April 15, 1969 J. A. MEANS 3,438,854

DUAL WIRE PAPER FORMING APPARATUS AND SUCTION BOX THEREFOR

Filed Oct. 29, 1964 Sheet 1 of 7

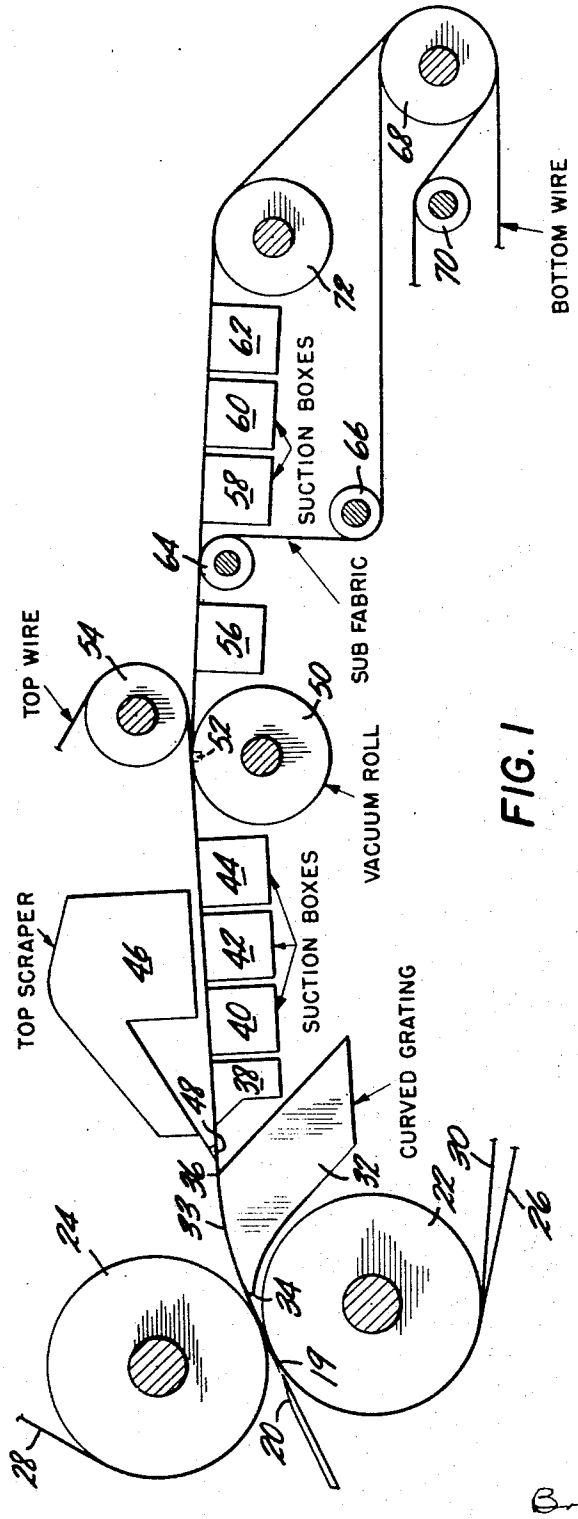

FIG. 1

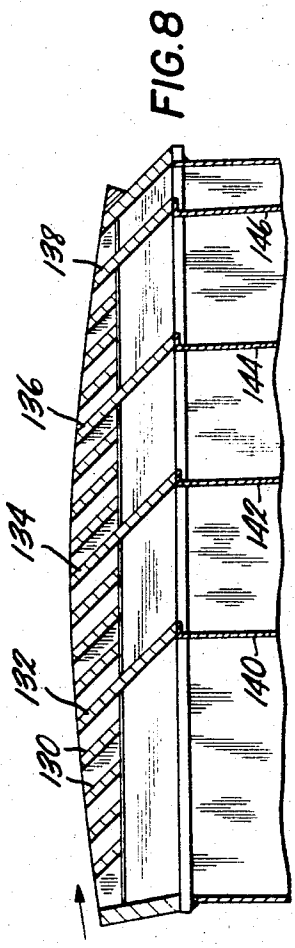

FIG. 8

INVENTOR.
JOHN A. MEANS

BY
Brumbaugh, Free, Graves & Donohue
his ATTORNEYS.

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DUAL WIRE PAPER FORMING APPARATUS AND SUCTION BOX THEREFOR

Filed Oct. 29, 1964 Sheet 2 of 7

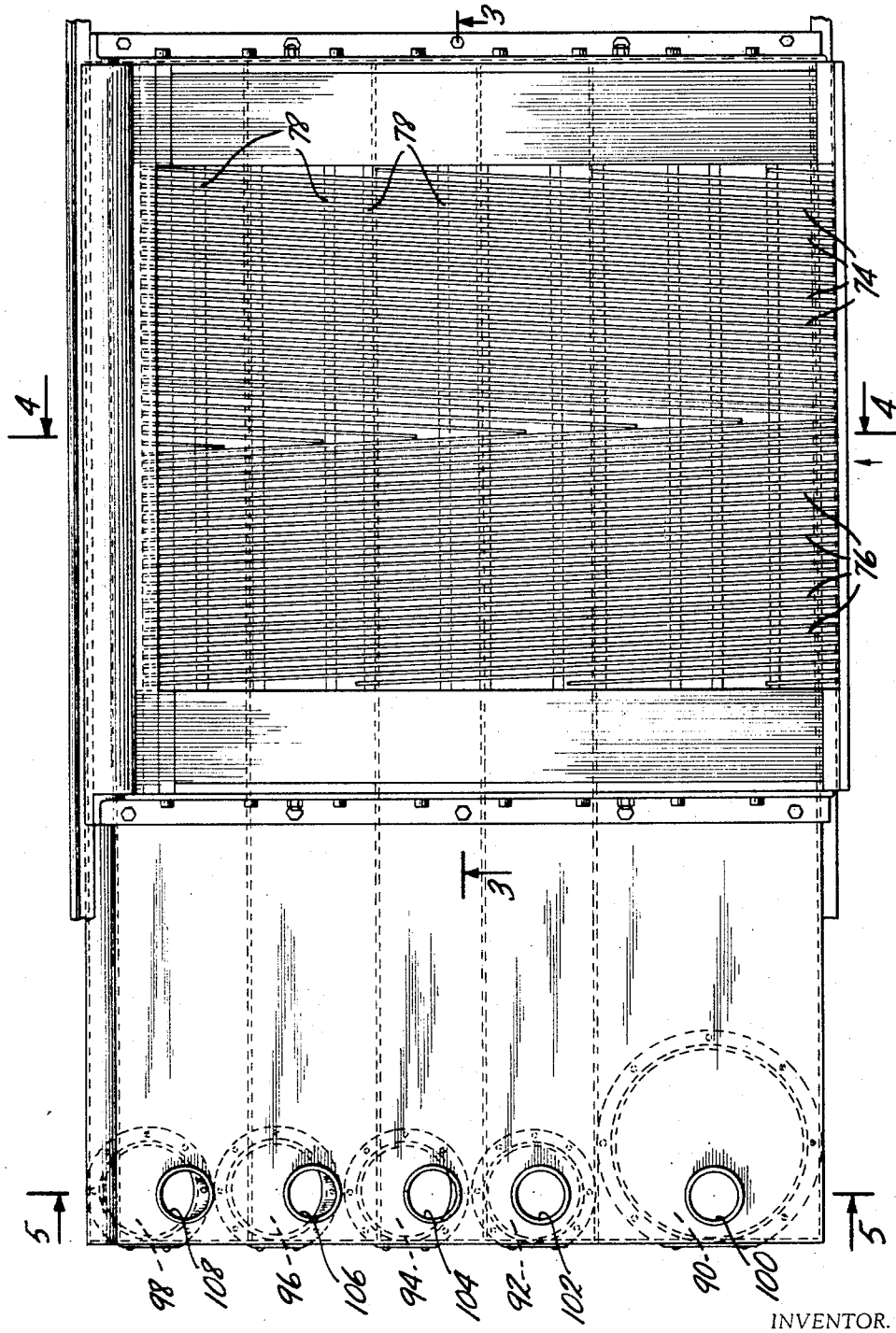

FIG.2

INVENTOR.
JOHN A. MEANS

BY
Brumbaugh, Free, Graves & Donohue
his ATTORNEYS.

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DUAL WIRE PAPER FORMING APPARATUS AND SUCTION BOX THEREFOR

Filed Oct. 29, 1964 Sheet 3 of 7

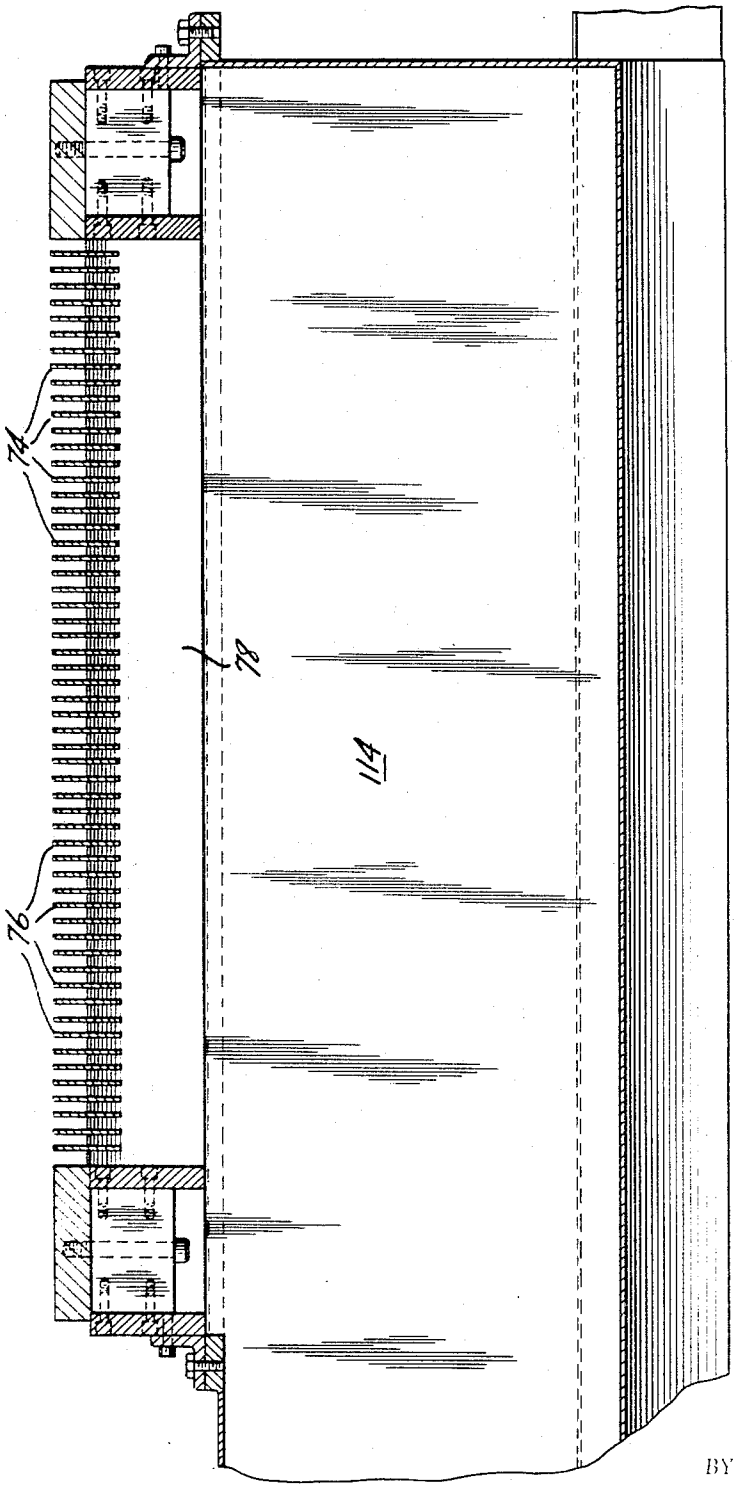

FIG.3

INVENTOR.
JOHN A. MEANS

BY
Brumbaugh, Free, Graves & Donohue
his ATTORNEYS.

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DUAL WIRE PAPER FORMING APPARATUS AND SUCTION BOX THEREFOR

Filed Oct. 29, 1964 Sheet 4 of 7

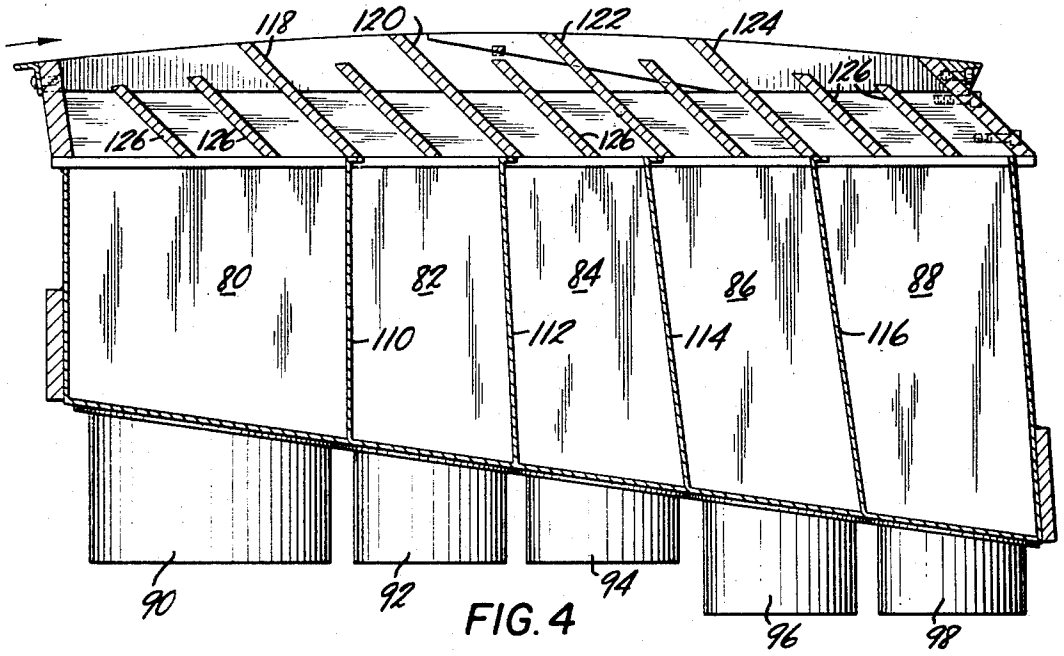

FIG. 4

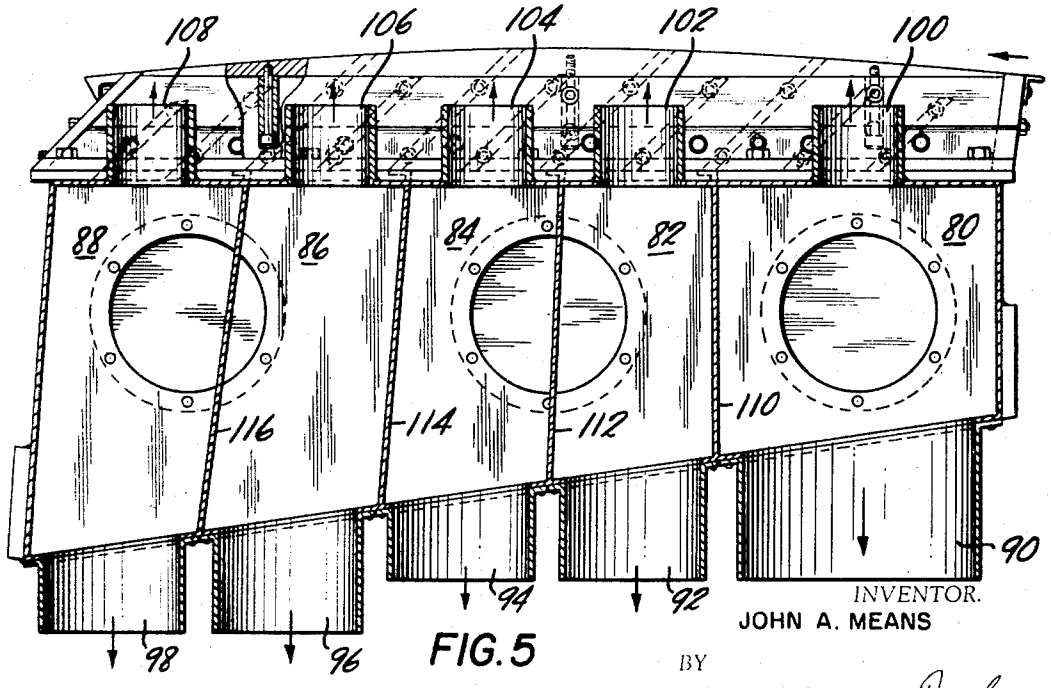

FIG. 5

INVENTOR.
JOHN A. MEANS
BY
Brumbaugh, Free, Graves & Donohue
his ATTORNEYS.

DUAL WIRE PAPER FORMING APPARATUS AND SUCTION BOX THEREFOR

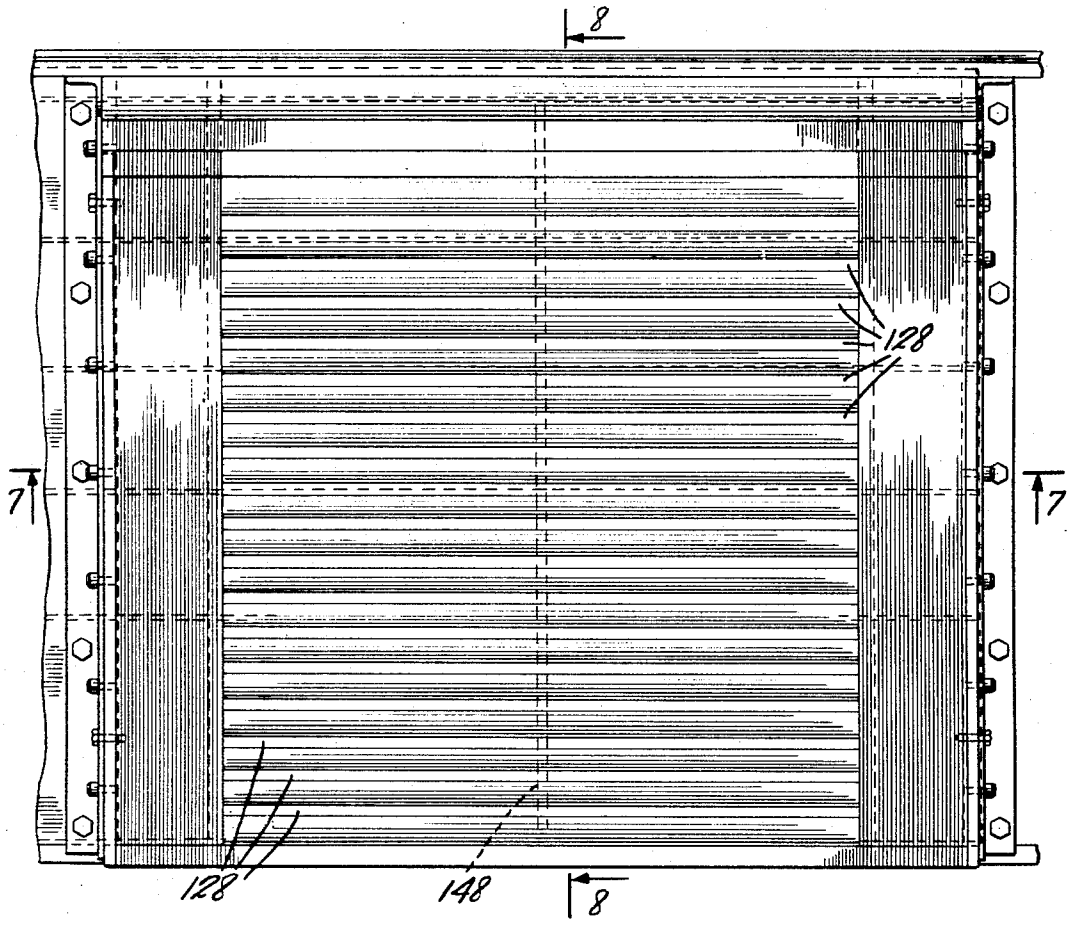

FIG. 6

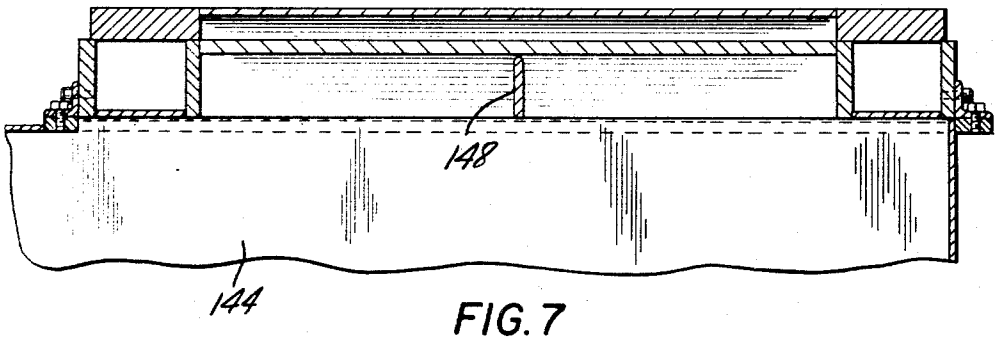

FIG. 7

INVENTOR.
JOHN A. MEANS
BY
Brumbaugh, Free, Graves & Donohue
his ATTORNEYS.

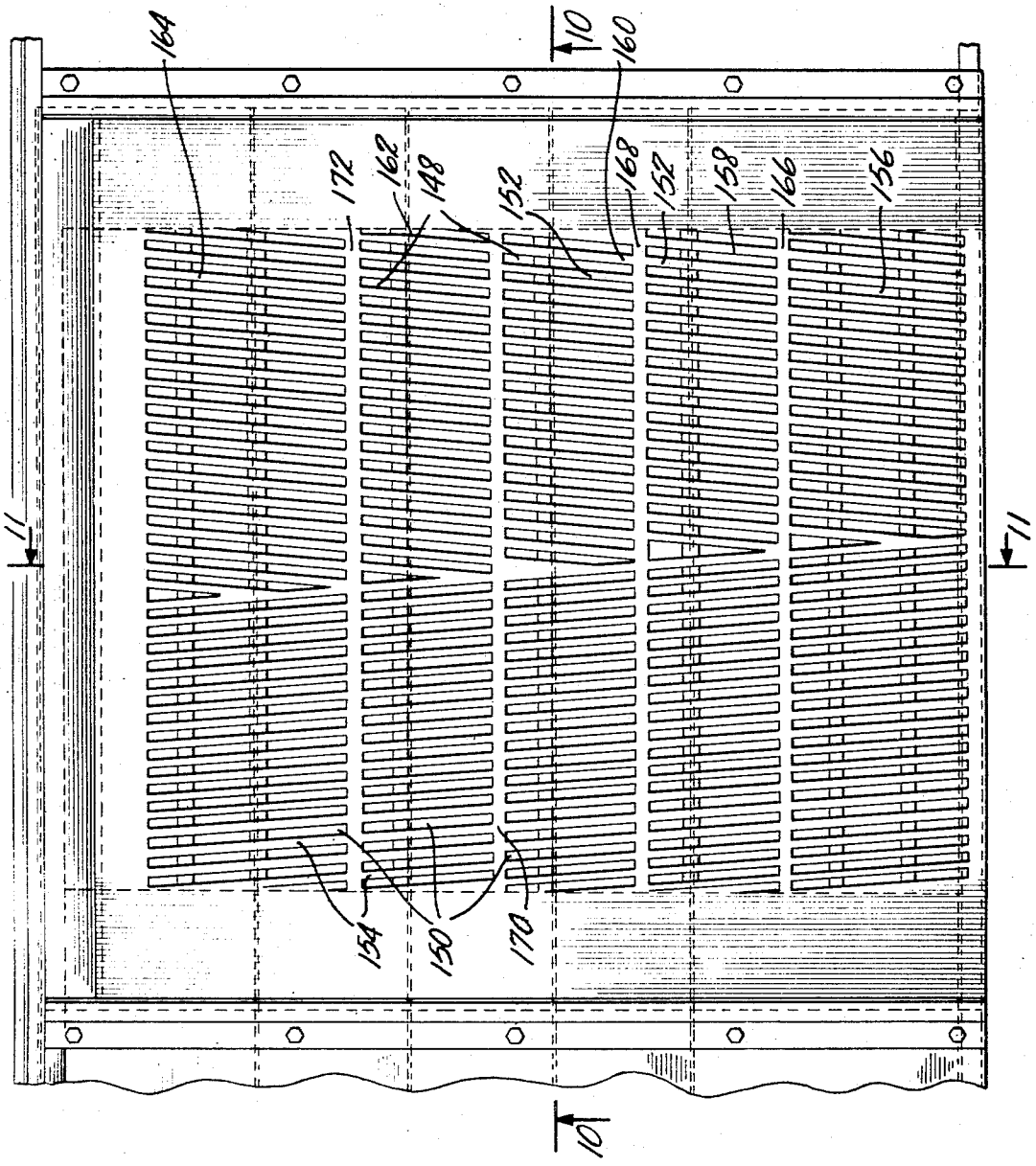

FIG. 9

INVENTOR.
JOHN A. MEANS
BY
Brumbaugh, Free, Graves & Donohue
his ATTORNEYS.

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DUAL WIRE PAPER FORMING APPARATUS AND SUCTION BOX THEREFOR

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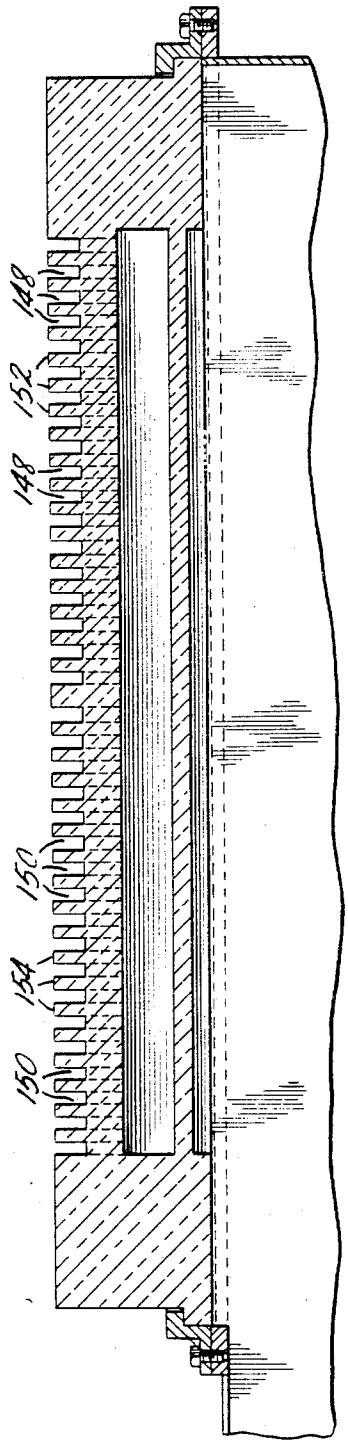

FIG. 10

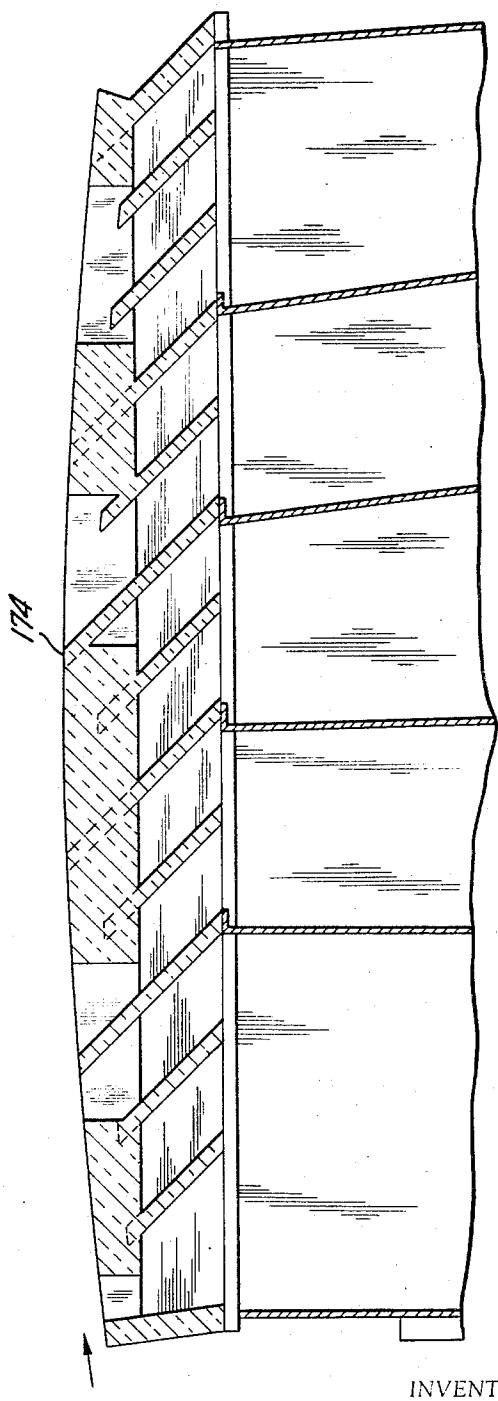

FIG. 11

INVENTOR.
JOHN A. MEANS

BY
Burnbaugh, Free, Graves & Donohue

his ATTORNEYS.

United States Patent Office 3,438,854 Patented Apr. 15, 1969

3,438,854

DUAL WIRE PAPER FORMING APPARATUS AND SUCTION BOX THEREFOR

John A. Means, South Norwalk, Conn., assignor to Time, Incorporated, New York, N.Y., a corporation of New York

Filed Oct. 29, 1964, Ser. No. 407,307
Int. Cl. D21g 9/00; D21f 9/02
U.S. Cl. 162—303 2 Claims

ABSTRACT OF THE DISCLOSURE

A twin-wire paper-making machine is provided with a forming box having a permeable, stationary, curved forming surface. The box is formed with a plurality of blade means which, while themselves straight in a preferred embodiment, assist in the definition of the curved surface. The orientation of the box and, adjacent thereto, the forming wires, is such that the force of gravity tends in the absence of countervailing forces to effect removal of water through one of the wires more than through the other. One web-contacting wire of the machine is wrapped about a break roll downstream of the curved forming box through an arc of about 6° to facilitate separation of a paper web formed on the machine from the other of the web-contacting wires.

This invention relates to paper-making methods and apparatus and, in particular, to novel and highly-effective methods and apparatus permitting the rapid and economical production of high-quality paper (the term "paper" is used herein not merely in a specific sense but also in a generic sense to include paperboard and similar products).

The recently-developed "twin-wire" paper-making machine—i.e., a machine in which the paper web is formed between two forming wires—is generally superior to the earlier-developed machines in which the paper web is formed on one forming wire rather than between two. Conventional twin-wire paper-making machines have certain drawbacks, however.

A representative problem encountered with such machines is that they provide insufficient control over the rate of convergence of the twin wires with respect to each other and fail to mount the wires with sufficient resilience to pass lumps in the stock, snags in the wires, etc. As a result, the formed paper has numerous imperfections and the wires are subject to frequent breakage.

Another problem encountered with twin-wire paper-making machines is that the web tends to separate into two layers where the twin wires are separated from each other by a turning roll about which one of the wires is directed.

Still another problem, which is encountered not only with twin-wire machines but also with the earlier-developed machines referred to above, is that the suction box tops employed therein are expensive and ill-suited to the removal of water from the paper stock.

An object of the present invention is to remedy the problems outlined above.

More particularly, an object of the invention is to provide a novel forming box specifically adapted for use in twin-wire machines.

Another object of the invention is to provide inexpensive suction box tops adapted to facilitate removal of water from an inchoate paper web highly effectively.

Another object of the invention is to facilitate the use of a twin-wire machine without the attendant danger of web separation at the point where the twin wires are separated from each other.

For the attainment of these and other objects of the invention, a paper-making machine wherein first and second paper-forming foraminous elements such as conventional Fourdrinier wires move in substantially parallel paths at substantially the same velocity in contact with and on opposite sides of an inchoate paper web through at least a part of a forming zone and then separate from each other is provided with means adjacent to the first foraminous element at the locus of separation of the first and second foraminous elements and on the side of the first foraminous element opposite the web for directing the web to follow one of the foraminous elements, the second foraminous element being free of restraining means at the locus of separation of the first and second foraminous elements, whereby the paper web separates from the other of the foraminous elements integrally and without being crushed.

A forming box having a stationary, open, and specially-curved moving-foraminous-element-contacting surface is also provided. The forming box is herein called a "curved" forming box, because of the curvature of its moving-foraminous-element-contacting surface. Partition means in the curved forming box divides the box into a plurality of compartments, and vacuum means associated with each compartment establishes an individually-adjustable vacuum therein.

In certain respects, the invention is an improvement of the invention disclosed in a co-pending application of David E. Robinson for "Paper-Forming Apparatus and Methods," Ser. No. 311,278, filed Sept. 16, 1963, now Pat. No. 3,232,825.

For an understanding of further aspects of the invention, reference is made to the following detailed description of several representative embodiments thereof, in conjunction with the accompanying figures in the drawings, in which:

FIG. 1 is a side elevational schematic view of apparatus constructed in accordance with the invention;

FIG. 2 is a top plan view of one embodiment of a curved forming box constructed in accordance with the invention;

FIG. 3 is a view taken substantially along the line 3—3 of FIG. 2 and looking in the direction of the arrows;

FIG. 4 is a view taken substantially along the line 4—4 of FIG. 2 and looking in the direction of the arrows;

FIG. 5 is a view taken substantially along the line 5—5 of FIG. 2 and looking in the direction of the arrows;

FIG. 6 is a plan view of another embodiment of a curved forming box constructed in accordance with the invention;

FIG. 7 is a view taken substantially along the line 7—7 of FIG. 6 and looking in the direction of the arrows;

FIG. 8 is a view taken substantially along the line 8—8 of FIG. 6 and looking in the direction of the arrows;

FIG. 9 is a plan view of another embodiment of a curved forming box constructed in accordance with the invention;

FIG. 10 is a view taken substantially on the line 10—10 of FIG. 9 and looking in the direction of the arrows; and

FIG. 11 is a view taken substantially along the line 11—11 of FIG. 9 and looking in the direction of the arrows.

FIG. 1 shows a wide flat stream of paper stock 19 ejected at high speed from a slice 20, the "wide" dimension of the stream extending into the plane of the figure. The stock 19 is directed between lower and upper breast rolls 22, 24 rotatably mounted in spaced-apart relation with respect to each other. The rolls 22, 24 may be solid or open but are preferably solid for greater rigidity. Similarly, the spacing with respect to each other of the points of their respective circumferences closest to each other may be varied but is preferably greater than the

thickness in the plane of FIG. 1 of the jet of stock **19** to avoid pumping of the stock. A lower movable paper-forming foraminous element **26** such as a conventional bronze Fourdrinier wire is trained about the lower breast roll **22**, and an upper movable paper-forming foraminous element **28** such as a conventional bronze Fourdrinier wire is trained about the upper breast roll **24**. A movable foraminous drainage element **30**, which may be made of a tough plastic such as nylon, is preferably also trained about the lower breast roll **22**, between it and the lower forming wire **26**.

A stationary forming box **32** constructed in accordance with the invention and referred to herein as a "curved" forming box is mounted beneath the foraminous drainage element **30** in closely-spaced-apart relation to the lower breast roll **22**. The elements **26**, **28**, **30** are trained about the open, curved surface **33** of the forming box **32** in such a way that the forming box **32** assists in the establishment of a convergence between the movable paper-forming foraminous element **26** and the movable foraminous drainage element **30** on the one hand and the paper-forming foraminous element **28** on the other. As noted above, the surface **33** of the forming box **32** adapted to contact the movable foraminous drainage element **30** (or, if the element **30** is not employed, the movable paper-forming foraminous element **26**) is curved. In a cross section taken in the plane of FIG. 1, the curve described by the surface **33** may be part of a circle, parabola, hyperbola, or sine wave, or it may be a French curve or some other curve. In a typical case, the curve is part of a circle, which means that the surface **33** itself describes part of a cylinder. The surface **33** preferably curves through an arc of about 20°, as disclosed in the co-pending Robinson application Ser. No. 311,278 referred to above.

The curvature of the movable-foraminous-element-contacting surface **33** facilitates the subjection of the inchoate web therebetween to a progressively increasing pressure as the web traverses the surface. The curvature of the surface **33** is related, moreover, to the rate of convergence of the paper-forming foraminous elements **26**, **28** and to the tension to which the upper element **28** must be subjected in order to perform its intended function. In general, the smaller the radius of curvature of an arc of a given number of degrees (or, for curves other than cylindrical ones, the "sharper" the curvature), the more abrupt the convergence of the paper-forming foraminous elements **26**, **28** and the less the tension to which the upper element **28** must be subjected in order to maintain the desired relation between it and the element **26** and, more particularly, in order to maintain the desired pressure (force per unit area) on the inchoate web.

Thus, a radius of curvature that is quite large or a curve that is not sufficiently "sharp" is not optimum; it requires great tension on the element **28** in order to prevent unacceptable bulging thereof from the element **26**. Such tension tends to wrinkle and even rupture the element **28** and, in any event, to shorten its life. Similarly, a radius of curvature that is quite small or a curve that is quite sharp is also not optimum; it results in a rate of convergence of the elements **26**, **28** that exceeds that facilitating production of the highest-quality paper.

In accordance with a preferred embodiment of the invention, the surface **33** is curved cylindrically through an arc of 20°, as noted above, and about a five-foot radius. That is, the surface **33** is a portion of an imaginery cylinder having a diameter of ten feet. It has been found that the resulting curvature is an optimum one for the production of paper at speeds within the range of about 1500 to 2500 feet per minute, both from the standpoint of facilitating the proper rate of convergence between the paper-forming foraminous elements **26** and **28** and from the standpoint of prolonging the life of the element **28**.

In accordance with the present invention, moreover, the curved forming box **32** is tilted counterclockwise with respect to the orientation disclosed in the aforesaid Robinson application through an angle of approximately 3°, so that, at the upstream end **34** of the curved forming box **32**, the inclination of the curved surface **33** and hence of the paper-forming foraminous element **26** and foraminous drainage element **30** is approximately 23° above the horizontal in the direction of web movement. Similarly, at the downstream end **36** of the curved surface **33**, the inclination of the surface **33** and hence of the elements **26**, **28**, and **30** is approximately 3° above the horizontal in the direction of web movement. The reason for this orientation of the curved forming box **32** is that, in a maner set forth below, it facilitates the provision of a "humped" construction of the portion of the forming zone downstream of the curved forming box **32** and hence the separation of the element **28** from the paper web and the elements **26** and **30** without crushing of the web or separation of the web into a plurality of layers.

Suction boxes **38**, **40**, **42**, and **44** and a top scraper **46**, all of which may be conventional per se, are provided for dewatering the inchoate web at opposite sides thereof. In accordance with the present invention, however, the suction boxes **38**, **40**, **42**, and **44** are spaced apart from each other and arranged with their tops sloping in the direction of web movement at an angle of approximately 3° above the horizontal. Similarly, the paper-forming-foraminous-element-contacting surface of the scraper blade **48** for the top scraper **46** slopes upwardly in the direction of web movement at an angle of about 3°.

Downstream of the suction box **44**, training means such as a vacuum break roll **50** rotatable about its axis and having a suction box **52** is provided in accordance with the invention. The suction box **52** of the vacuum roll **50** is urged against the element **30** (or, if the element **30** is not employed, against the paper-forming forminous element **26**) so that the elements **26**, **28**, **30** move in substantially a straight line from the downstream end **36** of the curved forming box **32** to the suction box **52** upwardly in the direction of web movement at an angle of about 3°. The element **28** continues to move substantially in the same straight line to a tail roll **54**, about which it is trained, and loops back to the upper breast roll **24**. The roll **54** is mounted above and somewhat downstream of the roll **50**.

Downstream of the roll **50**, additional suction boxes **56**, **58**, **60**, **62** are provided. The suction boxes **56**, **58**, **60**, **62** may be conventional per se, but they are spaced apart from each other and their upper surfaces are inclined downwardly 3° in the direction of web movement so that, in its run from the roll **50** to a roll **72** downstream thereof, the element **26** lies in a plane inclined about 3° downwardly in the direction of web movement. Thus, the angle formed by the portions of the elements **26**, **28**, **30** immediately upstream of the roll **50** and the portions of the elements **26**, **30** immediately downstream of the roll **50** is about 6°, and the web executes a turn of about 6° as it passes the roll **50**.

At the locus of contact of the vacuum roll **50** with the wire **30**, therefore, the element **28** is separated from the elements **26**, **30**. The suction box **52** applies suction to the web and assures that the web continues to travel with the elements **26**, **30** rather than with the element **28**. It is to be noted that the element **28** is free of restraining means (such as a roll) opposite the suction box **52** where the elements **26**, **30** and the web on the one hand separate from the element **28** on the other.

This arrangement permits separation of the elements **26**, **30** and the web on the one hand from the element **28** on the other without separation of the web and without crushing the web.

If the roll **50** does not form a "hump" in the forming zone—if, in other words, the elements **26**, **28**, **30** extend in a straight line from the downstream end **36** of the curved forming box **32** to the point where the element **28** separates from the web and the elements **26**, **30**, and the elements **26**, **30** extend in a continuation of the same

straight line downstream of the locus of separation of the element **28** from the elements **26, 30** and the web—the roll **54** is in virtual contact with one face of the web. That face of the web, being wet, tends to follow the surface of the roll **54**, even if the surface is "open." This causes separation of the web, which at this point in its formation is not very cohesive.

Similarly, if the rolls **50** and **54** are mounted in opposed nip-defining relation, so that the vacuum box **52** in the roll **50** is positioned to maintain the web on the element **26**, the arrangement is unsatisfactory; in such case, the nip formed by the rolls **50** and **54** tends to crush the web, which at this point in its manufacture is not sufficiently set to withstand strong pressures.

Nor is it satisfactory to mount the roll **54** opposite the roll **50** but spaced apart therefrom, for in such case the element **28** downstream of the curved forming box **32** is not flush against the web but diverges therefrom in the direction of web motion. This is particularly true because, as noted above, a certain amount of tension must be maintained on the element **28** in order to maintain the desired relation between it and the element **26** in the vicinity of the curved forming surface **33** of the forming box **32**. The separation of the paper-forming foraminous element **28** from the web downstream of the downstream end **36** of the curved forming box **32** results in a sacrifice of many of the advantages of twin-wire formation.

Thus, of the above-disclosed possible alternative structures, only the arrangement in accordance with the present invention provides satisfactorily for the separation of the paper-forming foraminous elements of a twinwire machine without crushing or separating the inchoate web.

Between the suction boxes **56** and **58**, the element **30** is trained over a roll **64** rotatable about its axis and having its upper circumference tangent to the plane of travel of the elements **26** and **30** in the forming zone downstream of the roll **50**. The element **30** is then trained around a roll **66**, a roll **68**, and a roll **70**, each of the three rolls being rotatable about its respective axis. The element **26** is passed over the section boxes **58, 60, 62** with the web and trained about a rotatable roll **72** and then about the same roll **68** as the element **30**. The element **26** bypasses the roll **70**, however, and returns via appropriate tension rolls (not shown) to the roll **22**, where it rejoins the element **30**.

FIGS. 2–5 show in detail one form of curved forming box constructed in accordance with the invention.

FIG. 2 shows a first plurality of blades **74** disposed on the right half of the box as seen in the figure, and a second plurality of blades **76** disposed on the left half of the box. The blades **74** and **76** may be about 1/16 of an inch or less thick in a "transverse" direction parallel to the plane of stock flow and substantially transverse of the "longitudinal" direction or direction of stock flow. The latter direction is indicated by the arrow at the bottom of the figure.

The blades **74** are disposed in uniformly-spaced-apart (by, say, ¼ of an inch) planes parallel to one another and normal to the portions of the elements **26, 28, 30** transversing the curved forming box **32**. Similarly, the blades **76** are disposed in uniformly-spaced-apart planes parallel to one another and normal to the portions of the elements **26, 28, 30** transversing the curved forming box **32**. Further, in order to prevent shadow marking of the web, the blades **74** should be angled to give to one part of the water passing therebetween a first component of motion normal to the direction of movement of the web, and the blades **76** should be angled to give to another part of the water passing therebetween a second component of motion opposite to the first component of motion.

To this end, the blades **74** on the one hand and **76** on the other are given oposite inclinations with respect to the "machine direction" or direction of travel of the inchoate paper web over the curved forming box. This construction is effective to divert the water expressed from the web and between the blades **74** on the one hand and **76** on the other in opposite direction so as not to produce a net reaction on the wire. The wire thus is not urged towards either side of the machine but runs true. The inclination of the blades also produces a slight scraping effect which facilitates the removal of water.

Transverse support members **78** (FIG. 3) are provided for the purpose of bracing the blades **74** and **76** and permitting them to withstand the considerable stress to which they are subjected when a vacuum is applied within the curved forming box.

As FIG. 4 shows, the curved forming box is preferably divided into a plurality of suction-box compartments **80, 82, 84, 86, 88** disposed in a row extending longitudinally of the direction of the web movement—i.e., the direction indicated by the arrow at the top of the figure. The number of suction box compartments should be at least three and is preferably five. Each suction box is provided with a separate white-water drain **90, 92, 94, 96, 98**, as shown in FIGS. 2, 4, and 5. (It is to be noted that FIGS. 4 and 5 are views from opposite directions, so that the direction of web movement is from left to right in one figure and from right to left in the other.) The drains **90, 92, 94, 96, 98** are either sized in accordance with the amount of water to be removed thereby or provided with valves to control their water-draining capacity. In this way, a water seal is maintained across the cross section of each drain. The drains are displaced laterally from the forming area of the curved forming box, as shown in FIG. 2.

Each suction box **80, 82, 84, 86, 88** is provided also with a separate air suction line **100, 102, 104, 106, 108**. The suction lines may be connected to a common manifold (not shown) and may be provided with individually-adjustable valve means (not shown) whereby individually-adjustable vacuums in the suction boxes **80, 82, 84, 86, 88** may be provided. The vacuum in the suction boxes **80, 82, 84, 86, 88** increases progressively in the direction of web movement, the box **80** having the lowest vacuum (greatest absolute pressure) and the box **88** having the highest vacuum (least absolute pressure). The suction box **88** may have a vacuum ranging up to about 12 inches of water.

The suction boxes **80, 82, 84, 86, 88** are separated from each other by partitions, a first partition **110** separating the first two boxes **80, 82**, a second partition **112** separation the second and third boxes **82, 84**, a third partition **114** separating the third and fourth boxes **84, 86** and a fourth partition **116** separating the fourth and fifth boxes **86, 88**.

Each partition **110, 112, 114, 116** is connected to one of a plurality of sloping partition blades **118, 120, 122, 124**. Each blade **118, 120, 122, 124** extends from one side of the forming box to the other transversely of the direction of web movement and from the upper edge of the corresponding partition **110, 112, 114, 116** to the locus of contact of the element **30** with the curved forming box. In this way, the divisions of the suction boxes **80, 82, 84, 86, 88** of the curved forming box are maintained all the way to the element **30** shown in FIG. 1 so that individually-adjustable vacuums can be maintained in the boxes **80, 82, 84, 86**, and **88** by the vacuum-producing means.

The intermediate sloping supports **126** need not run all the way to the locus of the element **30** and preferably terminate short thereof. The partition blades **118, 120, 122, 124** and the intermediate sloping supports **126** are inclined at about 45° to the horizontal, diverging downwardly from the web in the direction of web movement, to facilitate removal of water.

FIGS. 6–8 show another embodiment of a curved forming box constructed in accordance with the invention. In this embodiment, the box has a number of "transverse"

blades **130, 132**, etc., described below, but is devoid of "longitudinal" foraminous-element-contacting blades—i.e., devoid of blades which extend in the direction of web movement and which are adapted to contact the element **30**. As a result, the elements **26, 28, 30** and the web tend to follow paths composed of a large number of straight segments, each segment being limited by the supporting surfaces **128** of the adjacent blades **130**, etc., and being very small. The change in direction of adjacent segments is slight—approximately 1°, for example, where the blades are approximately 20 in number and the total arc of the curved surface of the forming box is about 20°.

An advantage of this construction is that the element **30** can be eliminated and a bronze wire run directly on the curved forming box without undue wear of the bronze wire, because there is no lattice. A further advantage of the construction is that the forming box is readily and economically manufactured. In particular, although the advantages of the curved forming box are realized, it is not necessary to machine a curve.

The sloping partition blades **132, 134, 136, 138** are continuations of the partition members **140, 142, 144, 146** and facilitate the division of the box into a plurality of compartments, in this case five, each of which may be provided with a different degree of vacuum as disclosed above. Short sloping blades **130** extend from the locus of the element **30** downwardly to a point somewhat less than half way to the plane of the upper edges of the partitions **140, 142, 144, 146**. A longitudinally-extending web **148** may be provided for the purpose of supporting the sloping blades **130, 132, 134, 136**, and **138**.

FIGS. 9–11 show another embodiment of curved forming box constructed in accordance with the invention. FIG. 9 shows two groups of perforations **148** and **150**. The perforations **148** to the right of the machine center line are canted to the right in the direction of web movement, while the perforations **150** to the left of the machine center line are canted to the left. The perforations **148** and **150** are about ¼ of an inch wide. Between the perforations, lands **152** and **154**, respectively, also about ¼ of an inch wide, are provided. The perforations are, moreover, arranged in a plurality of rows **156, 158, 160, 162**, and **164** separated by lands **166, 168, 170**, and **172**. The groups of perforations **148, 150** are thus subdivided into a number of smaller groups. Each land **166, 168, 170**, and **172** is about ¼ of an inch wide in the direction of web movement. Preferably, the suction-box top is molded, and the lands are covered with silicon carbide, which is polished to a mirror-like finish. The suction-box top is thus long-wearing and easy to manufacture. Moreover, its low friction increases wire life.

Thus, there is provided in accordance with the invention novel and highly-effective papermaking methods and apparatus enhancing the worth of the twin-wire machine and eliminating its chief drawbacks. In particular, it will be observed that, in the entire length of the forming zone (FIG. 1), there is no point where restraining means such as rolls, scrapers, and suction boxes are mounted in opposed relation against the movable foraminous elements on opposite sides of the web. Thus, lumps in the stock, snags in the movable foraminous elements, etc., can pass without disrupting the web, breaking the foraminous elements, or otherwise doing serious harm. Machine down time and hence the cost of paper manufacture are substantially reduced by the methods and apparatus of the invention.

Many modifications of the specific embodiments disclosed herein will readily occur to those skilled in the art. For example, while the schematic view of FIG. 1 shows a machine that is substantially "horizontal," the forming zone immediately before and after the roll **50** sloping upwardly at an angle of about 3° and downwardly at an angle of about 3°, respectively, the present invention of means for separating the elements **26** and **28** without separating or crushing the web is also operative in machines having other orientations. Further, while the suction box **52** in the roll **50** has been disclosed as exerting a suction on the web to retain it on the element **26**, it may also apply air pressure to the web to direct it to follow the element **28**. This may be done on a machine which is patterned, for example, after the machine of FIG. 1 imaged through a plane mirror lying in a horizontal plane above or below the machine of FIG. 1 and which is further modified as compared to the machine of FIG. 1 in having the roll **54** mounted considerably downstream of its position in FIG. 1, in having the elements **26, 30** trained about the roll **50** and then directly back to the roll **22**, and in having the suction boxes **38, 40, 42, 44** and **56, 58, 60, 62** mounted adjacent to the element **28** rather than **30**. Accordingly, the invention is to be construed as including all of the modifications thereof which fall within the scope of the appended claims.

I claim:

1. A paper-making wet-end machine comprising the combination of first and second foraminous elements movable in substantially parallel paths at substantially the same velocity in contact with and on opposite sides of an inchoate paper web through at least a part of a forming zone and training means adjacent to said first foraminous element for training said first foraminous element through an arc of about 6° and separating said first foraminous element from said second foraminous element, said first foraminous element approaching said training means at an angle 3° above the horizontal and departing from said training means at an angle 3° below the horizontal and said second foraminous element being free of restraining means at the locus of separation of said first and second foraminous elements, whereby said paper web is separable from one of said foraminous elements integrally and without being crushed.

2. In a forming box for mounting on a paper-making machine to facilitate the making of paper, said box having a surface operatively associated with a foraminous paper-forming element moving in a given direction, the improvement comprising the combination of

(a) a plurality of blade means having edges extending transversely of said direction of movement and assisting in the definition of said surface, said surface being
  (i) permeable,
  (ii) stationary, and
  (iii) curved in said direction of movement;
(b) partition means dividing said box into a plurality of compartments; and
(c) individually-adjustable vacuum means for establishing individually-adjustable vacuums in said compartments.

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S. LEON BASHORE, *Primary Examiner.*

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