A headbox structure for feeding a slurry of stock onto a traveling forming surface for a paper making machine including a tapering slice chamber with a slice opening and trailing elements positioned in the slice chamber extending in a downstream direction with the elements being unattached at their downstream edges and being self-positionable responsive to pressures of stock flowing past the element with the edges of the elements adjacent the pond sides being extended for obtaining a more uniform stock delivery and basis weight of paper web.
PAPERMAKING MACHINE HEADBOX WITH SLICE CHAMBER CONTAINING FLEXIBLE TRAILING ELEMENTS HAVING EXTENDED EDGES

BACKGROUND OF THE INVENTION

The invention relates to improvements in paper making machines, and more particularly to improvements in headboxes for delivering fibrous stock to a traveling forming surface.

In commercial paper making processes involving delivery of flowing stock from a headbox through a slice opening onto a traveling forming surface such as a fourdriner wire, the principal objective in achieving uniform formation of a paper web is the formation of the natural tendency of the fibers to flocculate. Flocculation causes nonuniformity with its inherent disadvantages including nonuniform appearance, nonuniform thickness, nonuniform ink receptivity and so forth. Improvements have been made to correct these difficulties as shown in Hill et al. U.S. Pat. No. 3,607,625 and Hill U.S. application Ser. No. 121,775 filed Mar. 8, 1971, now abandoned.

In the demands made on high speed paper making machines, in order to increase production or to accommodate new roll size demands, it has become desirable to attempt to reduce the size of trim or waste at the edge of the paper machine wire. Because of the gradual decrease in basis weight near the edges of the headbox which normally occurs, it was not sufficient to simply reduce the amount of edge trim. The problem is one of producing a sheet from a headbox which will maintain its optimum basis weight as near the edge of the formed web as possible. Difficulty increases with speeds of formation of pressure within the headboxes, and the pressure effects and frictional effects of the stock flowing through the headbox increase.

It is accordingly an object of the present invention to provide an improved headbox construction which will obtain a more uniform basis weight at the edges of the formed web. A further object of the invention is to provide an improved headbox with flexible elements therein wherein stock delivery from the slice opening approaches a uniform volume fully to the edge of stock delivery onto the forming surface, thus reducing the width of the sheet edge which has to be trimmed. A feature of the invention embodies providing trailing element means of the types described in the above patent and application, but uniquely shaped to unexpectedly obtain the objectives set forth above. It has been found that in a slice chamber of a headbox containing flexible trailing element, higher pressure occurs in the center of the headbox toward the slice opening because of velocity decrease. It has been discovered that by extending the flexible elements adjacent the pond sides, an increase in velocity is obtained at that location with a lower pressure. This results in the stock moving laterally from the higher pressure head in the center of the headbox toward the edges to provide a compensating flow of stock at the lateral edge of the slice opening to thereby increase the basis weight of the sheet edge. By particular shapes of the edge of trailing element, the uniformity of basis weight toward the edge of the sheet can be substantially enhanced. Other objects, advantages and features, as well as equivalent structures which are intended to be covered herein will become more apparent with the teaching of the principles of the invention in the disclosure presented in the specification, claims and drawings, in which:

DRAWINGS

FIG. 1 is a somewhat schematic side elevational view, shown in section, of a headbox constructed and operating in accordance with the principles of the present invention;

FIG. 2 is a fragmentary vertical sectional view taken substantially along line II—II of FIG. 1;

FIG. 3 is a fragmentary sectional view of a portion of another form of the mechanism;

FIG. 4 is a fragmentary sectional view of a portion of another form of the mechanism; and

FIG. 5 is a fragmentary sectional view of another form.

DESCRIPTION

As used herein, transverse refers to the cross-machine direction whereas longitudinal refers to the machine direction.

In FIG. 1, it will be seen that there is a forming wire F traveling around a breast roll 10 to define a conventional forming surface onto which papermaking stock is fed through a slice opening indicated generally at S. The slice S is mounted at the forward end of a headbox indicated generally at 11, such headbox being what constitutes a slice chamber 11a and a preslice flow chamber 11b in that it aligns the stock for flow toward to slice S.

In a conventional stock inlet the stock is generally fed to the headbox, such as the one here employed, from a fan pump or other suitable source of stock in a relatively small high-speed conduit which is indicated in FIG. 1 by the reference numeral 12 as a tapered cross-machine header having an inlet 12a at the side of the headbox 11 from which it is viewed in FIG. 1 and an outlet 12b of diminished cross-sectional area at the backside of the chamber 12 for flow of stock in a generally transverse direction through the tapered inlet header 12. Any of a number of known stock-inlet devices may be provided to present a transverse flow of stock into the chamber 12 under a substantially uniform pressure in the general area of the barrier or perforated mounting plate indicated at 13. The perforated plate 13 extends transversely of the stock inlet 12 and it is provided with a plurality of apertures 13a, 13b, 13c, etc. which are generally parallel and which are spaced transversely to define a multiplicity of generally parallel apertures extending across the entire plate 13. The plate 13 carries a multiplicity of diffuser nozzles 14a, 14b, 14c, etc. each of which is received in one of the multiplicities of apertures 13a, 13b, 13c in the plate 13. At their downstream end the diffuser nozzleless communicate with a preslice flow chamber 11b. The chamber 11b, in the direction of stock flow, is defined by the downstream end of the diffuser nozzles 14a, 14b, 14c, etc., and a perforated plate 15 extending transversely of the headbox 11.

The plate 15 contains a multiplicity of perforations 15a, 15b, 15c, etc. distributed between land areas 16a, 16b, 16c, etc.

The perforations 15a, 15b, 15c, etc. extend in generally horizontal rows thus leaving continuous land areas 16a, 16b, 16c, etc. between the rows.
Extending through the land areas are plates 19, 20, 21, etc. These plates extend transversely of the slice chamber 11a and longitudinally towards the slice S. It will further be noted that the plates 19, 20, 21, etc. also longitudinally extend through the plate 15 in an upstream direction and have mounted thereto at their upstream ends transversely extending rods 22, 23, 24, etc. This unique and novel combination of perforations 15a, 15b, 15c, etc. land areas 16a, 16b, 16c, etc. plates 19, 20, 21, etc. extending upstream of the perforated plate 15 and rods 22, 23, 24, etc. permits a substantial increase in open area of the perforated plate 15 the desirability of which will be hereinafter described in detail.

With an increase in open area of the plate 15 the area of the lands between the perforations will be substantially reduced. These narrow land areas will tend to collect fibers which collection will gradually increase and may result in large chunks of fibers being released into the slice chamber 11a causing disruption of the papermaking process. In order to avoid the stapling of fibers to the land areas of plate 15 the plates 19, 20, 21, etc. are extended in an upstream direction with respect to the land areas. To prevent stapling of fibers to the upstream ends of the plates, rods 22, 23, 24, etc. are mounted to the plate ends. The rods are large enough in diameter to prevent stapling of fibers thereto. Of course, the rods may have various shapes such as flat, flint or teardrop.

As shown in the drawings the slice chamber 11a gradually decreases in cross-sectional area in the direction of flow towards the slice opening S and its longitudinal boundaries are defined by the perforated plate 15 and the slice opening S. Plates or trailing members 25, 26, 27, etc. extend from the plate 15 to the slice opening S and divide the slice chamber into multiplicity of approximately vertically spaced longitudinally extending channels 29, 30, 31, etc. The channels also extend transversely of the slice chamber 11a. The trailing members are anchored only at their upstream ends to the perforated plate 15 and are free floating downstream. It is therefore desirable that the trailing members are reasonably close to neutrally buoyant to allow positioning by the hydrodynamic effects of stock flow between the trailing members. It has also been found desirable for the trailing members to progress from stiff thich members at their upstream ends to thin relatively flexible members at their downstream ends. To accomplish this, as shown on the drawing, the trailing members defining the converging channels are simultaneously slowly decreasing in stiffness in the direction of stock flow.

In a practical embodiment of the present invention the spring C of the individual channels between trailing members preceding the slice opening S should be in the order one eighth inch or smaller and the size of the solid areas between the channels at their exits should be much smaller than the size of the channels themselves. The exit open area should therefore be preferably in the order of at least 80 – 95 percent. However, open areas in the order of 50 percent and larger are conceivable. In order to prevent plugging of the entrance portion of the slice chamber it is desirable to maintain the vertical dimension of each of the channels 29, 30 and 31, etc. at the upstream end in the order of 1 inch and the overall open area of the perforated plate 15 should preferably be greater than 30 percent. However, as a general rule the openings in the distributor should be as small as possible for maintaining the flow pattern small but large enough to avoid plugging. These criteria will vary with the particular application and stock characteristics.

It has further been found desirable to impart some flexibility to the downstream end of the trailing members 25, 26, 27, etc. This flexibility provides a convenient way to achieve the small uniform spacing of the members across the width of the slice chamber at the downstream end since this uniform spacing is a hydrodynamically stable condition for this particular structure as indicated by experiments. Thus, flexibility allows the trailing members to be positioned by the dynamic forces of flow, that is, to conform to the streamlines. Alternatively, it would be difficult to achieve uniformly spaced rigid trailing members without mounting the members to the sides of the slice chamber and even then it would be difficult.

It is also desirable to impart some flexibility to the trailing members to allow the passage of large particles which are inevitably present in a commercial stockflow system. It is therefore a feature of the present invention not to have the trailing members attached to the sides of the slice opening 25, 26, etc. extending further toward the stream opening at the pond sides than inwardly therefrom. In FIG. 2, the trailing element is shown as preferably being flexible, but it is contemplated that a plate can be used which would be pivotedly supported at its upstream end. FIGS. 3 and 4 have trailing elements 25a and 25b shown which extend transversely across the headbox from pond side to pond side.

However, the trailing elements as shown in FIG. 5 at 25c may be of multiple strands with the strands being longer at the edge adjacent the pond side 33c. As shown in FIG. 2, the edge of the trailing element 25 adjacent the pond side at 37 is curved outwardly toward its longer extremity. As shown in FIG. 3, for the extension 38, the longer portion is flat at 38 and tapers angularly at 39 back toward the trailing edge 36c of the sheet.

In the arrangement of FIG. 4, the sheet is angled back sharply at 39 adjacent the pond sides to form a triangular shaped portion at 39. In FIG. 5, the trailing elements which may be in the form of plural rods or filaments are longer at 40 at the edge than away from the pond side 33c.

As above mentioned, it has been found that with the conversion of the flowing stock to a higher pressure in the center of the machine, by the extended edges such as 37, 38, 39 or 40, the velocity is lowered with a resul-
tant lower pressure, and the stock fans out or flows laterally toward the edges to take away from the rest of the headbox and compensate for the other effects which would tend to give a lower basis weight at the headbox edge. Instead, in the operation of the mechanism, a substantially uniform basis weight is obtained completely to the edge of the web.

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 trailing element means positioned in the slice chamber extending in a downstream direction;
   means supporting the upstream end of said trailing element means;
   said element means being unattached at its downstream edge and being self-positionable responsive to pressures of stock flowing past the element means toward the slice opening, said element means extending in a direction transversely of the slice chamber and substantially to the pond side of the slice chamber,
   said element means having a downstream edge and having a longer portion extending further toward the slice opening at the pond side than the portion inwardly therefrom.

2. In a headbox for delivering stock to a forming surface, the headbox having slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein said element means is flexible.

3. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein said element means is rigid.

4. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein said element means includes multiple strands.

5. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein said element means extends transversely across the headbox continuous for the full width of the slice chamber substantially to both the pond sides.

6. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein said element means includes a plurality of separate elements spaced apart in a direction vertically relative to the horizontal extent of the slice chamber.

7. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein the ends of the element means adjacent the pond sides are triangular shaped.

8. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein the elements adjacent the pond sides are curved shaped.

9. In a headbox for delivering stock to a forming surface, the headbox having a slice chamber and a slice opening, the improvement constructed in accordance with claim 1:
   wherein the element means adjacent the downstream edge portion adjacent the pond sides extends parallel to the slice opening for a short distance and then angles in a direction away from the slice opening.

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