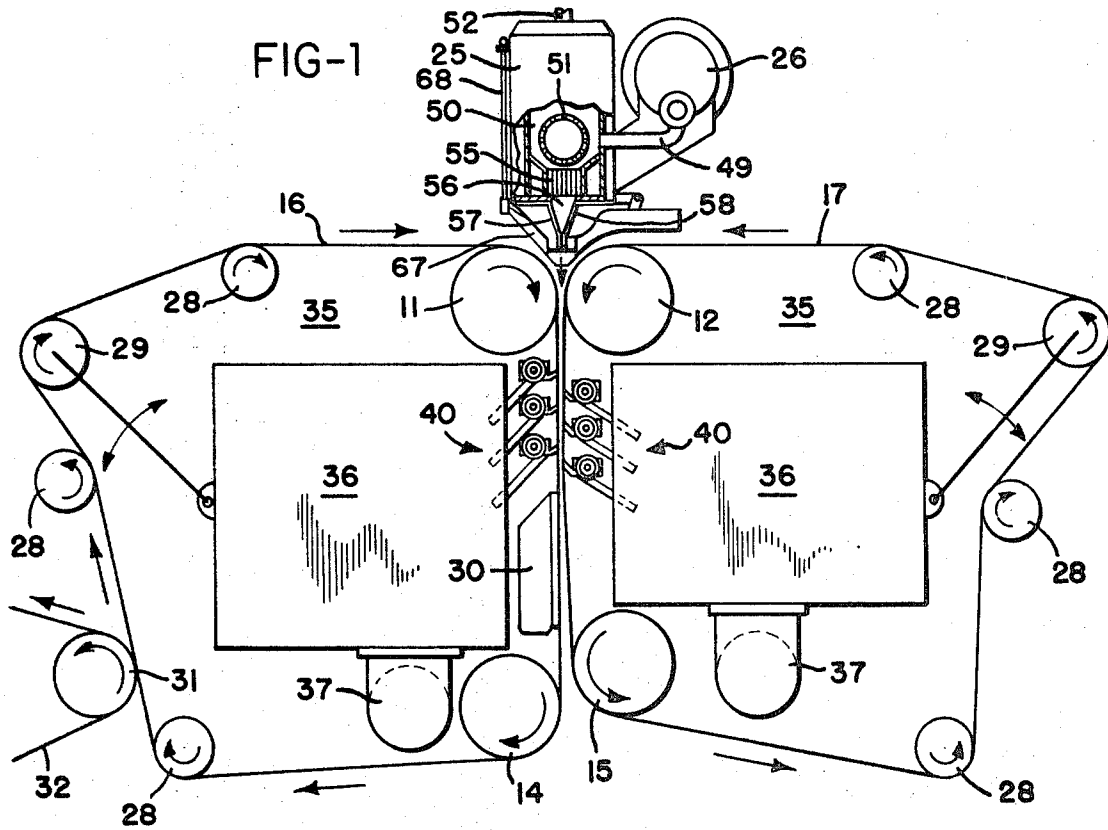
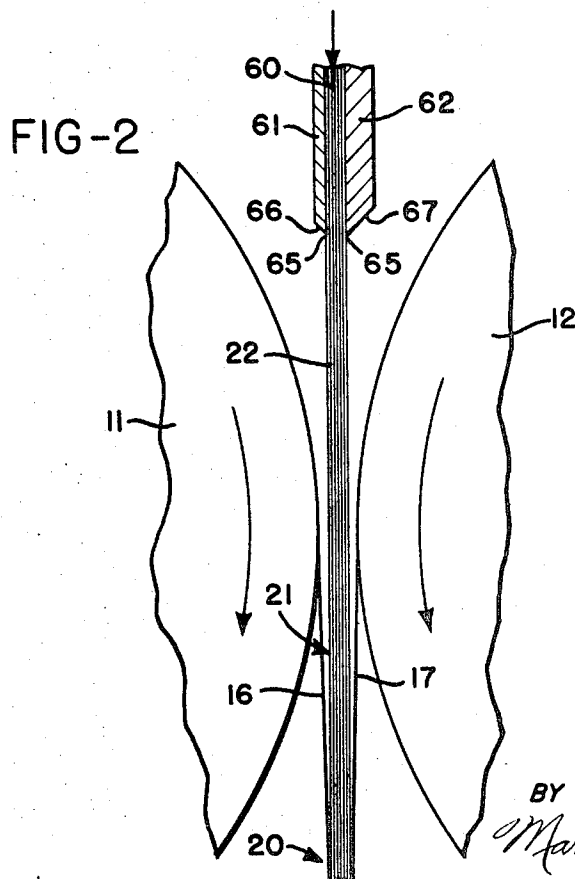
May 11, 1971

W. C. NOTBOHM ET AL
VERTICAL PAPER MACHINE WHEREIN STOCK IMPINGES
WIRES BELOW THE BREAST ROLLS

3,578,556

Filed Aug. 27, 1968

2 Sheets-Sheet 1



INVENTORS

WILLARD C. NOTBOHM &
PAUL M. SCHAFFRATH

BY

Marechal, Biebel, French & Bugg
ATTORNEYS

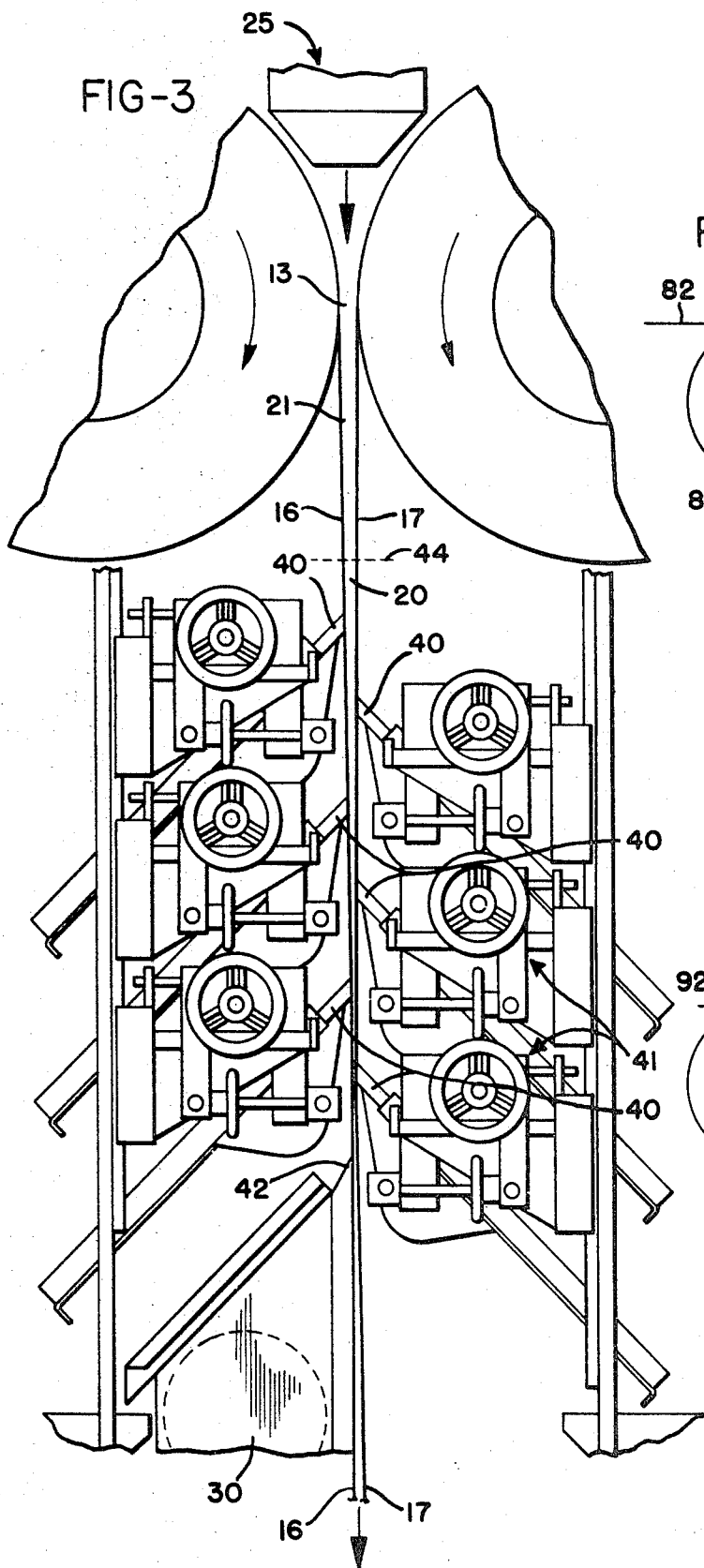
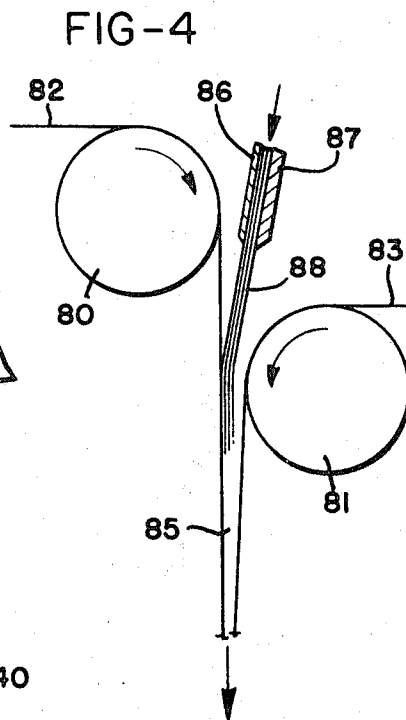
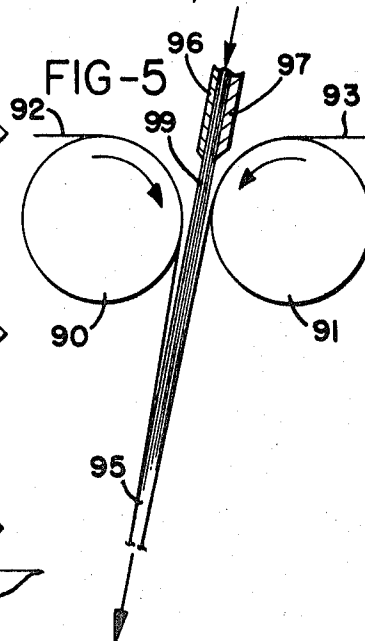
May 11, 1971

W. C. NOTBOHM ET AL
VERTICAL PAPER MACHINE WHEREIN STOCK IMPINGES
WIRES BELOW THE BREAST ROLLS

3,578,556

Filed Aug 27, 1968

2 Sheets-Sheet 2



1

2

3,578,556

VERTICAL PAPER MACHINE WHEREIN STOCK IMPINGES WIRES BELOW THE BREAST ROLLS
Willard C. Notbohm and Paul M. Schaffrath, Watertown, N.Y., assignors to The Black Clawson Company, Hamilton, Ohio

Filed Aug. 27, 1968, Ser. No. 755,602

Int. Cl. D21f 1/06

U.S. Cl. 162—203

9 Claims

ABSTRACT OF THE DISCLOSURE

In a two-wire vertical paper machine, opposed downwardly traveling reaches of the two wires are guided in converging relation to define a forming zone of predetermined dimensions, and a free standing sheet-like stock jet of a thickness less than the width of the mouth of the forming zone is delivered into the forming zone in such manner that it does not impinge on either of the wires until it reaches a level sufficiently below the breast rolls to avoid their pumping action. The relative speeds of the wires and the stock jet are regulated to produce desired characteristics in the paper sheet i.e., such as the ratio of tear strength in the cross machine direction to the machine direction.

REFERENCE TO COPENDING APPLICATIONS

Ser. No. 703,299, filed Feb. 6, 1968, Notbohm et al.; Ser. No. 706,514, filed Feb. 19, 1968, McCarrick et al.; Ser. No. 711,583, filed Mar. 8, 1968, McCarrick et al.

BACKGROUND OF THE INVENTION

This invention relates to paper making machines generally of the type shown in Baxter Pat. No. Re. 25,333, and characterized by the incorporation of a pair of endless forming wires arranged to wrap a corresponding pair of horizontally spaced breast rolls in such manner as to provide a pair of opposed reaches which travel downwardly from the breast rolls in closely spaced converging relation to create the zone wherein the paper sheet is formed. The invention also relates to the similar vertical paper machines shown in Baxter et al. Pat. No. 3,215,594 and characterized by the provision of multiple deflectors which support the traveling wires in the desired converging relation wherein they define the forming zone.

Both of the above patents, and also Green Pat. No. 3,215,593, show vertical paper machines equipped with headboxes designed to fill the space between the converging wire reaches with stock up to at least the gap between the two breast rolls. The above application Ser. No. 703,299 shows a vertical paper machine wherein the headbox is characterized in part by a pair of depending slice lips having elongated opposed inner walls which define a correspondingly elongated slice passage designed to discharge a sheet-like jet of stock between the breast rolls and into the forming zone, and further characterized by an adjustable mounting of one of the slice lips designed to maintain a substantially parallel relationship of the lips when they are adjusted to change the cross-sectional dimensions of the slice passage.

The present invention is particularly concerned with the establishment of forming conditions in a vertical paper machine which will assure a minimum entrapment of air within the stock in the forming zone while also minimizing the forces tending to draw liquid outwardly from within the forming zone or otherwise to create voids there-within, and especially which will assure properly controlled drainage through the converging wires and thereby promote optimum uniformity of sheet formation.

SUMMARY OF THE INVENTION

The invention lies in part in a two-wire paper machine wherein the components which define the forming zone are so constructed and arranged that this zone is maintained full of stock throughout the complete extent thereof below the horizontal level at which the stock contacts each wire, but drainage is prevented from the upper portions of the space between the converging wires which would be subject to suction induced by rotation of the breast rolls. This result is aided in the practice of the invention by delivering stock to the forming zone in a free standing sheet-like jet which passes freely between the breast rolls and does not impinge on the wire reaches defining the forming zone until it reaches a level sufficiently below the breast rolls to be free of the suction or pumping action created by their rotation.

Another significant feature of the invention lies in the fact that the deflectors along the outside of the forming zone function only to support the wires in converging relation and to doctor off the water which is forced through the wires while offering minimum tendency to educt water through the wires. This has the result in operation of causing the liquid constituent of the stock in the forming zone to be extruded or expressed through the wires while the fibers remain in the forming zone and are intermingled and compacted into a sheet, with minimum tendency for voids or pin holes to develop as the sheet is being formed.

The results desired by the invention are also aided by the provision of a relatively small number of supporting deflectors for the wire reaches which define the forming zone, and also by the arrangement of these deflectors in staggered relation with each other such that no deflector is directly opposed at the same level by a deflector for the other wire, so that the other wire is constrained in that area only by the tension thereon and can move as required to maintain desired pressure conditions between the two wires in the space occupying the same level as the deflector.

The invention includes among its objects the provision of a vertical paper machine having a forming section capable of accomplishing the above objects, by forming a paper sheet of outstanding characteristics with respect to uniform smoothness of both surfaces and desired characteristics of strength in both the machine direction and the cross machine direction. The invention also has among its objects the provision of improved methods of forming paper on a twin wire vertical paper machine which will enable the desired control of the characteristics of the paper, as well as the provision of improved apparatus for carrying out such new methods.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation illustrating diagrammatically one form of a vertical paper machine constructed in accordance with the invention;

FIG. 2 is an enlarged fragmentary and somewhat diagrammatic view illustrating the upper portion of the forming zone of the paper machine of FIG. 1;

FIG. 3 is an enlarged fragment of FIG. 1 showing in more detail the arrangement of deflectors along the forming zone; and

FIGS. 4 and 5 are diagrammatic views similar to FIG. 2 and showing other forms of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows the general construction of a vertical paper machine including a pair of breast rolls 11 and 12 supported in horizontally spaced relation to define a nip or gap 13 therebetween, and a pair of couch rolls 14 and 15 are mounted below the breast rolls 11 and 12. A pair

of endless forming webs or wires 16 and 17 each constituting a closed loop are looped around the respective pairs of breast and couch rolls 11-14 and 12-15, the term "wires" being used generically as including formaminous forming webs of any suitable material. The couch rolls 14 and 15 are provided with suitable drive means (not shown) to cause the wires to travel downwardly from the breast rolls 11-12 at regulated speeds toward and around the couch rolls 14 and 15.

The reaches of the wires 16 and 17 directly below the breast rolls 11 and 12 are guided so that they converge to define therebetween a forming zone 20 of generally triangular section having an entry passage or mouth 21 defined by the gap 13 and the portions of the wires immediately adjacent the breast rolls. A free standing sheet-like jet 22 of stock is continuously delivered into the mouth 21 from a headbox 25 mounted above the breast rolls and having a supply header 26. The remainder of the loop of each of the forming wires 16 and 17 is provided with suitable fixed guide rolls 28 and tensioning rolls 29. A suction box 30 is mounted above the left-hand couch roll 14 for loosening the newly formed paper web from the wire 17 and causing it to adhere to the wire 16 as the latter wraps the couch roll 14 and travels to the pickup roll 31 by which it is transferred to the pickup felt 32.

The spaces 35 within the loops of the wires 16 and 17 are open to the atmosphere, and save-all pans 36 having drain pipes 37 are provided within these spaces 35 for receiving water from the wire-supporting deflectors 40 and delivering it to a station remote from the machine. These deflectors 40 are shown as having adjustable mounting assemblies 41 of the type disclosed in the above copending application Ser. No. 703,299, but they may be of other forms, for example as shown in the above Baxter et al. patent.

One objective of the invention is to assure that all drainage within the forming zone will occur in such manner that it is compensated for by progressive reduction in the volume of the forming zone, so that the zone will remain completely full of liquid suspension and no voids or holes can occur in or through the sheet as it is being formed. A related objective is to minimize the possibility of localized disturbances of the fibers after forming has commenced, such as occur on a conventional Fourdrinier machine as the wire passes over successive table rolls, which tend to throw water against the underside of the wire along its on-running side and then to subject it to suction on its off-running side. For optimum achievement of these objectives, there should be a definite relationship between the arrangement of the deflectors 40, the width of the gap 13, and the thickness of the stock jet 22 as now described.

Referring particularly to FIG. 3, highly satisfactory results have been obtained in the practice of the invention using only three deflectors 40 on each side of the forming zone, and with the upper edges of the suction box 30 also provided with or formed as an additional deflector 42. As shown, these deflectors are arranged in staggered relation such that each deflector occupies a generally horizontal plane which is spaced vertically from the similar plane occupied by the nearest deflectors on the opposite side of the forming zone. For example, in an installation wherein the distance from the gap 13 to the level at which wire 16 engages the edge of deflector 42 is approximately 48 inches, adjacent deflectors 40 supporting the same wire may be spaced approximately 15 inches apart and approximately centered on the respective spaces between the deflectors for the other wire.

The lowermost pair of opposed deflectors 40 are preferably so spaced that the wires converge to their minimum relative spacing as they approach and move past the lowermost deflector 40 for the righthand wire 17. Then as the wires reach the edge of deflector 42 and the suction area of the suction box 30, the newly formed sheet is drawn gently toward the wire 16, and the wire 17 is preferably

guided toward its couch roll 15 in slightly diverging relation with the opposite portion of the wire 16 to cause the sheet to separate from wire 17 and to remain on wire 16 around the couch roll 14, which is therefore preferably a suction roll. In addition, with each deflector 40 generally centered on the space between opposed deflectors for the other wire, as one wire passes the edge of any of the deflectors, it will be drawn tightly against the deflector, but the other wire will be constrained only by its tension and therefore can move as may be required to maintain the proper spacing and volume between the wires.

The relative spacing of the uppermost pair of deflectors is also important, and it should be so coordinated with the width of the gap 13 and the thickness of the stock jet 22 that the jet will be projected freely through the gap 13 in spaced relation with both breast rolls and will not impinge on either wire until it is below the range of the pumping effect of the associated breast roll. To provide an adequate margin of safety, this range may be considered as extending downwardly from the level at which each wire is tangent to its breast roll to a level at which there is a space of at least several inches between the wire and the surface of the breast roll, for example 4 to 6 inches, and such level is indicated by the broken line 44 in FIG. 3. The uppermost deflector 40 may be placed somewhat below this level, and satisfactory results have been obtained in the above example with each breast roll 30 inches in diameter and with the uppermost deflector 40 approximately 18 inches below the horizontal plane of gap 13. Satisfactory operating conditions can be maintained in this example with the gap 13 approximately one inch wide and with the stock jet 22 dimensioned and directed to have a clearance of at least 1/4 inch with each of the breast rolls 11-12.

Optimum results are obtained if the stock impinges on both wires at substantially the same horizontal level. With the structural and operational relationships outlined above, however if the stock jet does not impinge on both wires simultaneously, significant drainage will not occur until the level at which the forming zone between the wires is completely filled with stock. Below that level, there is minimum tendency for entrained air to be present in the forming zone, particularly if the headbox is properly constructed as described herein, and from that level down to at least the lowermost deflector 40, the forming zone is subjected to continuous positive pressure by reason of the converging paths of the wires 16-17. The water in the stock is therefore continuously extruded or expressed through the wires, resulting in compaction of the intermingled fibers to form the paper sheet. These conditions, however, particularly with the wires free to move to the extent required to compensate for changes in the volume of material within the forming zone, provide maximum assurance against the development of voids or holes in the sheet because there is minimum tendency to draw air into the sheet to replace expressed liquid, as well as minimum tendency for the development of eddies capable of disturbing formation.

The use of the pattern of deflectors shown in FIG. 3 has produced highly satisfactory results, but other patterns can be used, and it is possible to dispense with the use of deflectors if the essential conditions of the invention are otherwise satisfied. The major function of the deflectors is to support the reaches of wire along the forming zone in such converging relation that the desired pressure conditions are maintained on the stock within the zone. This supporting action of the deflectors is therefore supplemental to wire tension, and if the tension is sufficiently high, such support becomes unnecessary, particularly since the wires can be arranged to define angles of such relatively small size, namely of the order of 1° or less, and travel in the desired relatively high speed range, from approximately 1000 to several thousand feet per minute. This is especially the case because of the extremely short length of the forming section in contrast with the cor-

5

responding length of a conventional Fourdrinier machine, namely a wire length of only 48 inches in the above example from the center line of the breast rolls to the suction box 30, as contrasted with more than 25 feet from the headbox to the first suction box on a conventional Fourdrinier machine of comparable size and capacity.

As already noted, it is important in achieving the objectives of the invention that the stock jet 22 be accurately controlled from the standpoint of maintained dimensions and direction of travel through the gap 13. The headbox 25 is accordingly shown as constructed in accordance with the above application Ser. No. 703,299, and components thereof which contribute to achievement of the objectives of the present invention will be briefly described.

The supply header 26 is connected by multiple pipes 49 with a mixing chamber 50 containing a rectifier roll 51, and the upper portion of this chamber is shown as having a connection 52 for connection to a supply of air under pressure as required to maintain the desired stock discharge velocity. An assembly 55 of multiple bunched small tubes leads downwardly from the interior of chamber 50 to a throat passage 56 of generally triangular section defined by converging walls 57 and 58. The throat passage 56 delivers the stock into the slice discharge passage 60 defined by the inner surface of the slice lips 61 and 62, which form in effect parallel continuations of the converging walls 57-58 terminating upstream of the center line of said breast rolls 11, 12.

In operation, the rectifier roll 51 facilitates the blending of the supply flows from the pipes 49, and it also aids in distributing the outlet flows to the bunched tube assembly 55, as well as minimizing flocculation of the stock and preventing clogging or plugging of any of the small tubes. The multiple flows from these tubes into the throat passage 56 are blended in that passage by the combined action of sudden deceleration followed by immediate acceleration as the stock is delivered into the narrow outlet passage defined by the lips 61 and 62, which forms the discharge flow of stock into the desired accurately dimensioned jet.

In the above example, with a vertical dimension of approximately 12 inches for the inner surface of the lips 61-62, and with the lips adjusted to form a discharge slot in the range of $\frac{1}{8}$ to $\frac{3}{4}$ inch in width, the resulting stock jet 22 has been found in practice to maintain its discharge direction and dimensions sufficiently accurately to pass freely through the gap 13 as desired and to impinge on the wires 16 and 17 below the level at which it would be subject to any pumping action on either of the breast rolls. It has also been found that these results are considerably enhanced if the lips 61-62 are provided with knife edges 65, by finishing these lips so that their lower edge surfaces 66 and 67 are inclined upwardly away from their inner surfaces which define the sides of the passage 60.

Additional structural features of the headbox of application Ser. No. 703,299 also enhance its utility for the practice of the present invention. In particular, the bunched tube assembly 55 serves as a structural element of great inherent rigidity which effectively stabilizes the walls 57-58 and thereby contributes to maintaining accurate linearity of the throat passage 56. The rigidity thus imparted to the walls 57-58 aids in stiffening and maintaining the alignment of the upper portions of the slice lips 61-62, and the lower portion of the lip 61 is further reinforced by the multiple warping levers 67 and their associated adjusting mechanisms 68 by which localized straightening of the lip can be effected. The opposed lip 62, which is adjustable to change the width of the passage 60, is preferably of adequate rigidity to resist operational deflection, by reason of its overall beam structure and its greater wall thickness as shown in FIG. 2, but it may be provided with further bracing for this purpose if desired.

Since the dimension of the forming zone in the machine direction is so very much shorter than in a conventional

6

Fourdrinier machine, namely of the order of only 30 inches, it is important in obtaining uniform production that the dimensions of the jet and the fiber distribution therein be essentially uniform across the width of the machine. It appears that the most important conditions to be satisfied for achieving these results involve maintained smoothness and uniform spacing of the inner surfaces of the slice lips 61-62, particularly at the discharge end of the passage 60. Thus the inner surfaces of the slice lips should be as smooth and flat as possible, and they should be uniformly spaced from each other in each horizontal plane through the passage 60. It does not appear essential that these surfaces be parallel, however, and satisfactory results have been obtained with the inner surfaces of the slice lips converging toward their discharge outlet.

There are definite advantages if the slice lips 61-62 are maintained with their opposed inner surfaces essentially parallel. Not only does this condition appear to promote optimum results from the standpoint of the quality of the paper sheet produced, but it offers the practical advantage that if the lip surfaces are essentially parallel, the headbox can be mounted with these lip surfaces essentially vertical, and they will remain vertical in all positions to which they may be adjusted to change the thickness of the stock jet. If, on the other hand, these lip surfaces define an angle, neither surface should occupy a vertical plane, or it may be necessary to tilt the headbox as a whole for some adjusted positions of the lips in order to make sure that the stock jet will be directed properly through the gap 13 into the forming zone.

The velocity of the jet 22 with respect to the forming wires is also a significant factor in the practice of the invention. If it is desired to produce a sheet having as nearly as possible the same tear strength in both the machine direction and the cross machine direction, the optimum results are obtained if the velocity of the jet essentially matches that of the wires at the level where the jet impinges on the wires. If the wire speed is greater than the velocity of the jet, the resulting sheet will have a correspondingly increased ratio of tear strength in the cross machine direction as compared with the machine direction, and vice versa if the wire speed is less than the velocity of the jet. Such changes in relative velocities are readily achieved by conventional controls for the paper machine drive and the spouting velocity of the headbox, and satisfactory results have been obtained with ratios of jet velocity to wire speed throughout the range of 0.5:1 to 1.3:1, but it is to be understood that this range is given for illustrative purposes and not as a critical limitation.

The overall arrangement shown in FIG. 1, with the breast rolls of the same size and mounted in the same horizontal plane, offers practical advantages of construction and maintenance, but it is not essential to the practice of the invention if the principles of the invention are observed. Thus FIG. 4 shows a modified arrangement in accordance with the invention wherein the rolls 80 and 81 are of different sizes and are mounted in vertically spaced planes but in such horizontal relationship that their respective forming wires 82 and 83 converge downwardly to define a forming zone 85. The mouth of this forming zone is defined by the gap between the two wires in the plane containing the axis of the breast roll 81. The headbox used with this arrangement of breast rolls should accordingly have its slice lips 86 and 87 positioned and arranged to discharge a free standing jet 88 of stock of such dimensions and direction that it does not impinge on the wire 83 until it reaches a level sufficiently below the line of tangency of wire 82 with respect to breast roll 81 to be free of the pumping action of roll 81. It is not material if this jet strikes the wire 82 above the plane of the axis of roll 81 so long as its initial contact with wire 82 is at a level sufficiently below breast roll 80 to avoid its pumping action.

It is also not essential that the center line of the forming zone be precisely vertical so long as the overall structure

and mode of operation of the paper machine are in accordance with the principles of the invention as disclosed herein. Such an arrangement is shown in FIG. 5, wherein the breast rolls 90 and 91 are mounted in approximately the same horizontal plane, but the respective forming wires 92 and 93 are guided in such converging relation that the forming zone 95 which they define has its center line in a substantial angle to the vertical. With this arrangement, the principles of the invention are achieved if the associated headbox has its slice lips 96 and 97 positioned and arranged to discharge a free standing jet 99 of stock in substantially aligned relation with the central plane of the mouth of the forming zone 95, so that it does not impinge on either of the wires until it reaches a level sufficiently below the line of tangency of the wire 92 with respect to the couch roll 90 to be free of any pumping action produced by roll 90.

While the methods and forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. The method of forming a fibrous sheet between a pair of looped forming wires which comprises the steps of continuously advancing said wires towards each other in closely spaced relation defining forming zone having an upstream end, maintaining said wires in predetermined spaced relation at said upstream end of said forming zone to define a mouth thereto of predetermined maximum width, continuously delivering to said zone a free standing jet of fiber-containing stock of predetermined thickness less than said width of said mouth, controlling the direction of said jet to cause said jet to pass freely through said mouth in spaced relation with both of said wires and to impinge on said wires downstream of said mouth, continuously guiding said wires in maintained converging relation from said mouth toward a station of predetermined minimum relative spacing to exert positive pressure on the stock within said forming zone forcing the liquid therein to be extruded substantially freely through both of said wires and thereby causing the fibers in said zone to form a sheet, and removing said extruded liquid from within the loop of each of said wires.

2. A method as defined in claim 1 comprising the step of controlling the velocities of said jet and said wires to cause said jet to impinge on said wires while travelling at a speed having a predetermined relation to the speed of said wires.

3. A method as defined in claim 1 comprising the step of controlling the velocities of said jet and said wires to cause said jet to impinge on said wires while travelling at substantially the same speed as said wires.

4. A multiwire papermaking machine comprising a pair of endless forming wires each constituting a closed loop, support means positioned within each of said loops and

supporting said wires in opposed runs defining a forming zone converging in width from a maximum spacing adjacent an upstream end thereof to a minimum spacing adjacent a downstream end thereof, said support means including a pair of breast rolls extending in spaced parallel relationship to each other adjacent said upstream end of said forming zone, and additional support means for permitting substantially free drainage through each of said wires along said forming zone, headbox means for supplying papermaking stock to said forming zone, and means for delivering from said headbox into said forming zone at a point downstream of said breast rolls and downstream of said upstream end of said forming zone a free standing, sheet-like jet of stock having a thickness less than said maximum spacing of said forming zone, said delivery means including a pair of slice lips having opposed inner surfaces spaced from each other at the downstream edges thereof a distance less than said maximum spacing of said upstream end of said forming zone with said edges terminating at a position upstream of the center line of said breast rolls.

5. Apparatus as defined in claim 4 wherein said additional support means include a plurality of deflectors positioned within each of said loops for extruding liquid from said stock through said wires, and means mounting said deflectors in engagement with the surfaces of said wires on opposite sides of said forming zone with deflectors on one side of said forming zone in staggered relation with respect to deflectors on the other side of said forming zone.

6. Apparatus as defined in claim 5 comprising a suction box positioned within one of said loops downstream of said deflectors within said one of said loops for causing a web formed in said forming zone to adhere to the wire within the loop of which said suction box is positioned.

7. Apparatus as defined in claim 4 wherein the axes of said breast rolls lie in a common horizontal plane.

8. Apparatus as defined in claim 4 wherein the axes of said breast rolls lie in different horizontal planes.

9. Apparatus as defined in claim 4 wherein said downstream edges of said lips have outer surfaces inclined outwardly in an upstream direction away from said forming zone and define with said inner surfaces said downstream edges of said lips.

References Cited

UNITED STATES PATENTS

3,215,503	11/1965	Green	162—301X
3,326,745	6/1967	Graham	162—124X

OTHER REFERENCES

Castagne, M.R., "With the Verti-Forma," in Paper Industry, October 1965, pp. 40-49.

S. LEON BASHORE, Primary Examiner

R. H. TUSHIN, Assistant Examiner

U.S. Cl. X.R.

162—214, 303, 317

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,578,556 Dated May 11, 1971

Inventor(s) Willard C. Notbohm et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 51, "desiged" should read -- designed --.
Column 3, line 60, "speced" should read -- spaced --; line 68,
"th" should read -- the --. Column 7, line 26, "getween" should
read -- between --; line 29, after "defining" insert -- a --;
line 38, "wides" should read -- wires --. Column 8, line 46,
"3,215,503" should read -- 3,215,593 --.

Signed and sealed this 22nd day of February 1972.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents