PAPERMAKING MACHINE HEADBOX
SLICE CHAMBER CONTAINING
PIVOTABLE THIN RIGID PLATES WITH
FLEXIBLE ELEMENTS ATTACHED
THERETO

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ABSTRACT
A headbox construction for a paper making machine which includes a slice chamber having a linearly converging downstream portion and a non-linearly converging upstream portion which is connected to a preslice flow chamber. The slice chamber contains a plurality of transversely extending thin rigid plates which are curved to conform to the non-linear shape of the upstream end of the slice chamber and are pivotally supported at their upstream ends. Flexible trailing elements are attached to the downstream ends of each of the rigid plates and extend in the downstream portion of the slice chamber. These flexible trailing elements are unattached at their downstream ends. The elements and the plates each are locked in their pivotal positions or are self-positionable so as to be solely responsive to forces exerted thereon by the stock flowing toward the slice.

16 Claims, 9 Drawing Figures
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BACKGROUND OF THE INVENTION

The invention relates generally to a headbox for a paper making machine and more particularly to a headbox construction having a tapered narrow slice chamber with a plurality of rigid plates pivotally supported at their upstream ends so that they can float or be self-positionable due to the forces exerted thereon by the stock flowing toward the slice, or they can be locked in a uniformly spaced pivotal position. The invention provides improvements over structures such as U.S. Pat. No. 3,607,625 while utilizing the principles thereof.

In headbox structures it has been proposed to advantageously employ tapered slice chambers of relatively thin dimensions. These thin channel headboxes extend in an upward direction to avoid the accumulation of air and often require turns or bends in the slice chamber. In utilizing the principles of U.S. Pat. No. 3,607,625, it has been discovered that the thin flexible trailing members cannot extend into the curved or bent portion of the slice chamber because the flexible members cannot tolerate bending by the hydraulic forces without becoming distorted and unstable. These distortions will cause roughness in the discharge jet and unsatisfactory paper formation. The present invention utilizes thin rigid plates upstream of the flexible trailing members with the plates extending into the curved flow zone of the slice chamber. Problems have been encountered in mounting the rigid steel plates at their upstream ends due to thermal expansion and contraction and also due to the distribution of the plates and the forces on the plates caused by the hydraulic forces of the flowing stock. In accordance with the principles of the present invention, the plates are pivotally mounted at their upstream ends mounted so as to be freely positionable either self-positionable by the flow of stock through the headbox, or positionable by fixed spacers. The mounting preferably takes the form of a hinged support at the upstream end of each of the plates to allow them to pivot about their point of upstream attachment.

With flow through the headbox, the sheets or plates will then be uniformly distributed in the flow channel.

It is accordingly an object of the present invention to provide an improved headbox construction using the principles of self-positionable trailing elements of U.S. Pat. No. 3,607,625 and providing an improvement therein particularly well suited for use in thin elongated tapered slice chambers.

A further object of the invention is to provide a structure of the type described which solves the problems presented in a curved or angular tapered slice chamber. A general object of the invention is to provide a headbox for a paper making machine which produces a fine scale dispersion of the fibers, which dispersion will not deteriorate excessively as the turbulence decays.

Additional objects, advantages and features of the present invention, and alternate embodiments within the scope of the invention will become apparent from the teaching of the principles of the invention in connection with the description of the preferred embodiment of the specification, claims and drawings, in which:

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view in section illustrating a paper machine headbox embodying the principles of the present invention; FIG. 1A is a somewhat enlarged fragmentary view showing details of FIG. 1; FIG. 2 is a somewhat schematic side elevational view of a slice chamber illustrating only one trailing element for simplicity; FIG. 3 is an enlarged detailed segment of a portion of FIG. 2; FIG. 4 is another enlarged detailed view of a portion of FIG. 2; FIG. 5 is a somewhat schematic side elevational view of the preferred form of the invention showing only one trailing member for simplicity; FIG. 6 is an enlarged detailed fragmentary view of a portion of FIG. 5; FIG. 7 is a side elevational view of one form of trailing element; and FIG. 8 is a side elevational view of another form of trailing element.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1, the stock is delivered in a jet stream onto a traveling fourdriner wire 11 carried over a breast roll 12.

The stock is delivered to a headbox 10 from an inlet flow pipe 13 to flow into a chamber 14 at the entry end of the headbox. The stock flow passes through a multiplicity of diffuser nozzles 15 which are mounted on a perforate plate 15a at their upstream end and discharged through a perforate plate 15b at their downstream end. The diffuser nozzles discharge into a preslice chamber 16 which is provided with an air dome 17. A spray 18 reduces the foaming in the air dome of the preslice chamber. The preslice chamber feeds the stock into a tapered elongate slice chamber 19 which has a somewhat enlarged tapered upper end 19a. The slice chamber is defined between a lower slice wall 24 and an upper slice wall 24a, with the upper slice wall being pivoted at 23. A jack 22 mounted on the headbox raises or lowers the upper slice wall 24a. The slice chamber 19 leads to a slice opening 20 which is controlled in size by vertically movable slice lip 21.

Within the long tapered chamber are a plurality of flexible trailing elements 26. These elements are supported solely at their upstream end so as to be self-positionable by the forces of the flowing stock. They are supported at their upstream ends on the lower edges of rigid plates 25. The outermost of these plates are curved to accommodate the curvature of the narrowing slice chamber from its portion 19a to its thinner portion 19, and the degree of bend in each of the plates 25 diminishes from the outermost plates to the center where the center plate is substantially flat or planar.

At their upstream ends, the plates are supported at 27.

FIG. 1A shows in greater detail the head end of the tapered slice chamber. The plates are separated by a plurality of stacked washers 25a and 25g which act as spacers. Extending through the washers and through holes in the plates are bolts 25c and 25f. These bolts extend upwardly through a member 25e and extend downwardly through the bottom of the slice chamber.
The bolts are spaced in a cross-machine direction approximately 6 inches apart. The floor of the slice chamber is threaded to receive the bolts, and nuts are threaded onto the upper ends of the bolts to clamp downwardly against the plate 25e. The plate 25e forms part of the assembly which supports the knuckle joint 23 carrying the pivotal upper wall 24a of the slice chamber. Thus, in various arrangements, the plates may either be fixed in their position or be permitted to float so as to assume their natural position as dictated by the forces of the stock flowing past the plates into the tapered slice chamber.

The members 27 may be plastic rods which extend across the headbox in a cross-machine direction supported at their ends at the side walls of the headbox. The rods are cylindrical in shape and arranged to permit smooth flow of stock past them without adversely affecting the flow pattern of the stock or providing areas where fibers or dead areas of the stock can collect.

FIGS. 2 and 5 indicate a form of slice chamber wherein only the lower wall is bent or curved. That is, in the upper slice chamber 19a, the walls 19b and 19c are each curved so that the upper slice chamber 19a will taper into the elongate main slice chamber 19b. In FIG. 2, the upper wall 38 of the slice chamber is flat while the lower wall 39 is curved at 39a. Thus, the upper portion 31 of the slice chamber tapers into the main narrow elongate slice chamber 30.

Similarly, in FIG. 5, the upper wall of the slice chamber 47 is flat while the lower wall 48 is curved at 48a so that the larger upstream portion 45 of the slice chamber leads into the elongate thin main portion 46 of the slice chamber.

While FIG. 5 shows only one of the plates 50 for simplicity of illustration, it will be understood that there are a plurality of plates extending across the slice chamber each with a trailing element such as 49 thereon. In this preferred arrangement, the trailing element 49, as will be additionally described later herein, is mounted at an angle to the plate 54, which angle is chosen to be substantially the natural angle between the plate 50 and trailing element 49 as the stock flows through the slice chamber.

As above discussed, rigid plates are provided which are stiff enough to resist deformation by flow disturbances generated by the flow of stock around a curve in the slice chamber. The plates are in the structures of FIGS. 2–8, light enough to be positioned in the chamber by hydraulic forces. For this purpose, the plates are preferably of plastic which is stiff enough to resist deformation, but which has a weight that approaches the density of water so that the plate substantially floats in the slice chamber and is positionable solely by the forces of the stock on the surfaces of the plate.

As previously stated, it has been discovered that the flexible trailing elements cannot extend into the curved portion of the slice chamber. It has also been discovered that if the flexible trailing elements are bonded to the plates at an improper angle, a disturbance in the flow will result. Further if the bonding of the flexible trailing elements to the plates does not conform precisely to a streamlined pattern, flow disturbances will result in the stock flowing through the long tapered slice chamber.

As illustrated in FIG. 2, where only one trailing member is shown for the sake of simplicity although it will be understood that a plurality of trailing members such as shown in FIG. 1 will normally be employed, the plate 34 is curved to conform to the curvature of the slice chamber. At the upper edge of the plate 34, the plate is supported on a perforate support wall 35. This support wall is rigidly mounted in the headbox and provided with a plurality of flow passages 35e, FIG. 3. Along the width of the wall 35 extend horizontal dovetail slots 37 which receive rods or bars 36 that are welded or otherwise secured to the upper edges of the plates 34. These rods are thus pivotally mounted in the slots 37 to permit free pivotal movement of the plates 34. This permits them to be self-rotatable and the rods 36 are usually assembled by sliding endwise into the dovetail slot 37. The support plate may be of steel or plastic, but an advantage of plastic is the diminished danger of buckling of the plate due to changes in temperature.

The plurality of plates 25 as shown in FIG. 1 are preferably designed to terminate at the same location for the depth of the slice chamber 19. However, in manufacture the plates may additionally be of the same width in a machine direction, and although different boding curvatures are placed in the plates, the difference in position of their downstream edge will not be that great. The flexible trailing elements, however, should be of a length so that their downstream edge will end a uniform distance from the slice opening 20.

To accommodate a smooth flow pattern at the end of the plate, the plate is recessed at 40 as shown in FIG. 4 with the upper edge of the trailing element 33 being bonded in the recess. Where the plate and trailing element are formed of plastic, the two may be cemented together with an epoxy resin or may be joined by heat welding.

In the preferred form of the invention, the plates are not bent, but are flat and the flexible trailing elements are bonded to the plates at an angle, as shown in FIG. 5. In FIG. 5, the plates 50 have the trailing elements 49 within the slice chamber 46. The plates are pivotally supported by rods 52 secured along their upstream edges and mounted in dovetail grooves 53 in a perforate wall 51.

As shown in detail in FIG. 6, the trailing elements 49 are cemented to the beveled downstream edge 54 of the plates 50 with the bevel being cut so that it is equal to the angle 48a of bend of the slice chamber. Again in this construction the plates seek their own position in accordance with the flow of stock since they are flexibly or pivotally mounted at their upstream edges.

Another form of construction is shown in FIG. 7 wherein a rigid plate is connected to a flexible trailing element 64 by an extruded plastic connector 61. By this construction, a precise and accurate curve may be obtained simply by design of the extruded connector. An additional advantage in this structure is that the flexible sheets may be separated from the rigid plates for ease of replacement. Furthermore, by allowing the flexible sheet to move relative to the rigid plate at a joint between them, it relieves the need for having precisely correct angles of attachment of the flexible sheet to the rigid plate. The rigid plate may be formed as a single extrusion which, of course, would require a different extrusion for each different angle of bend for each plate. With the structure of FIGS. 7 or 8, the flat plates may be all constructed of the same size and dimension, and the plastic extruded connectors may take on the
different lengths and angles of curvature. FIG. 7 shows a flat plate 60 which has a hinge upstream support 66 and which is connected at its downstream edge to an extruded plastic connector 61. The connector is formed with a groove 62 which provides a recess for the lower edge of the plate in order to bond the plate to the connector.

At its lower edge the connector 61 has a groove 63 into which is bonded the flexible trailing member 64. The connector is necked down at 65 to provide a flexible hinge point to permit the trailing element 64 to float at the proper angle of curvature dependent upon the forces of the flowing stock.

In the arrangement of FIG. 8, a plate 70 is provided with a hinge support 76 at its upstream end and is bonded at its lower edge to an extruded connector 71. The connector is provided with a dovetailed slot and a curved inner surface to receive the beaded or bulbous upper edge of the flexible trailing element 72 in order to provide a pivotal connection for the trailing element. This permits the trailing element to assume its natural position as determined by the forces of the flowing stock. In each of the arrangements of FIGS. 7 and 8, different flow circumstances will be accommodated by permitting the flexible trailing member to assume its natural position without stress. This will also permit manufacturing tolerances in the curvature of the slice chamber and the plate mounted therein.

The pressure differences which are generated across the plate and trailing element support both their weights. The channels between the plates will tend to be thinner, and the pressure gradients in them higher toward the inside of the curve. This difference between the channels cannot be sustained in the flexible trailing elements and, therefore, is sustained by the more rigid plates.

We claim as our invention:

1. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement comprising, a plurality of rigid plates positioned in the slice chamber, each of said plates extending transversely of said headbox and projecting downstream generally in the direction of stock flow, trailing elements attached to the downstream ends of said plates, said elements being attached to said plates only at their upstream ends with their downstream portions unattached and constructed to be self-positioning so as to be solely responsive to forces exerted thereon by the stock flowing toward the slice opening, and means yieldably supporting said rigid plates so that the plates are self-positionable in a direction transverse of their surfaces so as to be solely responsive to forces exerted thereon by the stock flowing toward the slice.

2. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein said support means includes a stationary member in the slice chamber having a tapered slot with a downstream opening larger than the thickness of the plate and a pivotal member secured to the plate and being larger than said opening for pivotally supporting each of the plates at their upstream ends for movement about an axis extending across the headbox parallel to the plates.

3. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein said support means includes a stationary member in the slice chamber having a tapered slot with a downstream opening larger than the thickness of the plate and a pivotal member secured to the plate and being larger than said opening for pivotally supporting each of the plates at their upstream ends for movement about an axis extending across the headbox parallel to the plates.

4. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein said plates have a bend in a downstream direction.

5. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein said slice chamber is curved to have a curved flow zone and the plates extend through said curved flow zone and are curved in the direction of curvature of the zone.

6. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein said trailing elements are attached at an angle to the plane of the downstream ends of said plates.

7. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein the downstream edge of the plates are recessed and each trailing element for each plate is secured in said recess so the stock will flow smoothly past the location where the trailing elements are attached to the plates.

8. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein the structure includes a rigid connector member at the downstream edge of each of the plates which joins the trailing elements to the plates.

9. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein the connector has a thin portion in advance of the trailing element having a thickness less than the thickness of said plate.

10. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein the slice chamber is curved and the plate is flat and the connector member is curved in the direction of the curvature of the slice chamber.

11. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the construction in accordance with claim 1 wherein the connector has a laterally extending socket with a narrow downstream opening and the trailing element has a bulbous upper end positioned in said socket supporting the trailing element.

12. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement comprising, a rigid plate positioned in the slice chamber, said plate extending transversely of said headbox and projecting downstream generally in the direction of stock flow,
a trailing element attached to the downstream end of said plate,
said element being attached to said plate only at its upstream end with its downstream portion unattached and constructed to be self-positionable so as to be solely responsive to forces exerted thereon by the stock flowing toward the slice, and means supporting said rigid plate so that the plate is yieldable in a direction transverse of its surfaces and is self-positionable so as to be solely responsive to forces exerted thereon by the stock flowing toward the slice opening.

13. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement comprising, a rigid member positioned in the slice chamber, said member projecting downstream generally in the direction of stock flow, means supporting said member only at its upstream end and accommodating pivotal movement of said member so that the member is self-positionable responsive solely to forces exerted thereon by the stock flowing toward the slice opening, and a flexible element being attached to said member only at its upstream ends with its downstream portion unattached and constructed to be self-positionable so as to be solely responsive to forces exerted thereon by the stock flowing toward the slice opening.

14. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement comprising:

- a rigid plate positioned in the slice chamber, said plate extending transversely of said headbox and projecting downstream generally in the direction of stock flow,
- a trailing element attached to the downstream end of said plate, said element being attached to said plate only at its upstream end with its downstream portion unattached and constructed to be self-positionable so as to be solely responsive to forces exerted thereon by the stock flowing toward the slice, and means connecting said trailing element to said plate permitting free and independent positioning at the point of attachment,