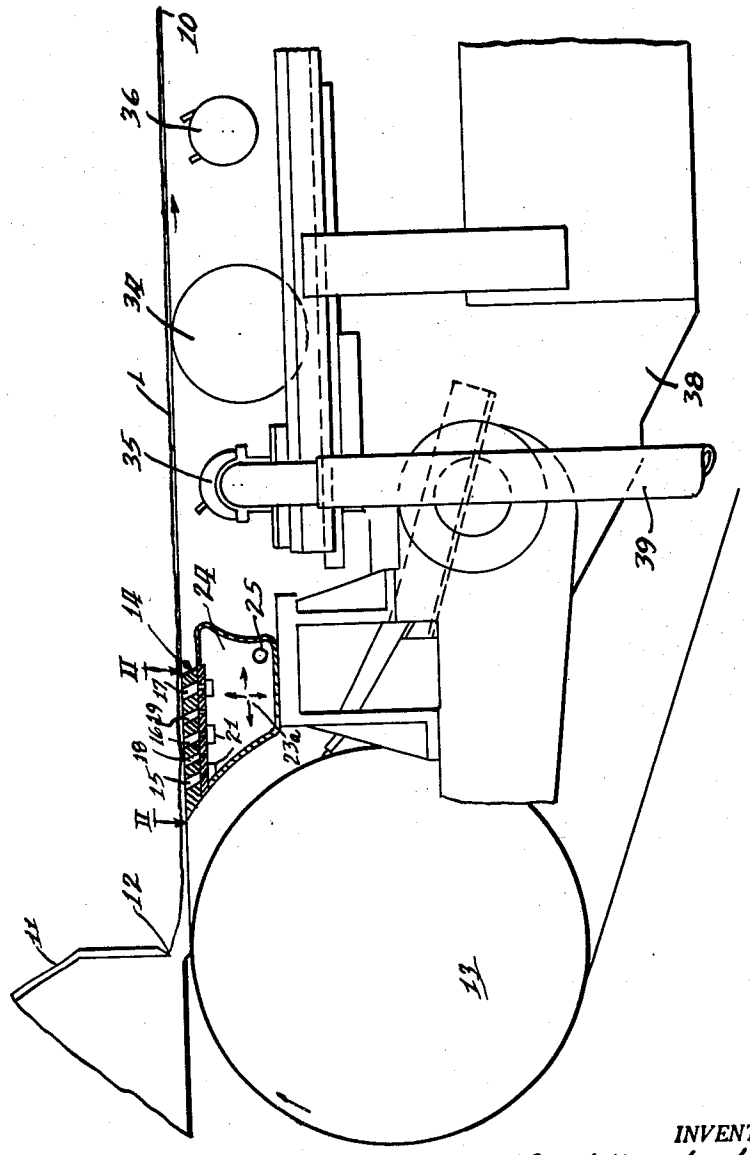
Sept. 15, 1964 L. HORNBOSTEL, JR 3,149,026

AIR ASSISTED FORMATION METHOD AND APPARATUS

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FIG. 1



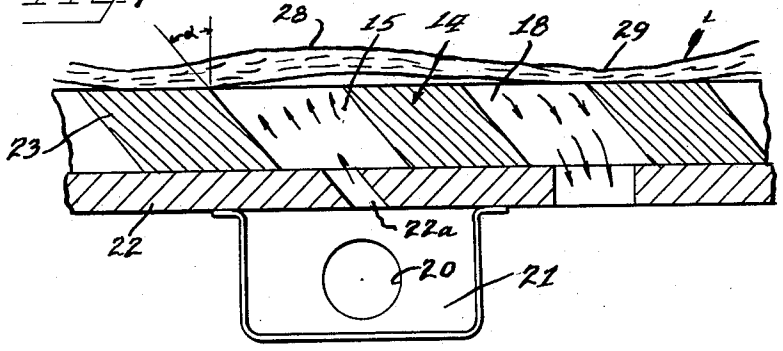
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AIR ASSISTED FORMATION METHOD AND APPARATUS

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Fig. 7



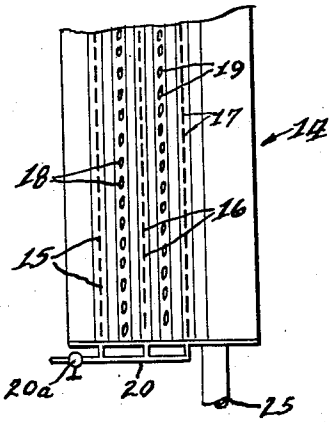


Fig. 2

Fig. 8

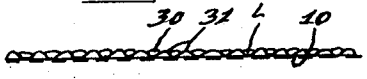


Fig. 9

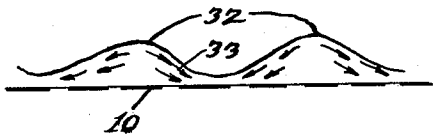
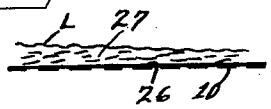


Fig. 6



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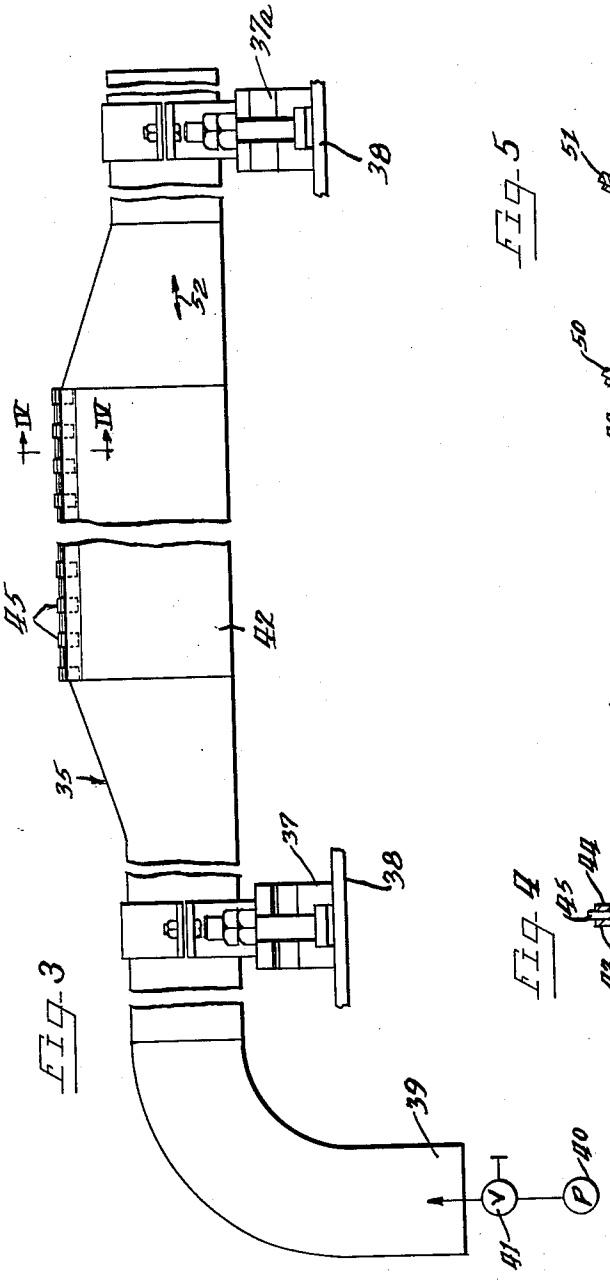


FIG. 3

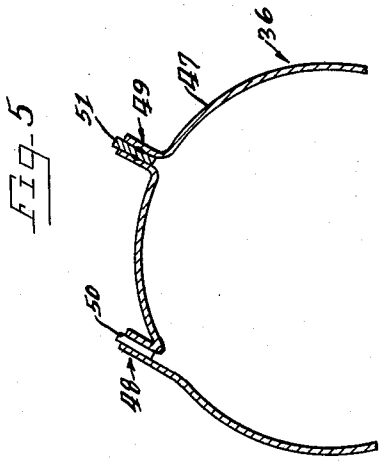


FIG. 5

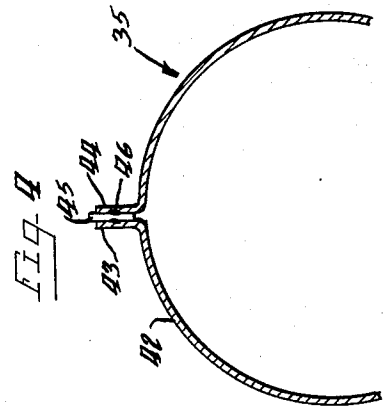


FIG. 4

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AIR ASSISTED FORMATION METHOD AND APPARATUS

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Filed Sept. 26, 1961, Ser. No. 140,744
7 Claims. (Cl. 162—208)

The present invention relates to improvements in paper machines and particularly to an improved method and mechanism for the improved removal of water and formation of a web from a layer of paper stock deposited on a travelling Fourdrinier wire.

In the formation of a paper web on a travelling foraminous surface, such as a Fourdrinier wire, a layer of paper stock is uniformly deposited on the moving surface from the head box, and the wire travels over table rolls and suction boxes for drainage of water from the layer to form the web. The stock issues from the head box beneath the slice lip and in deposition upon the moving Fourdrinier a large amount of water is flushed through the wire portion between the slice and the forming board, which is positioned directly after the breast roll. The drainage curve of the Fourdrinier represents a hyperbola with its highest value immediately after the slice lip and gradually decreasing toward the suction boxes where the curve becomes irregular due to the increased drainage at the suction boxes.

It has been discovered that due to the initial rapid flush through the stock a fine mat of fibers is formed on the wire and the fibers above the initial mat remain in suspension. This initial mat on the wire causes the drainage of water through the wire to decrease and consequently the activity of the fibers in suspension decreases. Fibers in non-active suspension tend to flocculate and thus produce a non-uniform web or sheet of paper and flocculation occurs as water drainage rate decreases.

A feature of the invention resides in the breaking up of the initial mat of fibers on the wire and the introduction in the stock of a fine scale agitation.

Methods have heretofore been used for the reduction of flocculation and the prevention of the formation of an initial mat such as by the horizontal and vertical shaking of the Fourdrinier table and the provision of air jets above the Fourdrinier table pointing down on the stock. These have not been fully satisfactory in that shaking the Fourdrinier has the disadvantage of costly construction, power consumption, and a reduction of drainage at the table rolls. Air jets or showers above the wire have not been satisfactory mainly because of their inability to penetrate the stock, and the stock has a tendency to accumulate on the showers above the wire resulting in lumps of fibers falling down on the stock with obviously undesirable results.

The present invention contemplates the provision of a plurality of air jets directed upwardly against the lower surface of the wire beneath the stock provided in the conventional type forming board, and/or provision of additional air jets along the Fourdrinier wire after the forming board. The air jets blow against the underside of the wire breaking up the above mentioned initial mat of fibers but do not penetrate or blow through the layer of stock, and they simultaneously introduce or create a hill and valley pattern in the stock on the wire which will tend to continue over the length of the Fourdrinier. Due to the up and down motion of this pattern, the pumping action of the table rolls will be increased which is of great importance in low speed machines. The invention further contemplates staggering the air jets in a cross machine direction to introduce a similar hill and valley pattern which causes the fibers to realign in a cross direction improving the fiber orientation in the sheet.

Accordingly, an object of the invention is to provide a method and apparatus which will successfully break up the initial fine mat of fibers formed next to the wire below the layer of stock deposited on a travelling forming wire, and which will result in an increase of drainage of water from the layer of stock.

A still further object of the invention is to provide a method and mechanism which will prevent the cessation of stock activity in the layer of stock on the wire and will actually provide an increase of stock activity and a decrease in the flocculation resulting in an improved paper web.

A still further object of the invention is to provide an improved method and apparatus for dewatering a paper web on a foraminous travelling surface which is particularly well suited to making heavy paper, and which obtains an increase in the ratio of the cross direction to machine direction strength ratio of the formed sheet and permits an adjustment of this ratio.

Other objects, advantages and features will become more apparent with the teaching of the principles of the invention in connection with the disclosure of the preferred embodiments thereof in the specification, claims and drawings, in which:

FIGURE 1 is a side elevational view shown in somewhat schematic form of the forming section of a paper machine constructed in accordance with the principles of the present invention;

FIGURE 2 is a fragmentary top plan view as viewed substantially along line II—II of FIGURE 1;

FIGURE 3 is an enlarged detailed elevational view of an air supply tube;

FIGURE 4 is a vertical sectional view taken substantially along line IV—IV of FIGURE 3;

FIGURE 5 is a vertical sectional view similar to FIGURE 4 and illustrating a structure providing plural rows of jets in a single tube;

FIGURE 6 is a schematic illustration of the formation of an initial mat from a layer of stock on a forming wire;

FIGURE 7 is an enlarged fragmentary detailed view of a portion of the forming board of FIGURE 1;

FIGURE 8 is a fragmentary vertical sectional view illustrating the profile of the layer of stock in a cross direction due to the staggered arrangement of jets; and

FIGURE 9 is an enlarged schematic view illustrating the resultant action on fibers in a cross direction due to the action of the air jets.

As shown on the drawings:

FIGURE 1 illustrates a portion of the Fourdrinier machine with a travelling wire **10** and a layer of stock L deposited thereon and being dewatered to form a paper web. The layer is deposited from a head box **11** having a slice **12**, and positioned above a breast roll **13** supporting the Fourdrinier wire **10**. The layer of stock flows beneath the slice **12** onto the wire **10** and across a forming board **14**. The upper surface of the forming board has a series of laterally extending rows of air emission openings or air jets **15**, **16** and **17**, FIGURES 1 and 2. Between the rows of air jets are laterally extending rows of drain openings **18** and **19**. The air jet openings are laterally staggered from the openings in previous rows as illustrated in FIGURE 2, for purposes which will later be described. Also, the drain openings may be positioned substantially directly after a preceding air jet opening.

Air is supplied to the jet openings through a supply line **20** which may be connected to a suitable air pressure supply such as is normally available in a mill having paper making machinery, and an air pressure control valve **20***a* is connected in the line to regulate the force of the air emitting from the jets. The air flows into mani-

fold headers **21**, FIGURE 7, beneath the jets, communicating with the openings such as **15** through openings **22***a* in a plate **22** below the top plate **23** of the forming board **14**. The top surface of the forming board **14** is smooth for supporting the wire, and the forming board is adjustable in vertical and horizontal directions on its support as indicated by the arrowed lines **23***a* of FIGURE 1.

Water drains out through the drain openings such as **18** in FIGURE 7, and through openings in the plate **22** down into a water drain box section **24** and out through a drain line **25**. Suction is applied to the drain line **25** to create a partial vacuum within the box section **24** and a pressure differential across the layer of stock L at the drain openings **18** and **19**.

In operation, with respect to initial drainage, as the stock issues from beneath the slice **12** and is deposited upon the Fourdrinier wire **10** a large amount of water is flushed through the wire portion between the slice and the forming board and this tends to form an initial fine mat of paper fibers on the wire as illustrated at **26** in FIGURE 6. The fibers at **27** in the layer L remain in suspension but the formation of the initial mat **26** causes the drainage of the water through the wires to decrease and consequently the activity of the fibers in suspension at **27** decreases. As the fibers lose their activity they tend to flocculate which is undesirable and forms a non-uniform paper sheet. When the layer L reaches the first row of air jets **15** on the forming board **14**, the jets raise the layer L above the wire **10** to break up the initial mat **26** of fibers and to also introduce in the stock fine scale agitation. The raised portion **28**, FIGURE 7, again lowers against the wire at **29** above the drain opening **18**. This formation of a slight hill or ripple in the layer L is repeated as the layer passes over the air jets **16** and then reaches the drain openings **19**, and then passes to the air jets **17**, FIGURE 2.

The air jets are shown as preferably directed in an angle toward the oncoming wire **10** with the angle being shown at α, and this angle is preferably 30° with respect to a line drawn vertical to the wire, or in other words at a 60° angle to the wire.

FIGURE 8 illustrates the effect on the layer of stock L due to the staggered arrangement of the air jets. The raised portions of the layer L are shown raised in FIGURE 8 for illustration, and the raised portions **30**, for example are being caused by the air jets **15** while the raised portions **31** are ahead of it, being caused by the air jets **16** and staggered with respect thereto. This insures breaking of the initial mat at the base of the layer uniformly across the layer and improves the activity of the fibers and their eventual orientation in the finished paper sheet.

FIGURE 9 illustrates the action of the raised portions of the layer of stocks with the figure being exaggerated in size to illustrate the fiber action, and being taken as looking at the layer in section taken across the machine. The rises **32** in the layer of stock introduce a hill and valley pattern so that fibers originally aligned in the direction of travel of the web or machine direction (MD) will be forced to realign and will flow in the direction of the arrows **33** in the cross machine direction (CD). The fibers in effect run downhill and the lateral spacing of the air jets, and the staggering of the air jets, gives more of a cross machine fiber orientation to the finished sheet. This results in an increase in the *CD/MD* strength ratio of the formed sheet. Further, adjustment of this ratio can be obtained by varying the air pressure to the air jets.

The hill and valley pattern in the layer of stock on the wire will continue over the length of the Fourdrinier, and due to the up and down motion will increase the pumping action of the table rolls. This is of great importance on low speed machines since the pumping action of the table rolls is proportional to the square of the machine speed.

Following the forming board, beneath the wire **10**, are a series of table rolls, as illustrated by the roll **34**. The table rolls are followed by suction boxes, and the structure of these, as well as the remaining structure of the wire and its support need not be shown since they will be apparent to those versed in the art.

Similar results for enhancing the formation of the web and improving draining can be obtained by providing air jet tubes **35** and **36** to provide air showers beneath the wire **10** as illustrated in FIGURES 1 and 3. The air shower tubes will extend longitudinally across the wire and will be supported at their ends in mounts **37** and **37***a* on the frame **38** of the machine. Air is supplied through an air supply line **39** from a pressure source **40** through a pressure control valve **41**. By change of air pressure the height of rises in stock above the web can be controlled to a desired amount and increase in height will increase the cross flow of fibers.

Individual jets for the air showers are formed by spreading the tube **35**, FIGURE 4, with the material **42** of the tube turned outwardly in flanges **43** and **44**, and axially separated spacers **45** placed between the flanges and held therein by spot welds **46**. The open areas between the spacers **45**, as defined by the flanges **43** and **44**, form air jets.

In FIGURE 5 the material of the tube **47** is opened at two locations to form rows **48** and **49** of jets. The jets are laterally staggered by placing spacers **50** and **51** in staggered arrangements, and attaching the spacers in the same manner of the structure of FIGURE 4.

It will be understood that the air shower tubes **35** and **36** may be used in addition to the forming board arrangement illustrated and described in FIGURES 1 and 2, or the boards may be used independently. Air showers may be placed between table rolls over the entire length of the Fourdrinier if desired, or at a ny part thereof. FIGURE 1 is selected to show both an air jet forming board and a tube with a single row of jets and a tube with plural rows but the arrangement and sequence is shown merely to illustrate the various forms of air jet means.

The air shower tube **35**, FIGURE 3, may be connected to a simple shake mechanism, shown schematically by the arrowed line **52**, FIGURE 3, which gives the tube an axial shaking movement for varying the effect on the web and improving the cross direction orientation of fibers in the finished sheet.

In brief summary of operation, paper stock flows in a layer L from a head box onto the wire **10**, and on the forming board **14** rows of air jets **15**, **16** and **17** with alternate suction drainage openings **18** and **19** form hills and valleys in the layer of stock breaking up the initial mat **26**, FIGURE 6, of fibers which is formed, causing a fine scale agitation of the fibers and improving drainage. This action continues in the surface of the web along the Fourdrinier and may be enhanced by the provision of air shower tubes **35** and **36** between the table rolls **34**.

Thus it will be seen that I have provided an improved paper forming machine which meets the objectives, advantages and features above set forth. The method and operation of the mechanism avoid disadvantages of attempts of prior art devices to accomplish the result, and a mechanism is provided which achieves an improved paper product.

The drawings and specification present a detailed disclosure of the preferred embodiments of the invention, and it is to be understood that the invention is not limited to the specific forms disclosed, but covers all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by the invention.

I claim as my invention:

1. In a Fourdrinier paper machine, a travelling Fourdrinier forming wire, means for depositing a layer of paper stock on the top surface of the wire, a first plurality of air jets extending laterally across beneath the wire and

directed upwardly, and a second plurality of air jets longitudinally spaced from said first plurality of air jets extending laterally across beneath the wire after said first jets and staggered laterally with respect to the first jets to inhibit the flocculation of the paper stock on the wire without penetrating the layer of stock.

2. The method of improving web formation from paper stock deposited on a foraminous moving surface subjected to a pressure differential thereacross for removing water downwardly through the surface, which comprises directing discrete streams of air beneath said forming surface across the width of the forming surface tending to raise the layer of stock at the locations of the streams without penetrating the layer of stock.

3. The method of improving web formation from a deposited layer of paper stock on a travelling Fourdrinier wire comprising directing discrete jets of air at longitudinally spaced laterally staggered locations across the wire upwardly through the wire raising the stock at said locations without penetrating the stock effecting changes in the horizontal plane of the layer of stock for shifting of fibers for improved orientation and inhibiting flocculation of fibers of the stock.

4. A mechanism for forming a paper web from stock deposited on a moving foraminous surface with a water draining pressure differential thereacross comprising a plurality of discrete air jets beneath the foraminous surface spaced laterally across the surface, means for supplying air to the jets, and means for adjustably controlling the pressure of the air to adjust the height of rises in the stock at the jets and the cross orientation of paper fibers without penetrating the stock.

5. In a paper machine, a moving foraminous paper forming surface, means for depositing a layer of paper stock on said surface, and means for directing separate small discrete streams of air onto the undersurface of the moving forming surface tending to raise the layer of stock and improving web formation without penetrating the layer of stock, said streams separated laterally across

the forming surface and longitudinally to form separate hills and valleys separated in a lateral and in a longitudinal direction.

6. A machine for forming a paper web comprising a moving foraminous paper forming surface, means for depositing a layer of paper stock on said surface, and means for directing individual small discrete streams of air upwardly on the undersurface of said layer of stock without penetratiang the layer of stock across the width of the forming surface at an angle against the movement of the forming surface.

7. The method of forming a paper web from stock deposited on a moving foraminous web forming surface which comprises alternately raising the layer of stock before the stock has been dewatered to an extent to fix the relative position of the fibers and the fibers are still in suspension at predetermined separate locations across the width of the forming surface above said surface and lowering the stock to the surface to cause a shifting of fiber deposition on the surface, and applying a pressure differential across the surface for drawing water downwardly from the layer of stock, such raising of the layer of stock being effected by directing discrete streams of air beneath said forming surface across the width of the forming surface tending to raise the layer of stock at the locations of such discrete streams without penetrating the layer of stock.

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