Aug. 20, 1968 K. B. LATIMER 3,398,048

PROFILE-CONTROLLING GRATING ASSEMBLY

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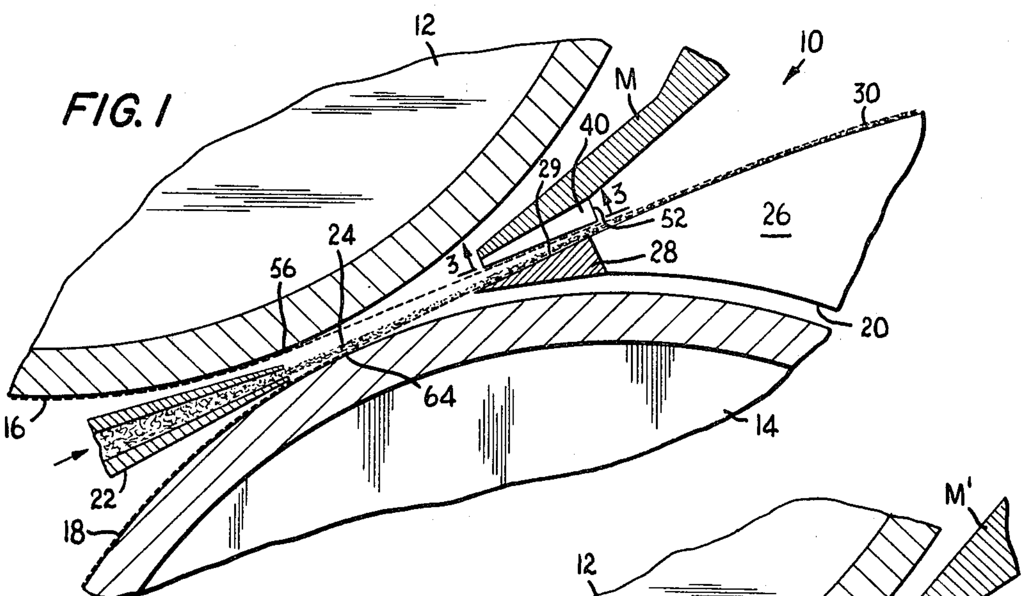


FIG. 1

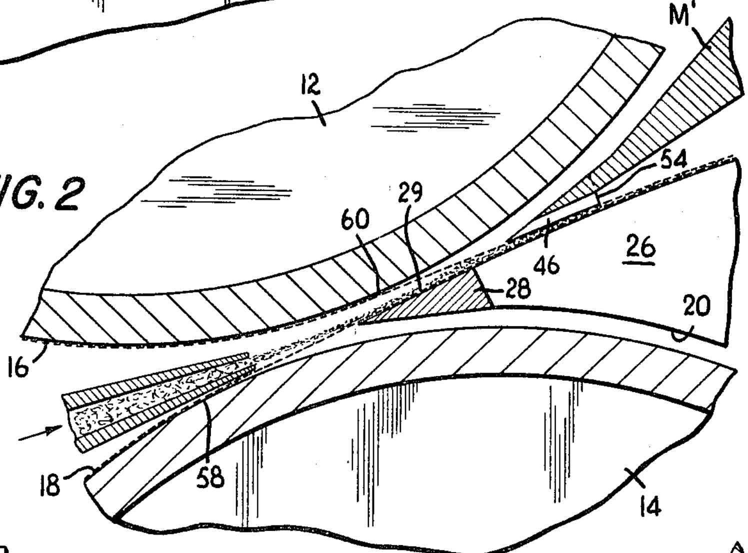
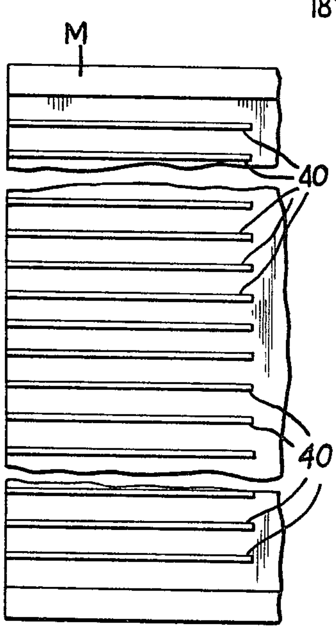


FIG. 2

FIG. 3



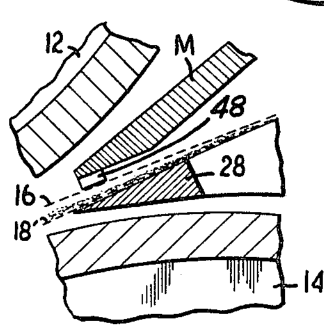


FIG. 4

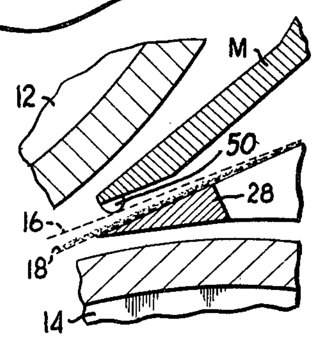


FIG. 5

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PROFILE-CONTROLLING GRATING ASSEMBLY

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ABSTRACT OF THE DISCLOSURE

In a twin-wire paper-making machine having upper and lower breast rolls and a curved forming box, a grating assembly of short blades is provided for lightly contacting the upper forming wire to define its transverse profile and facilitate control of the transverse basis-weight variation of a paper web made on the machine.

This invention relates to paper making and, more particularly, to novel methods and apparatus facilitating rapid and economical production of paper of the highest quality.

Paper-making machines have recently been greatly improved with the invention of the various species of curved stationary forming boxes disclosed in an application by David E. Robinson, Ser. No. 311,278, filed Sept. 16, 1963, for "Paper-Forming Apparatus and Methods," and an application by John A. Means, Ser. No. 407,307, filed Oct. 29, 1964, for "Paper Manufacture." The curved forming boxes disclosed in those applications mark a great advance in the art of paper making in that they facilitate, among other things, a high degree of control of the rate of drainage of water from a paper stock to form a paper web and yet facilitate the mounting of the Fourdrinier wires or other movable foraminous forming elements with sufficient resilience to permit the passage of lumps in the stock, snags in the wires, etc., without damaging the wires or disrupting the web.

The present invention is adapted for use on many types of paper-making machines and is particularly adapted for use on a machine employing a curved forming box. The invention facilitates control of the rate of removal of water from a paper stock yet does not impair the ability of the machine to remain in operation despite lumps in the stock and snags in the wire.

A preferred embodiment of apparatus constructed in accordance with the invention is particularly adapted for use on a paper-making machine which may be generally of the type disclosed in the Robinson or Means application mentioned above. Such a paper-making machine is a "twin-wire" machine having upper and lower belt-training means such as breast rolls and a stationary forming box having a convexly-curved foraminous-forming-member-supporting surface spaced apart from the breast rolls a substantial distance. The machine comprises an upper movable foraminous forming member such as a Fourdrinier wire trained about the upper belt-training means and forming box and having a straight run therebetween and a lower movable foraminous forming member such as a Fourdrinier wire trained about the lower belt-training means and forming box. The two wires are in opposed relation to each other and are adapted to receive a paper stock therebetween, dewater the stock, and form it into a paper web.

In a preferred embodiment of the present invention, the machine described above is improved by the provision of a grating assembly comprising a plurality of blades, each blade being mounted with an edge extending generally longitudinally of the direction of movement of the upper forming member and being adapted to contact the upper forming wire in the straight run between the breast roll and forming box. The blades are mounted with respect to one another in a row extending generally transversely of the direction of movement of the upper forming wire, and the wire-contacting edges of the blades define the transverse profile of the upper forming wire and hence facilitate control of the transverse basis-weight variation of a paper web made on the paper-making machine. Preferably, the wire-contacting edges lie in a plane. Further, the blades extend over but a small fraction of the distance between the upper breast roll and forming box, and most of the upper forming member in the straight run between the upper breast roll and forming box is free of restraining means in contact therewith.

An understanding of further aspects of the invention may be obtained from a consideration of the following detailed description of two representative embodiments thereof taken in conjunction with the appended figures of the drawings, in which:

FIG. 1 is a schematic side elevation, partly in section, of a first representative embodiment of apparatus constructed in accordance with the invention;

FIG. 2 is a schematic side elevation, partly in section, of a second representative embodiment of apparatus constructed in accordance with the invention;

FIG. 3 is a view taken generally along the line 3—3 of FIG. 1 and looking in the direction of the arrows; and

FIGS. 4 and 5 are fragmentary side elevations, partly in section, of alternate embodiments of a portion of the structure of FIGS. 1–3.

FIG. 1 shows the upstream portion **10** of the wet end of a paper-making machine. The paper-making machine includes belt-training means such as an upper rotatable breast roll **12** and a lower rotatable breast roll **14** spaced apart therefrom. Movable foraminous forming elements such as Fourdrinier wires **16** and **18** are trained in opposed relation to each other about the upper and lower breast rolls **12** and **14**, respectively. A lower stationary forming box **20** is mounted in spaced-apart relation to the upper and lower breast rolls **12, 14**. A slice **22** is mounted between the upper and lower breast rolls **12, 14** and directs between the wires **16, 18** a highspeed jet **24** of paper stock.

The rolls **12, 14** are preferably "solid" (i.e., have solid or impermeable circumferential surfaces) for maximum rigidity and spaced apart from each other a distance greater than the thickness of the jet **24** so that the jet **24** can be directed between the rolls **12, 14** without touching either, whereby pumping of the jet **24** by the rolls **12, 14** is avoided.

The lower stationary forming box **20** is provided with a vacuum area **26** by means of which a vacuum may be applied through the open or foraminous surface **30** of the forming box **20** to the jet **24** to facilitate its dewatering and formation into a paper web. The upstream end of the forming box **20** is provided with a solid member or plug **28** which prevents the jet **24** from penetrating the wire **18** before the jet **24** reaches the vacuum area **26** which facilitates controlled dewatering of the jet **24**. If the lower wire **18** consists of or includes a nylon forming member or other member having appreciable water-adsorbing capacity, the jet **24** may touch the wire **18** somewhat upstream of the plug **28**. Otherwise, the jet **24** is directed to strike the wire **18** where it traverses the upper surface **29** of the plug **28**. In either case, no appreciable water passes from the jet **24** to the space between the lower breast roll **14** and the forming box **20**.

The upper surface **30** of the forming box **20** is convexly curved through an arc which is preferably about 20° so that both the upper wire **16** and the lower wire **18** are trainable about the surface **30**. The wires **16, 18** are placed under tension by adjustable tension rolls (not shown) and are converged to facilitate removal of water from the stock through both of the wires **16, 18**.

The wires 16, 18 are thus mounted with sufficient resilience to permit passage of snags therein and of lumps in the stock without disrupting the inchoate web.

The upper breast roll 16 constitutes a first support means for the upper wire 16, and the curved forming box 20 a second. The upper wire 16 is generally concave upward where it is trained about the convex circumferential surface of the upper breast roll 16 and concave downward where it is trained about the convex surface of the curved forming box 20. The box 20 is mounted on the side of the upper wire 16 opposite the side of the upper wire 16 on which the upper breast roll 12 is mounted. The lower breast roll 14 constitutes a third support means for the lower wire 18, which has a run between the lower breast roll 14 and the curved forming box 20 and is adapted to move in the run in a direction nearly the same as, but convergent with respect to, the direction in which the upper wire 16 moves between the upper breast roll 12 and the curved forming box 20. The lower wire 18 laps a portion of the surface 30 of the forming box 20 greater than that lapped by the upper wire 16 and is between the upper wire 16 and the forming box 20. The paths of both wires 16 and 18 in the forming zone are thus curved at least in part.

The structure described above, which is disclosed in large part in the Robinson and Means applications and does not per se constitute the present invention, facilitates a high degree of control of the rate of removal of water from the stock and the rapid and economical manufacture of high-quality paper.

As noted above, the present invention facilitates even greater control of the formation of the web and, in particular, of the transverse basis-weight variation of the web. The basis weight of a paper web is a concept well known in the paper-making art. It is defined as the weight of fiber per specified area of a paper web. The specified area may be 1,000 square feet or some other area, depending on the type of stock under consideration. The transverse basis-weight variation is the variation of the basis weight in a direction transverse of the direction in which the web moves as it is formed. In the making of high-quality paper for books and magazines, it is important that the transverse basis-weight variation be as small as possible from one edge of the web to the other.

Minimization of the transverse basis-weight variation of the stock is facilitated in accordance with the present invention by the provision of a plurality of blades 40 shown in elevation in FIG. 1 and in bottom or inside plan view in FIG. 3. The blades 40 lightly contact the upper wire 16, preferably keeping it substantially in a plane. The blades 40 are short compared to the total length of the straight-line movement of the upper wire 16 between the upper breast roll 12 and the portion of the surface 30 of the suction box about which the upper wire 16 is trained. In an 18-inch-wide pilot paper-making machine, a blade length not exceeding 5 inches—less than half the straight-line run—has been found to give optimum results. Thus, the upper wire 16 is devoid of restraining means in contact therewith throughout most of its straight-line run between the upper breast roll 12 and the stationary forming box 20.

It is believed that the control exercised by the blades 40 arises from their elimination of ripples which might otherwise tend to form in a direction parallel to the direction of movement of the wire 16 between the upper breast roll 12 and the forming box 20. The blades 40 are about 1/16 of an inch to 3/16 of an inch thick in the direction normal to the plane of FIG. 1 and transverse of the direction of movement of the wire 16 and are closely spaced-apart—about 1/4 to 1/2 inch from center to center. There is thus no opportunity for the upper wire 16 to form the longitudinal ripples referred to above; any portion of the upper wire 16 tending to move upwardly beyond adjacent portions is prevented from doing so by the blades 40.

Moreover, the blades 40 are positioned by mounting means M adjacent to the upstream end of the forming zone or zone in which the water is removed from the jet of stock 24 of not-yet-interlocked fibers through the upper and lower forming wires 16, 18. At this point, the separation between the upper and lower wires 16, 18 is substantial—about 0.040 inch—so that lumps in the stock have adequate room between the wires 16, 18 through which to pass. Also, the wires 16, 18 can move slightly inwardly towards each other in the event of snags therein. Thus, such lumps and snags do not cause the disruption of the web which might occur if the forming wires 16, 18 were opposed by restraining means on opposite sides thereof farther downstream in the forming zone where the separation between the wires 16, 18 is very little.

FIG. 2 shows an alternate embodiment of the invention in which mounting means M′ similar to the mounting means M of FIG. 1 mounts blades 46 similar to the blades 40 shown in FIG. 1. In the embodiment of FIG. 2, the blades 46 are pointed at their upstream ends and are downstream of, rather than in opposed relation to, the plug 28. Other blade shapes may also be used provided they do not cause whitewater turbulence tending to disrupt the web. The relative positions of the breast rolls 12, 14 are modified in FIG. 2 as compared to FIG. 1. The positions of the breast rolls 12, 14 with respect to each other may vary in accordance with the invention and are not restricted by the location chosen for the top grating constituted by the blades 40 or 46.

The blades 40 and 46 are sufficiently short that they need not be angled with respect to the direction of movement of the wires 16 and 18. Because of its short length, each blade can be mounted in a separate plane parallel to the direction of movement of the wires 16 and 18, in the manner shown in the bottom or inside plan view of FIG. 3, without causing shadow marking of the web. The mounting of the blades parallel to each other and to the direction of movement of the upper wires 16 and 18 simplifies construction of the grating assembly and facilitates smooth flow of the whitewater in contact with the blades.

The blades 40 and 46 are preferably made of stainless steel, with or without a coating of tungsten carbide, or of micarta, hard polyurethane, or silicon carbide. The downstream ends 52 and 54 of the blades are sufficiently thin in a direction normal to the plane of FIGS. 1 and 2 to prevent pumping (dynamic drainage) of the inchoate web. Such pumping would tend to disrupt the web.

Where 38-inch breast rolls are used on an 18-inch-wide machine, the upstream ends of the blades 40 or 46 may be from somewhat less than 4 inches to somewhat more than 10 inches downstream of the line of separation 56 or 58 of the wire 16 from the rolls 12 or the wire 18 from the roll 14. The line of separation 56 is upstream of the line of separation 64 between the wire 18 and the roll 14 (FIG. 1), and the line of separation 58 is upstream of the line of separation 60 between the wire 16 and the upper breast roll 12 (FIG. 2).

In mounting the apparatus of the invention, the blades 40 or 46 are placed with their wire-contacting edges parallel to and either touching or slightly above the upper wire 16 when the machine is not in operation. For example, the separation between the edges of the blades 40 or 46 and the upper wire 16 may be 0.030 inch. With the machine in operation, the upper wire 16 bulges or is deflected slightly upwardly and lightly touches the wire-contacting edges of the blades 40 or 46. (In the absence of the blades 40 or 46, the upper wire 16 might have bulged a maximum of, say, 0.040 inch, depending on the speed, drainage rate, and consistency of the stock.) The upper wire 16 thus almost follows the path urged by the speed, drainage rate, and consistency of the stock. Nevertheless, the bulge in the upper wire is so slight that its run between the upper breast roll 12 and the forming box 20 remains substantially in a straight line.

FIGS. 4 and 5, fragmentary side elevations of a portion of the structure of FIGS. 1–3, show other blades 48 and 50, respectively, that may be used in accordance with the invention. The blades **48** and **50** are shorter than the blades **40** and **46**. The blades **48** are rectangular and about twice as long in the direction of movement of the wire **16** as in the direction in the plane of FIG. 4 normal to the direction of movement of the wire **16**. For example, the face of the blade **48** presented to view in FIG. 4 may measure ¾ of an inch by ⅜ of an inch. One edge of each blade **48** parallel to the direction of movement of the wire **16** contacts the wire **16** during operation of the machine, and the other edge of each blade **48** parallel to the direction of movement of the wire **16** is supported by the mounting means M. The blades **50** are semicircular and have a radius equal to half the length of the blades **48** in the direction of movement of the wire **16**. The curved edges of the blades **50** make substantially point contact with the wire **16** during operation of the machine, and the flat edges of the blades **50** are supported by the mounting means M.

The invention facilitates controlled convergence of the upper and lower wires **16**, **18** and accelerates the formation of the web by limiting the bulge in the upper wire **16**. The invention thus permits the use of stock of higher-than-normal consistency and reduces the amount of water the machine must handle. Further, it facilitates the formation of a web of greater homogeneity inasmuch as the quicker formation provides less time for the reformation of flocks in the stock prior to formation of the web.

Thus, there is provided in accordance with the invention novel and highly effective apparatus facilitating the rapid, efficient, and economical production of paper of the highest quality.

Many modifications of the representative embodiments of the invention disclosed herein will readily occur to those skilled in the art. For example, while the blades **40**, **46**, **48**, and **50** have been shown as particularly adapted to prevent rippling of the upper wire of a twin-wire machine, they may be used also to prevent rippling of the lower wire of a twin-wire machine or of the wire of a single-wire machine, where such wires are otherwise subject to rippling. Accordingly, the invention is to be construed as including all of the modifications which come within the scope of the appended claims.

I claim:

1. In a twin-wire paper-making machine having (a) first and second support means spaced apart from each other a substantial distance and third support means spaced apart from said first and second support means, (b) a first foraminous forming member trained about the first and second support means and being adapted to move in a given direction therebetween and a second foraminous forming member trained about the third and second support means in opposed relation to the first foraminous forming member and being adapted to move therebetween in a direction generally the same as but convergent with respect to said given direction, the first and second foraminous forming members defining a forming zone lying at least partly adjacent to the run between the first and third support means on the one band and the second support means on the other,

the improvement comprising a plurality of blades each mounted with an edge adapted to contact the first forming member in spaced-apart relation to the support means, the blades being mounted with respect to one another in a row extending generally transversely of said given direction and the edges in contact with the first forming member (a) defining the transverse profile of the first forming member and hence facilitating control of the transverse basis-weight variation of a paper web made on the paper-making machine and (b) extending over not more than five inches of the length of the first forming member

2. A paper-making machine according to claim **1** in which the first forming member is otherwise free of restraining means between the first and second support means.

3. A paper-making machine according to claim **1** in which the first and second support means are respectively mounted on opposite sides of the first forming member and have convex surfaces respectively presented to the first forming member, the first forming member being concave in a first direction where it is trained about the first support means and concave in a second direction generally opposite the first direction where it is trained about the second support means.

4. A paper-making machine according to claim **1** in which the blades are mounted at the upstream limit of the forming zone.

5. A paper-making machine according to claim **1** in which all the edges lie in one plane.

6. A paper-making machine according to claim **1** in which the edges are parallel to said given direction.

7. A paper-making machine according to claim **1** in which the edges are curved to make substantially point contact with said first forming member.

8. In a paper-making method in which a first foraminous forming member is moved (a) in a path which is straight at least in part and (b) in a given direction through a portion of a forming zone and a second foraminous forming member is moved (a) in a path which is curved at least in part and (b) in a direction generally the same as but convergent with respect to said given direction through the same portion of the forming zone, the improvement comprising the steps of (a) lightly contacting the first forming member along a line extending transversely of said given direction to define the transverse profile of the first forming member and hence facilitate control of the transverse basis-weight variation of a paper web made on the paper-making machine and (b) simultaneously maintaining the first forming member free of restraining means in contact therewith throughout more than 50% of its straight run.

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