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[54] **PAPERMAKING HEADBOX STOCK NOZZLE WITH LIQUID JACKET MEANS FOR ELIMINATION OF STOCK EXPOSURE TO AIR**
7 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **162/301,** 162/203, 162/214, 162/303, 162/317, 162/339, 162/347
[51] **Int. Cl.** **D21f 1/00**
[50] **Field of Search** 162/203, 303, 216, 346, 347, 317, 344, 339, 210, 214, 301

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ABSTRACT: A twin wire paper forming machine including a headbox having a stock outlet nozzle for directing a stream of stock into the forming nip of the machine. A liquid jacket means disposed on opposite sides of the stock nozzle discharges a stream of liquid into contiguous relation with the stock stream between the outlet of the stock nozzle and the nip to prevent exposure of the stock to ambient air. The stock outlet nozzle comprises wall members which include stationary and moveable portions, the area between the moveable portion of the outlet nozzle and the liquid jacket means varying as a function of the stock pressure in the outlet nozzle and liquid pressure in the liquid jacket means.

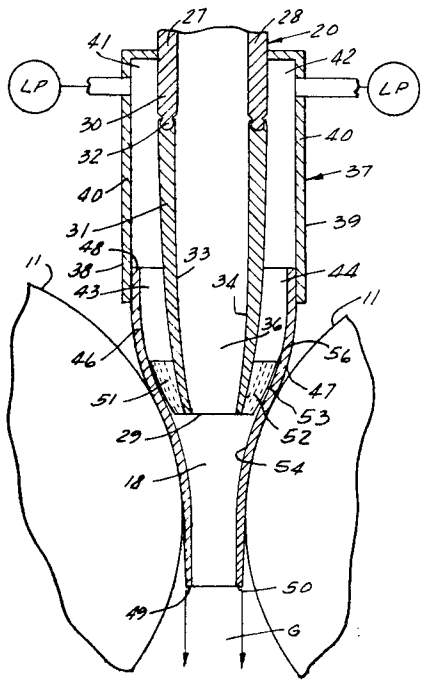


Fig. 2

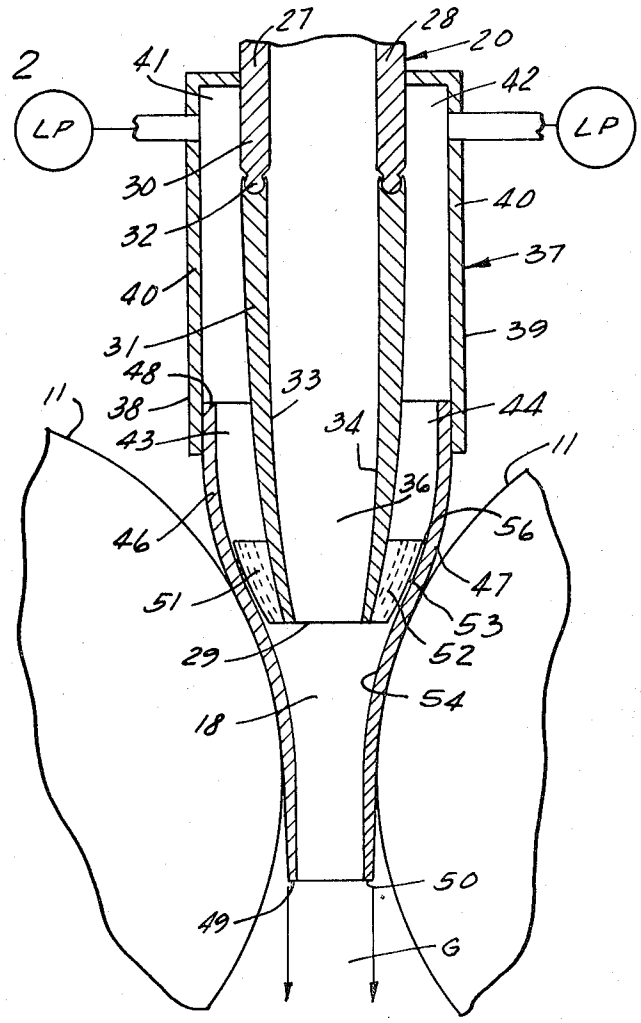
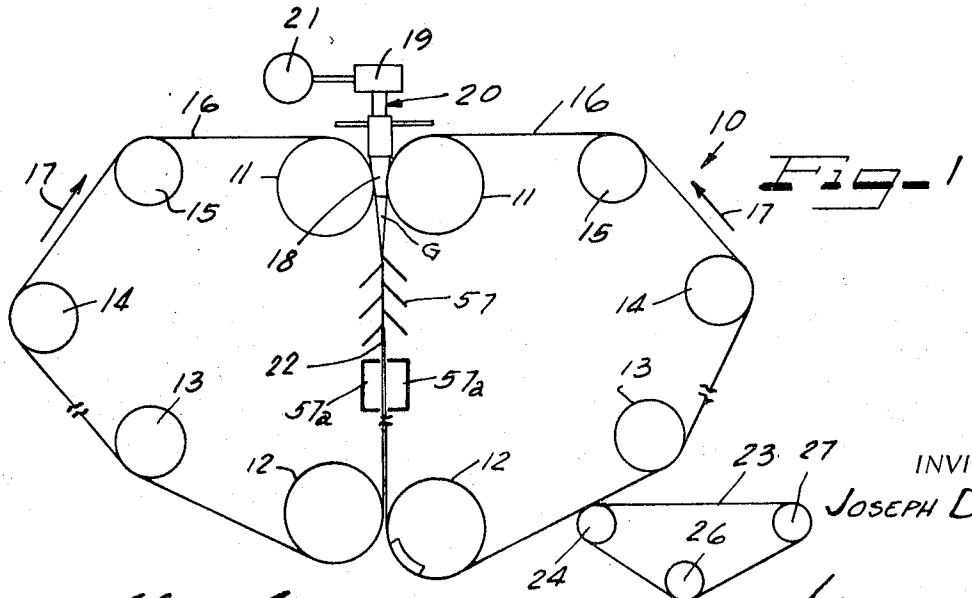


Fig. 1



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PAPERMAKING HEADBOX STOCK NOZZLE WITH LIQUID JACKET MEANS FOR ELIMINATION OF STOCK EXPOSURE TO AIR

BACKGROUND OF THE INVENTION

The present invention relates generally to the field of twin-wire paper forming machines and more particularly to the headboxes thereof.

Twin-wire paper forming machines are known generally in the prior art. Unlike the Fourdrinier machine a twin-wire machine comprises a pair of forming wires which extend in side-by-side relation and which run between a pair of breast rolls and couch rolls around which they are trained in continuous loops. The wires converge to provide a forming zone and stock is fed between the converging wires to be dewatered through both wires and to form a web. The headbox includes a nozzle which directs stock under pressure into the nip or gap formed between the opposed wire runs passing over the breast rolls. These portions of the forming wires which extend between the breast and couch rolls may be conveniently referred to as web-forming wire runs (which comprise the forming zone) and these runs may be disposed either horizontally or vertically in a twin-wire paper forming machine, which further distinguishes this type machine from a Fourdrinier machine.

A jet of stock is discharged from the headbox nozzle at a relatively high velocity to accommodate high machine speed and to produce a highly turbulent discharge. The outlet of the stock nozzle is spaced ahead of the gap formed between the breast rolls and as a consequence the stock jet is exposed to ambient air in the gap between the stock nozzle outlet and the forming gap.

In prior devices, the exposure of the stock jet to air coupled with the high state of turbulence of the jet had the effect of producing small pockets of air or craters in the surfaces of the jet, thus reducing the quality of the paper formed from the jet. It is to be problems resulting from the jet stock exposure to air that the present invention is principally addressed.

SUMMARY OF THE INVENTION

The present invention may be summarized as comprising apparatus for and a method of maintaining the stock jet ahead of the forming gap or nip of a twin-wire paper forming machine free from exposure to air and may be more particularly characterized as comprising a stock nozzle having an outlet spaced from and facing the forming gap to direct a stream or jet of stock into the gap and means for preventing exposure of the stock jet to ambient air including means for providing streams of liquid along the sides of the stock stream and in contiguous relation therewith between the outlet of the stock nozzle and the nip of the gap.

An object of the invention is to prevent the formation of air pockets or craters in the surfaces of the stock jet while maintaining high machine speed as well as satisfactory stock turbulence at the forming nip of the machine.

The invention involves the utilization of a pair of liquid jackets formed on the opposite sides of the stock nozzle and opening toward the forming nip and in the same direction as the stock nozzle outlet. Means are provided for directing streams of liquid from the open end of the chamber and into contiguous relation with the stock jet as it emerges from the outlet end of the stock nozzle to provide the stock jet with a surrounding outer layer of liquid between the nozzle outlet and the forming nip, the effect of which is to maintain the stock jet free from exposure to air therebetween.

Among salient features of the invention are included flexible apron means between the open end of the liquid jackets and the breast rolls and forming wires trained therearound to provide a liquid seal. The end portion of the stock nozzle is pivotally mounted to a stationary portion upstream therefrom and the inner walls of the nozzle form an approach channel immediately upstream of the outlet opening. Spacers may be formed on the outer walls of the pivotal portion of the stock nozzle for maintaining the nozzle walls in suitable spaced relation to the walls of the liquid jackets and to reduce liquid flow from the jackets while maintaining the pressure of the liquid at a suitable level.

A further object of the invention is to prevent a drainage or pumping action on the leaving side of the forming nip. The term "pumping action" generally refers to the result of the vacuum condition which normally exists at the point or along the line across which the forming wire leaves the breast roll.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a generally schematic view of a twin-wire paper forming machine constructed in accordance with the principles of the present invention.

FIG. 2 is an enlarged fragmental sectional view of the forming nip area of the paper forming machine of FIG. 1 including the outlet portion of a stock nozzle which delivers stock from the headbox to the forming nip.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a twin-wire paper forming machine constructed in accordance with the principles of the present invention is indicated generally at reference numeral **10** and may be more particularly characterized as comprising a pair of breast rolls **11, 11**, a pair of couch rolls, **12, 12**, a pair of wire drive rolls, **13, 13** and guide rolls **14, 14** and **15, 15**. Around each breast roll **11**, couch roll **12**, drive roll **13** and guide rolls **14** and **15** is trained a forming wire indicated at reference numeral **16** which extends in a continuous loop. Although the term "forming wire" is used herein it will be understood by those skilled in the art that the material of which the loops **16, 16** are constructed may be not only forming wire but in addition may be woven fabric, or any other foraminous material suitable in the formation of paper web. It will also be understood that the dewatering arrangement between the wires is shown schematically and that a longer dewatering zone between the wires with more dewatering aids will often be used.

The drive rolls **13, 13** continuously turn the loops of forming wire **16** in the directions indicated by the arrows at **17, 17** and each of the forming wires **16** thus travels over an upper quandrant of its respective breast roll **16** then substantially in a straight line to its respective couch roll **12** around which it is trained and guided to its respective drive roll **13**, thence to its corresponding guide rolls **14** and **15** and then back to its respective breast roll **11**.

The extents of the forming wires **16** disposed between the breast rolls **11** and the couch rolls **12** may be conveniently referred to as the web-forming wire runs and it is between these portions of the forming wires **16, 16** which extend substantially in side-by-side relation from the breast rolls **11** to the couch rolls **12** in which the stock is dewatered and formed into a continuous sheet of paper web.

A nip **18** formed between the breast rolls **11** is referred to herein as the forming nip and it is to the forming nip that stock is supplied under pressure from a headbox indicated at reference numeral **19** through a stock outlet nozzle indicated generally at reference numeral **20**. The stock is pumped to the headbox **19** by means of a suitable stock pump indicated at **21**.

After the sheet of paper web has left the web-forming wire run indicated generally at reference numeral **22**, it may be removed from the machine **10** by virtue of another looped felt **23** trained around a transfer roll **24** and drive and guide rolls **26** and **27** as will be understood by those skilled in the art.

Although twin-wire paper forming machines are often arranged such that the axes of the breast rolls, couch rolls and the like extend horizontally so that the web-forming wire run **22** extends vertically and the stock is discharged into the forming nip in a vertically downward direction. It should be understood that twin-wire forming machines may also be arranged in such a manner that the web-forming wire run extends horizontally and the stock emerges from the stock noz-

zle into the forming nip in a horizontal direction. The principles of the present invention are of equal applicability to either the vertical or horizontal twin-wire paper forming machine.

Referring to FIG. 2 the stock nozzle 20 may be more particularly characterized as comprising a pair of oppositely facing nozzle wall members 27 and 28 which extend substantially in spaced parallel relation from the headbox 19 across the entire length of the headbox and of the breast rolls 11, 11 and the width of the forming wires 16, 16. A distal end 29 of the nozzle 20 is open for directing a stream of stock into the forming nip 18. The central axis of the nozzle 20 is in alignment with the center of the forming nip 18 and the nozzle is essentially symmetrical about its central axis.

The nozzle wall members 27 and 28 each include a stationary portion 30 and a portion 31 immediately upstream of the stock outlet 29 which is pivotally mounted to the stationary portion 30 by means of a suitable pivotal connection as indicated at reference numeral 32. The interfacing inner walls 33 and 34 of the pivotal portions 31, 31 are curved slightly in the direction of the outlet 29 to form a biconvexly shaped zone within the stock nozzle 20 immediately upstream of the outlet 29 as indicated at reference numeral 36.

Although the stock outlet nozzle extends into the region between the breast rolls 11, 11 the outlet 29 thereof is spaced substantially ahead of the narrow of the nip 18, the narrow being defined as that portion of the nip 18 of least transverse dimension.

The space between the outlet 29 of the stock nozzle 20 and the nip 18 is a critical gap insofar as exposure of the stock to air is concerned. Turbulence and flow disturbances in the stock jet often have the effect of causing air pockets or craters in the surfaces of the jet adjacent the forming wires 16, 16 and the presence of such air pockets or craters in the surface of the free jet when it is enclosed in the nip between the wires may cause formation defects and air holes in the sheet of paper formed.

In order to eliminate exposure of the stock to air in the gap between the nozzle outlet 29 and the narrow of the nip 18 and hence to eliminate air pockets in the surfaces of the stock jet the present invention contemplates the utilization of streams of liquid flowing along the opposite sides of and in contiguous relation with the jet of stock as it emerges from the stock nozzle 29 and is fed into the nip 18.

To this end there is provided means indicated generally at reference numeral 37 which provides a pair of liquid jackets 38 and 39 disposed respectively on opposite sides of the stock nozzle 20 so as to encompass the nozzle. The jackets 38 and 39 may be more particularly characterized as comprising rigid imperforate jacket wall members 40 which form, in conjunction with the walls 27 and 28 of the nozzle 20, liquid chambers 41 and 42 having open ends indicated respectively at 43 and 44. Liquid is supplied into chambers 41 and 42 by means of suitable pumping mechanisms such as the low-pressure pumps indicated at reference characters LP.

Outlets 43 and 44 of the liquid chambers 41 and 42 open in the same direction as the nozzle outlet 29, that is, in the direction of the forming nip 18 and in order to channel the streams of liquid as they emerge from openings 43 and 44 and to provide a liquid seal, a pair of flexible aprons 46 and 47 are each connected in fixed assembly at one end 48 to its corresponding jacket wall member 40. The flexible aprons 46 and 47 extend in the direction of the forming nip 18 and engage the breast rolls 11 and the forming wires 16 trained therearound upstream or ahead of the forming nip 18 and follow the contour of the breast rolls 11 to distal ends 49 and 50 beyond the narrow of the forming nip 18 or to a point on the leaving side of the nip 18.

In order to prevent air from moving backwardly up along the inner surfaces of the aprons 46 and 47 it is only necessary that relatively small streams of liquid flow between the aprons and the stream of stock. To that end spacer members 51 and 52 are mounted on the outer surfaces of the pivotal wall members 31, 31 of the stock outlet 20. Each of the spacer members 51 and 52 comprises an outer wall 53 which is shaped to conform substantially to the contour of an inner wall 54 of its corresponding apron. There is a thin space or gap 56 between the surface 53 and the inner surface 54 of the apron. The width of the gap 56 as well as the area between members 33, 34 and the aprons 46, 47, may be varied as a function of the pressure of the stock in the nozzle 20 and the pressure of the liquid in the chambers 41 and 42.

The liquid utilized in providing the flowing air-free boundary layers on the sides of the stock stream may be a variety of liquids compatible with stock in the formation of paper web. For example, the liquid may be the stock itself. On the other hand, and in a more preferred sense, the liquid may be white water, although a mixture of white water and stock may also be utilized. Clear water, of course, may also be used.

As indicated in FIG. 1 a series of deflection foils shown schematically at reference numeral 57 may be utilized adjacent one or both of the forming wires 16 in the web-forming wire run 22. These press the wires toward each other providing the tapered forming gap "G" in which initial dewatering occurs. Of course as the stream clears the ends 49 and 50 of the apron, the thin layer of water will first be drained through the wires, and dewatering of the fibers will immediately follow. Additional dewatering means 57*a* are employed along the wires. Although the removal of water is necessary in the formation of the paper web, one critical point at which the provision of a vacuum is often harmful to the formation of quality sheet is at a point at which the forming wire leaves the surface of the breast roll. The loss of contact of the forming wire with the breast roll has the effect of creating a vacuum condition between the surface of the breast roll at the juncture thereof with the emerging forming wire. This also occurs if a stationary curved forming surface supports the wire. This vacuum condition, in turn, has the effect of tending to pull fibers of the web stock through the foraminous forming wire along with water from the stock, this action commonly being referred to as a drainage or pumping action.

The present invention also includes within its ambit the discovery that a pumping action can be eliminated by extending the distal ends 49 and 50 of the aprons 46 and 47 well beyond the narrow of the nip 18 on the leaving side of the nip. Thus in the critical area at which the forming wires depart from the surface of the breast rolls 11, 11 the stock between the forming wires is protected from the vacuum condition hereinabove described, and after the stock between the forming wires travels beyond the ends 49 and 50 of the aprons 46 and 47 it has reached a point at which the vacuum condition is no longer critical and a pumping action can no longer be maintained.

As a consequence of the foregoing it will be appreciated that the present invention not only finds utility in the prevention of stock exposure to air on the entering side of the nip 18 but also finds utility in reducing or entirely eliminating a pumping action on the leaving side of the nip. The present invention enables the twin-wire paper forming machine 10 to be operated at high production speeds while maintaining a high quality in the paper web produced thereby.

The flow rate of the liquid as contrasted with the flow rate of the stock is quite small since the streams of liquid forming the boundaries of the stock stream need not be very wide in a transverse direction. Furthermore, the streams of liquid preferably move at a velocity substantially lower than the velocity of the stock as it emerges from the stock nozzle outlet 29. By regulating the pressure of the stock the flow rates of the liquid streams can be regulated as a consequence of variations in the flow gaps 56 resulting in variations in stock pressure.

Although minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably come within the scope of my contribution to the art.

What I claim is:

1. In a twin-wire paper forming machine having a pair of breast rolls and a pair of couch rolls rotatably mounted, a pair of forming wires entrained around said rolls to provide a gap between said breast rolls and to provide a web-forming wire run between the breast rolls and the couch rolls and dewatering means contacting said wires between said breast rolls and said couch rolls the improvement comprising, a stock headbox including nozzle wall means forming a stock outlet nozzle having an outlet for directing stock under pressure into the gap and mans for preventing exposure of the stock to air between said outlet and said gap, said nozzle wall means including a pair of spaced wall members, each including a stationary portion and a movable portion pivotally connected to said stationary portion and extending towards the gap and forming said outlet, the moveable portion allowing for varying the size of the outlet of the nozzle, said means for preventing exposure of the stock to air comprising a liquid jacket means encompassing said nozzle wall means and extending a distance toward said gap sufficient to contact said forming wires and including a means for supplying liquid under pressure into said liquid jacket means to effect discharge of said liquid into the gap at a velocity less than the stock velocity, said stationary and moveable portion of said nozzle wall means varying the area between said liquid jacket means and said nozzle wall means as a function of the respective pressure of the stock and of the liquid in the nozzle and in the liquid jacket means.

2. In a twin-wire paper forming machine as defined in claim 1 wherein the nozzle wall means comprise a pair of spaced wall members having mutually facing inner wall surface forming a generally biconvexly shaped zone immediately upstream of the nozzle outlet.

3. In a twin-wire paper forming machine as defined in claim 1 wherein the liquid jacket means comprises a pair of spaced parallel jacket wall members disposed respectively on opposite sides of the nozzle wall means and in spaced relation thereto including flexible seal means connected to said jacket wall members for providing a liquid seal between said jacket wall members and said breast rolls.

4. In a twin-wire paper forming machine as defined in claim 3 wherein the flexible seal means comprise a pair of flexible aprons extending from the jacket wall members into sealing relation with the forming wires entrained around the breast rolls and beyond the outlet of the nozzle outlet.

5. In a twin-wire paper forming machine as defined in claim 3 wherein the flexible seal means comprise a pair of flexible aprons extending respectively from said jacket wall members into the nip between the breast rolls and into sealing engagement with said forming wires entrained around said breast rolls on the upstream side of the narrow of said gap and extending at least to the narrow of said gap whereat the space between the breast rolls is the least.

6. In a twin-wire paper forming machine as defined in claim 5 wherein the flexible aprons extend beyond the narrow of the gap in sealing engagement with their respective forming wires.

7. In a twin-wire paper forming machine as defined in claim 5 wherein spacer means are attached to the nozzle outlet between the outlet thereof and the flexible aprons said spacer means having outer surfaces generally conforming with the inner surfaces of the flexible aprons.

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