Nov. 25, 1952 S. A. STAEGE 2,619,011

PAPER MACHINERY

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Fig-1

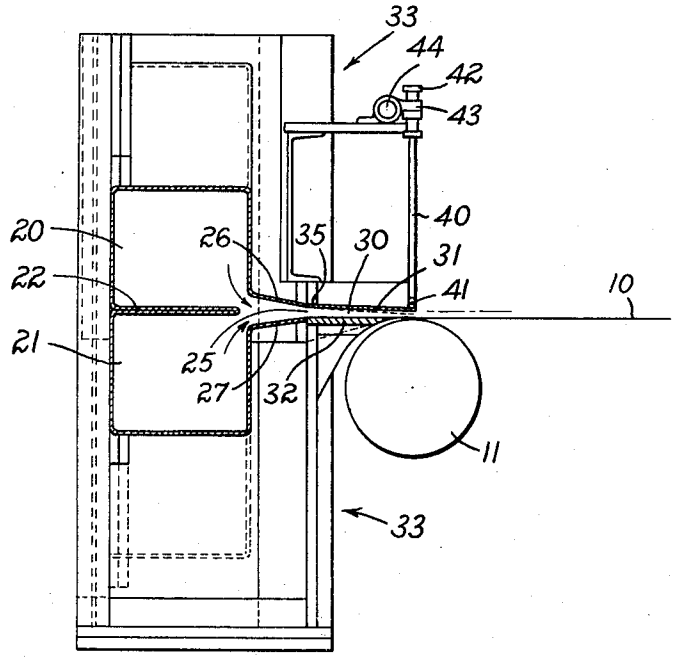


Fig-2

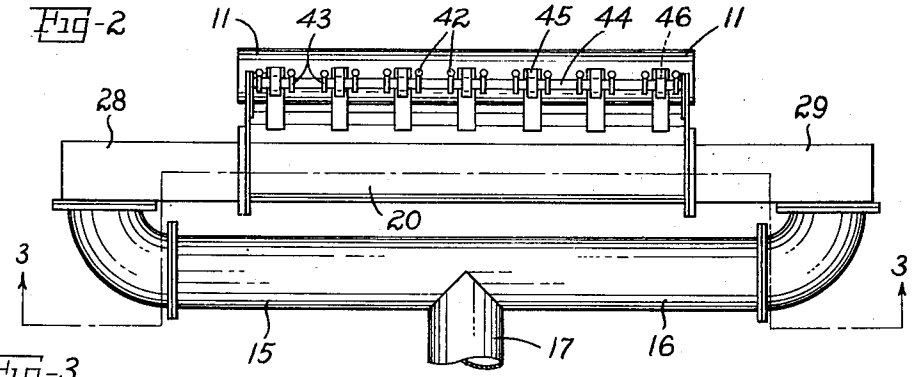
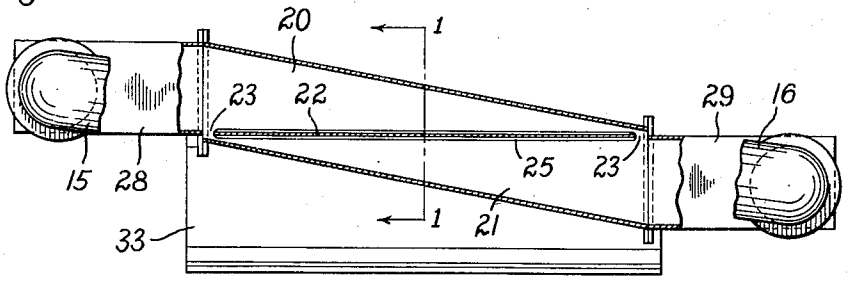


Fig-3



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PAPER MACHINERY

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5 Claims. (Cl. 92—44)

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This invention relates to paper making, and more particularly to stock supply means for paper making machines.

One of the objects of the invention is to provide an inlet for supplying paper making stock to a high speed paper machine under controlled conditions of substantially uniform velocity flow across the width of the machine to give a high degree of uniformity of weight and fiber distribution in the web or sheet.

An additional object is to provide for controlling the flow conditions of stock approaching the forming member of a paper making machine to cause delivery of the stock to the forming member at a velocity which is maintained or increased substantially uniformly across the width of the machine while avoiding flocculation of the stock and minimizing the development of eddy currents and other non-uniform flow conditions.

It is also an object of the invention to provide a stock inlet for a high speed paper machine which is adapted to discharge stock through a slot orifice at a definite and substantially uniform velocity across its lateral extent and to deliver such stock to the forming member at substantially unreduced velocity and without loss of uniformity of fiber distribution.

Another object is to provide a stock supply system for a high speed paper machine which includes a closed conduit having a discharge orifice of restricted dimensions to receive stock under pressure and to discharge the stock at a definite and substantially uniform velocity across the width of the machine and which also includes a stock inlet passage constructed and arranged to deliver the stock from the discharge orifice of the conduit to the forming member substantially without loss of velocity and substantially without flocculation or the development of eddy currents or other conditions tending to produce non-uniform fiber distribution.

Still another object is to provide a method of supplying stock to the traveling forming member of a paper making machine in which the stock is maintained under predetermined controlled conditions of velocity and direction of flow throughout its passage up to the forming member to assure uniformity in the flow conditions, distribution of fiber across the sheet, and paper making characteristics.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawing and the appended claims.

In the drawing:

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Fig. 1 is a view in side elevation, partly broken away and in section substantially on the line 1—1 of Fig. 3, to illustrate details of internal construction, showing stock supply means in accordance with the invention for a Fourdrinier paper machine;

Fig. 2 is a partial top plan view of the apparatus shown in Fig. 1; and

Fig. 3 is a view of the same apparatus partly in rear elevation and partly in section substantially on the line 3—3 of Fig. 2.

Referring to the drawing, which illustrates a preferred embodiment of the present invention, Fig. 1 shows a portion of a Fourdrinier paper machine including a forming wire 10 traveling over a breast roll 11. The stock is initially conveyed to the machine through conduits 15 and 16, which are shown as branches of a main conduit 17 and which lead to a pair of counterflow inlet conduits 20 and 21 shown as of substantially the same construction disclosed in U. S. Patent 2,347,717, assigned to the same assignee as this application. As shown, the conduits 20 and 21 extend generally transversely of the forming wire 10 and are separated by a baffle 22 except for limited communication around the ends of this baffle as indicated at 23.

The baffle 22 is positioned adjacent and parallel to a discharge orifice 25 common to the two conduits 20 and 21. The baffle extends diagonally, as shown in Fig. 3, and thus provides a cross-sectional taper in the conduits 20 and 21, the taper being such that the axial rate of travel of stock through these two conduits is approximately uniform throughout their length for any given volume of flow. The orifice 25 is in the form of a slot of substantially the same lateral extent as the web or sheet to be formed on wire 10, and it is of restricted dimensions and hence of restricted cross-sectional area with respect to the conduits 20 and 21, thus providing a throttling effect and a constant pressure differential across the slot orifice throughout its entire lateral extent with resulting uniform volume discharge of stock through the entire lateral extent of the slot at a uniform velocity, which will be substantially higher than the velocity of flow through conduits 20 and 21.

It will be noted that the directions of flow through orifice 25 and in conduits 20 and 21 are at substantially right angles to each other. In order to minimize possible non-uniform velocity flow conditions because of the flow component perpendicular to this desired direction of flow through the orifice, the respective cross-sectional

areas of the tapered conduits and the slot orifice are controlled to provide a substantial difference in the velocity of flow through the orifice as compared with the corresponding velocity through the conduits 20 and 21. Satisfactory results have been obtained with these velocities at a ratio of not less than about 4 or 5 to 1, and with this ratio still higher, it is possible to hold the velocity in conduits 20 and 21 to a low value, for example from 0.5 to 2.5 feet per second, such that the undesired angular flow component is kept to a minimum, while still obtaining desired high velocity rates of flow through the orifice 25. At such accelerated velocities, fiber flocs tend to be broken up and the fibers dispersed in passing through the slot orifice. In addition, since all of the stock is subjected to the same hydraulic conditions, there is minimum tendency to stratification or separation of light and heavy fibers due to inertia or centrifugal force.

In operation, stock is supplied at a desired pressure to the conduit 17 and thence to the branch conduits 15 and 16, which are connected with extension portions 28 and 29 of the tapered conduits 20 and 21, respectively, at opposite sides of the machine to supply stock to the larger end of each of the tapered conduits. It will also be noted, as shown in Fig. 2, that the branch conduits 15 and 16 connect with these conduit extension portions 28 and 29 at positions spaced at a sufficient distance laterally of the machine from the ends of the slot orifice 25 so that the flow of stock is adequately straightened out in parallel lines of flow before reaching the slot orifice, satisfactory results having been obtained with distances from each end of the slot to the center line of the adjacent supply conduit of 3 to 5 feet or more, depending upon the size of the machine. Also, the stock is brought into the conduit extensions 28 and 29 in directions substantially perpendicular to their length, with the result that the velocity of that component of the flow which is perpendicular to the lengths of the conduits is largely overcome or practically extinguished, and the stock has an opportunity to increase that component of flow which is in a direction at right angles to its entering direction, and to establish substantially parallel lines of flow crosswise of the wire before reaching the tapered conduits and the slot orifice 25. There is thus provided a flow of stock through orifice 25 at a substantially higher velocity than the velocity in the tapered conduits, in accordance with the supply pressure and the ratio of the respective areas of the orifice and the tapered conduits as described, and this velocity and the distribution of fiber and flow in the stock will be substantially uniform across the width of the machine.

An inlet passage 30 or nozzle is provided for delivering the stock from orifice 25 to the forming wire 10 at substantially maintained or increased velocity while avoiding flocculation and the development of eddy currents or other conditions of non-uniform flow and fiber distribution tending to cause non-uniform sheet formation. Referring particularly to Figs. 1 and 2, it will be noted that the tapered conduits 20 and 21 are arranged one above the other and are mounted at such height as to position the slot orifice 25 in close proximity to, and in substantially the same horizontal plane as, the forming wire 10. As shown, the orifice 25 is formed by an upper wall 26 and lower wall 27 which are inclined inwardly towards each other at a relatively small included angle from their points of connection to conduits 20 and 21. Satisfactory results have been obtained with this angle of the order of approximately 5° to 10°, for example a combined taper of the order of 0.875 inch in 6 inches.

The walls 26 and 27 also serve to provide an orifice connection to the inlet passage 30 or nozzle for conducting the stock from the slot orifice 25 directly to the forming wire. This inlet passage 30 is of substantially the same lateral extent as orifice 25, and it is so constructed and arranged as to deliver the stock from this orifice to the forming wire at a maintained velocity at least as great as the velocity of the stock as discharged through orifice 25 and without loss of uniformity in velocity and fiber distribution across the width of the machine.

Referring to Fig. 1, the inlet passage 30 is formed by upper and lower walls 31 and 32, respectively, which are supported in the frame 33 in such manner as to constitute in effect continuations of the orifice walls 26 and 27 and thus to provide for a steady and even flow of stock from orifice 25 to the wire without the formation of pockets, eddy currents or other non-uniform flow conditions. The lower passage wall 32 has a plane upper surface, and as shown it is mounted in frame 33 in fixed relation to the forming wire. The upper passage wall 31 is formed by a flexible plate 31 which also serves as the adjustable slice lip, this plate 31 being secured to the frame at 35 adjacent the orifice 25 and being vertically adjustable to control the degree of opening of the slice at the outer end of this lip or nozzle.

The slice lip 31 or upper wall of inlet passage 30 and the lower passage wall 32 are arranged to provide a continuation of the slot orifice walls 26 and 27, preferably with a slight taper which may be somewhat less than that of the orifice walls themselves, thus preventing deceleration of the stock and tendencies towards spraying of stock at the discharge end of the nozzle and also minimizing straightening of the fibers in the direction of flow such as may result from steeper angles of taper. Satisfactory results have been obtained with this angle of the order of not more than approximately 5°, for example with the walls 31 and 32 tapering from a relative spacing of 1.125 inches at their points of attachment to slot walls 26 and 27 to an adjustable spacing of from 0.25 inch to 0.75 inch at the outer end of the inlet passage or nozzle, and with the length of this passage 30 defined by walls 31 and 32 being approximately 11 inches in the direction of wire travel. The resulting continuous and gradual throttling effect on the stock over the entire course from the tapered conduits to the forming wire tends to promote uniform flow conditions and fiber distribution in the stock and correspondingly uniform sheet formation. In addition, with close vertical spacing of the passage walls 31 and 32 of the order illustrated by the above dimensions, the depth of flow of stock through the passage 30 is maintained so correspondingly small that the turbulence which results from skin friction of the stock against the surfaces of these walls extends throughout substantially the entire cross-section of the flow, and since this turbulence comprises primarily eddies of small radius, it has the useful effect of overcoming the tendency of the fibers to line up when flowing at high speeds and thus promotes the desired maintained uniform distribu-

tion of fiber within the stock flow as it is delivered to the forming wire.

With this construction, the two surfaces of walls **31** and **32** are non-diverging in the direction of flow, and it will be seen that there are no pockets or enlargements such as might cause reduction in velocity or cavitation tending to impair the desired conditions of uniformity in the stock flow. Accordingly, the stock will be delivered through passage **30** from the slot orifice **25** to the forming wire at a velocity of flow which does not decrease and preferably continues to increase, and since the time of flow will be relatively short, for example only about one twenty-fifth of a second in an inlet of the above dimensions with the machine running at 1500 feet per minute, flocculation of the stock will be substantially precluded. Furthermore, even at substantially slower speeds, this time will still be so short that under the conditions described, the desired uniformity of velocity and fiber distribution will be maintained.

Figs. 1 and 2 illustrate means for adjusting the degree of opening of the slice lip to control the volume of stock discharge onto the wire. The plate **31** may be of flexible material arranged to bend about its point of attachment **35** to the frame **33**, or it may be of substantially rigid material having a hinged connection at **35** to the frame. A plurality of adjusting screws **40** are arranged in spaced relation across the width of the machine, and each has its lower end pivotally connected at **41** to the forward edge of plate **31**. The upper part of each screw **40** is threaded through an adjusting nut **42** carried by a housing **43** which is in turn mounted on a shaft **44** extending across the upper part of frame **33**. The shaft **44** is rotatably supported in bearings **45**, and each housing **43** is mounted on an eccentric portion **46** of shaft **44**. Thus when the shaft is rotated, it raises or lowers all the housings **43** and the adjusting screws **40** to provide for vertical adjustment of the entire slice lip to the correct size of slice opening for the desired volume of stock. Any necessary fine adjustments, to assure a uniform slice opening across the width of the machine, may be made along the slice lip through the individual adjusting screws **40**.

It will accordingly be seen that the present invention provides a stock inlet capable of delivering the stock to the forming member of a paper machine under controlled conditions of substantially uniform velocity across the width of the machine while minimizing flocculation and the development of eddy currents and other non-uniform flow conditions tending to interfere with the desired uniformity of fiber distribution in the stock as delivered to the forming member. The invention thus offers substantial advantages in connection with paper machines operating at any of the usual speeds but is of particular advantage at high speeds of operation, and its simplicity of construction and effectiveness in promoting uniform velocity and fiber distribution in the stock across the width of the machine have been found to assure a high degree of uniformity in the resulting sheet.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In a stock supply system for a paper making machine including a forming wire, the combination of a pair of oppositely tapered conduits arranged transversely across said machine and each adapted to be supplied at the larger end thereof with stock under pressure, means forming a slot orifice common to said pair of conduits and extending across the full width of said machine through which said stock is discharged from said conduits at a predetermined high velocity of flow and with substantially uniform distribution of fiber across the width of said machine, said orifice being of materially restricted flow area relative to said conduits to maintain said predetermined velocity substantially higher than the velocity of flow of said stock in said conduits and substantially uniform across the width of said machine, means supporting said conduits one above the other with said orifice closely adjacent and facing said machine to discharge the stock therefrom in substantially straight line flow towards said wire, means including upper and lower walls forming a short inlet passage of substantially the same width as said orifice for conducting stock from said orifice to said wire, the end of said passage adjacent said orifice being of substantially the same dimensions as said orifice and being directly connected therewith to receive the stock therefrom at said predetermined velocity of flow, said walls being converged substantially continuously towards said wire at a small total included angle to prevent cavitation within said flow, and said angle being not more than 5° to minimize straightening of the fibers in the direction of flow as said stock is delivered through said passage to said wire.

2. In a stock supply system for a paper making machine including a forming wire, the combination of a pair of oppositely tapered conduits arranged transversely across said machine and each adapted to be supplied at the larger end thereof with stock under pressure, means forming a slot orifice extending across the full width of said machine and common to said pair of conduits to receive stock directly from both thereof for simultaneous intermixture and discharge across the width of said machine, said orifice being of such materially restricted flow area relative to said conduits as to establish a high velocity of flow therethrough more than four times higher than the velocity of flow of said stock in said conduits and to effect substantially uniform distribution of fiber across the width of said machine, means supporting said conduits one above the other with said orifice closely adjacent and facing said machine to discharge the stock therefrom in substantially straight line flow towards said wire, means including upper and lower walls converging towards said wire and forming a short inlet passage of substantially the same width as said orifice for conducting stock from said orifice to said wire, the end of said passage adjacent said orifice being of substantially the same dimensions as said orifice and being directly connected therewith to receive the stock therefrom at said established velocity of flow, and the total included angle of convergence of said walls being not more than 5° to minimize straightening of the fibers in the direction of flow therethrough while effecting sufficient acceleration of the velocity of said flow to prevent cavitation and resulting eddy

currents within said stock as delivered through said passage.

3. In a stock supply system for a paper making machine including a traveling forming member, the combination of a pair of oppositely tapered conduits arranged transversely across said machine, said conduits being adapted to be supplied at the larger ends thereof with stock under pressure and having a slot orifice common thereto and extending across the full width of said machine to receive stock directly from both of said conduits for simultaneous intermixture and discharge therethrough, means supporting said conduits one above the other with said orifice facing and in close proximity to said forming member to discharge the stock therefrom in the direction of travel of said forming member, means including upper and lower walls forming a totally enclosed inlet passage leading directly from said orifice to said forming member and of substantially the same width as said orifice, said orifice being of materially restricted flow area relative to said conduits to establish a high velocity of flow of said stock therethrough correspondingly higher than the velocity of flow of said stock in said conduits and to effect substantially uniform distribution of fiber across the width of said machine, the end of said passage adjacent said orifice being directly connected with and of substantially the same dimensions as said orifice to receive the stock therefrom at undiminished velocity, said passage walls being converged in the direction of flow therethrough at a small total included angle of not more than 5° to prevent deceleration of the velocity of flow of said stock therethrough and to maintain the vertical spacing of said walls within the correspondingly restricted dimension of said orifice causing the turbulence within said flow resulting from the skin friction of said walls to be effective throughout substantially the entire cross-section of the flow therethrough.

4. A stock inlet for the forming wire of a paper making machine comprising a pair of oppositely tapered conduits adapted to extend transversely across said machine and to be supplied at the larger ends thereof with stock under pressure, means forming a slot orifice of the full width of said machine and common to said pair of conduits to receive stock directly from both thereof for simultaneous intermixture and discharge across the width of said machine, said orifice being of such materially restricted flow area relative to said conduits as to establish a high velocity of flow therethrough more than four times higher than the velocity of flow of said stock in said conduits and to effect substantially uniform distribution of fiber across the width of said machine, means for supporting said conduits one above the other with said orifice closely adjacent and facing said machine to discharge the stock therefrom in substantially straight line flow towards said wire, means including upper and lower walls forming a short inlet passage of substantially the same width as said orifice for conducting stock from said orifice to said wire, the end of said passage adjacent said orifice being of substantially the same dimensions as said orifice and being directly connected therewith to receive the stock therefrom at said established velocity of flow, the vertical relative spacing of said passage walls being not greater than the corresponding dimension of said orifice to produce a correspondingly restricted depth of flow therethrough causing turbulence within said flow resulting from the skin friction of said walls to extend throughout substantially the entire cross-section of said flow and to maintain uniform fiber distribution therein, and said passage walls being converged in the direction of flow from said orifice at a small total included angle of not more than 5° to prevent deceleration of said flow therethrough while minimizing straightening of the fibers in the direction of said flow.

5. A stock inlet for the forming wire of a paper making machine comprising a pair of oppositely tapered conduits adapted to extend transversely across said machine and to be supplied at the larger ends thereof with stock under pressure, walls extending from said conduits in inclined relation towards each other to form a slot orifice of the full width of said machine and common to said pair of conduits to receive stock directly from both thereof for simultaneous intermixture and discharge across the width of said machine, the total included angle of relative inclination of said walls being not more than 5° to 10°, said orifice being of such materially restricted flow area relative to said conduits as to establish a high velocity of flow therethrough more than four times higher than the velocity of flow of said stock in said conduits and to effect substantially uniform distribution of fiber across the width of said machine, means for supporting said conduits with said orifice closely adjacent and facing said machine and with the lower said wall thereof having the downstream end thereof in substantially the same horizontal plane as said wire to effect discharge of the stock from said orifice in substantially straight line flow towards said wire, upper and lower passage walls forming a short inlet passage connecting directly with said orifice and of substantially the same width as said orifice at the connecting end thereof for conducting stock from said orifice to said wire, said lower passage wall being substantially coplanar with said downstream end of said lower orifice wall and said wire, and said upper passage wall being inclined downwardly away from said orifice at an angle less than said angle of relative inclination of said orifice walls to produce a correspondingly restricted depth of flow through said passage and to prevent cavitation and resulting eddy currents within said stock as delivered through said passage.

STEPHEN A. STAEGE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,690,203	Niks	Nov. 6, 1928
1,866,607	Wood	July 12, 1932
2,344,281	Berry et al.	Mar. 14, 1944
2,344,282	Berry et al.	Mar. 14, 1944
2,347,717	Staege	May 2, 1944
2,347,850	Staege	May 2, 1944
2,381,286	Hornbostel	Aug. 7, 1945
2,465,445	Goldsmith	Mar. 29, 1949

FOREIGN PATENTS

Number	Country	Date
512,808	Great Britain	Sept. 26, 1939

OTHER REFERENCES

"A stock inlet for paper and paperboard machines," by Staege, Paper Trade Journal, April 4, 1946, pages 43 and 44.