March 15, 1960 P. E. WRIST 2,928,465

DRAINAGE ELEMENT FOR PAPER MACHINES

Filed April 27, 1959 3 Sheets-Sheet 1

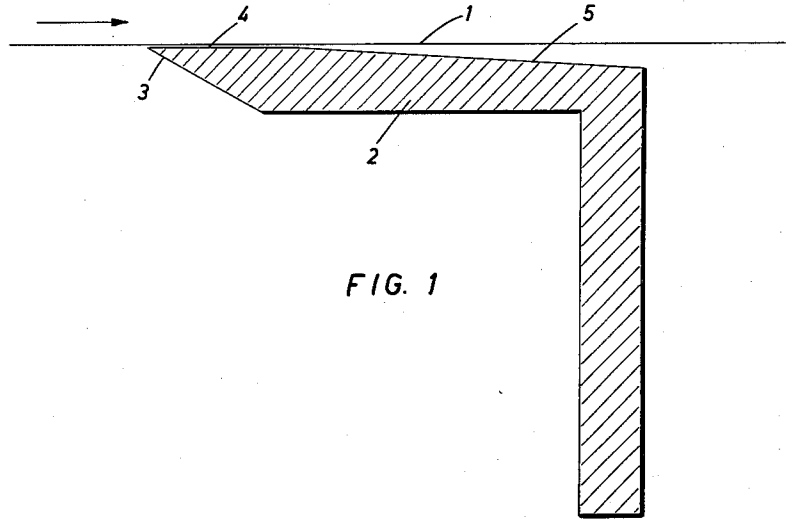

FIG. 1

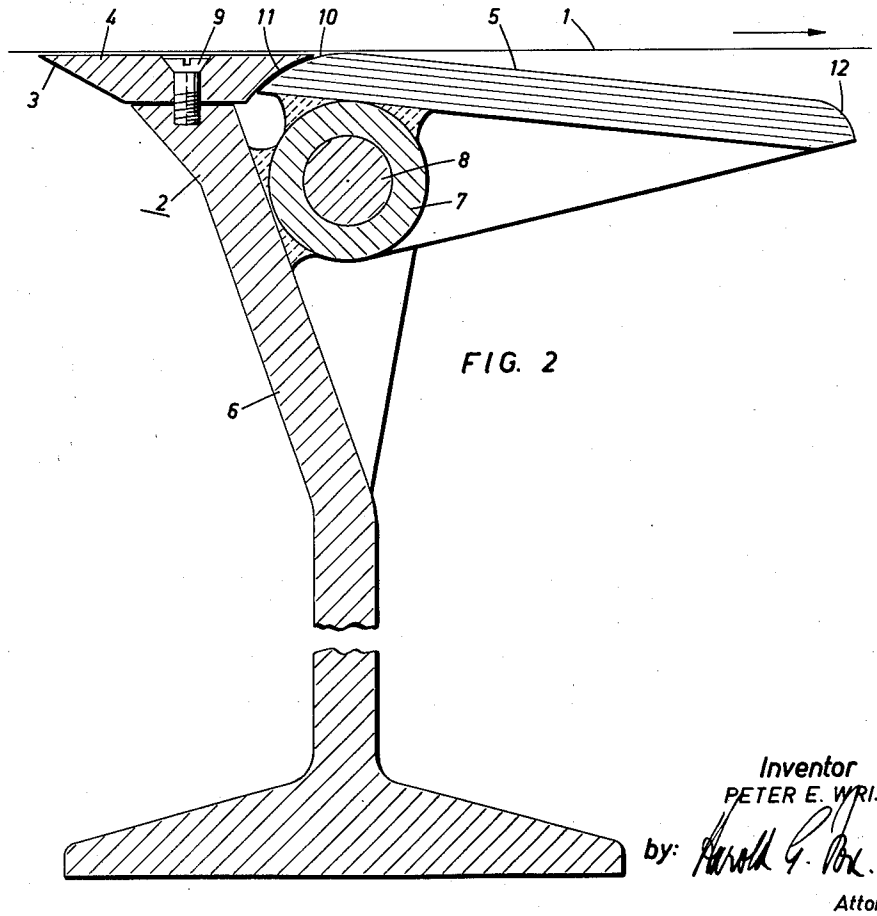

FIG. 2

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DRAINAGE ELEMENT FOR PAPER MACHINES

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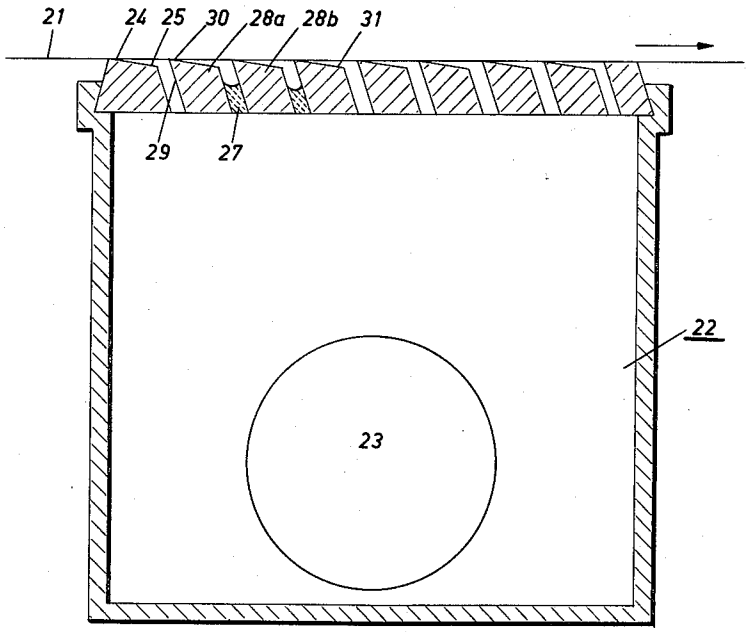

FIG. 3

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DRAINAGE ELEMENT FOR PAPER MACHINES

Filed April 27, 1959 3 Sheets-Sheet 3

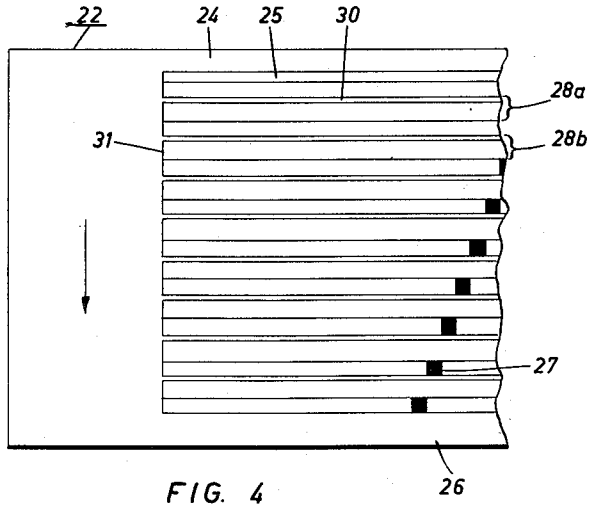

FIG. 4

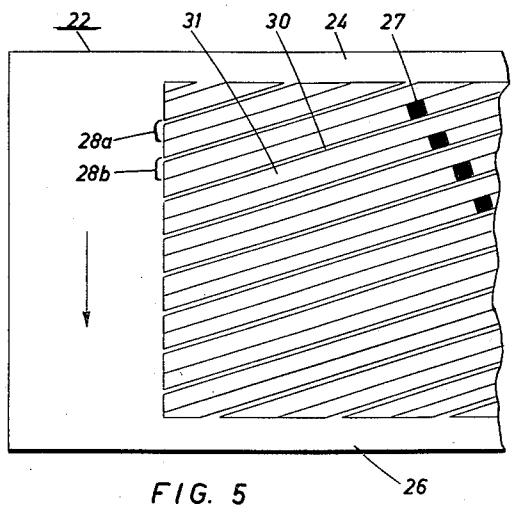

FIG. 5

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2,928,465

DRAINAGE ELEMENT FOR PAPER MACHINES

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Application April 27, 1959, Serial No. 809,180

13 Claims. (Cl. 162—352)

This invention relates to apparatus and methods for improving and regulating the drainage of water from the wire part of Fourdrinier paper machines and for effecting the same with less disturbing effect upon the forming web on the wire of the paper machine than is caused by conventional drainage means.

A further embodiment of my invention relates to an improved form of suction box for use in improving and regulating the drainage of water from Fourdrinier machines.

In a Fourdrinier machine a suspension of fibres or "stock" is discharged through an orifice or "slice" on to a moving endless wire screen or "wire." The greater part of the water associated with the stock as discharged from the slice is drained away through the wire, leaving most of the fibres on the wire in the form of a continuous felted fibre mat. Such drainage occurs principally in the vicinity of certain wire-supporting means as hereinafter described.

In the making of paper on a Fourdrinier paper machine several problems are current. One of these is the problem of obtaining the necessary drainage of the water from the stock without excessive removal of the fine fibres or "fines" as they are known in the art. A second problem is that of "kick-up," namely, the formation, in the course of travel of the stock on the wire over the Fourdrinier table of upward splashings or columns of stock projecting above the mass of the stock on the wire. Kick-up becomes manifest and increasingly severe as the speed of the paper machine increases and is materially affected by the suction exerted as a result of drainage at or near certain wire-supporting means as presently employed. Such kick-up occurs in the region immediately following the contact of a table roll with the wire and more particularly at those table rolls immediately following the breast roll. To those skilled in the art, it is well understood that kick-up is deleterious to the formation of the web because it disrupts the uniformity of distribution of the stock over the wire, thereby producing a sheet of poor quality. In addition, the agitation of the forming fibre mat reduces the retention of fines.

On a Fourdrinier machine of the old and slower type, the stock is delivered from the slice onto the wire at the location of the breast roll, whence the wire bearing the stock passes over the table rolls, suction boxes and couch roll, at which point the stock, now in the form of a web or sheet, is transferred into the press section. The drainage capacity of a given table roll increases with the speed of the wire travel and is also directly proportional to the roll diameter. On high speed machines, therefore, the drainage of water occurs so suddenly that disturbance or kick-up is caused to a degree which is harmful to the formation of the web. Since the breast roll is of relatively large diameter, the rate of drainage at the breast roll becomes very high as the machine speed increases. This results in objectionable kick-up at the breast roll at lower speeds than those at which kick-up becomes objectionable at the table rolls. For this reason at high

machine speeds the stock is delivered from the slice over and beyond the breast roll onto the wire supported by a forming board rather than onto the wire in the region of the breast roll. Drainage occurs as the wire progresses toward the couch roll and this drainage is assisted by the suction action exerted by the table rolls and by the suction boxes.

Kick-up at high speeds is particularly prevalent in the region of the table rolls. Two factors especially contribute to the formation of kick-up in this region: first, the suction effect exerted by the table rolls and, secondly, the action of water carried into the in-going nip of a table roll, either from having been carried on the underside of the wire, or having been thrown onto the table roll by a preceding roll. Various attempts have been made to solve this problem. Baffle plates of varying designs and sizes have been employed between the table rolls to deflect the draining water from entering the nip of the succeeding roll. These baffles have sometimes taken the form of scrapers coming into contact with the underside of the Fourdrinier wire. Scrapers serve the triple function of removing water from the underside of the wire, of providing the necessary deflection of this water and of supporting the wire between the table rolls. These various methods have been moderately satisfactory, but by no means solve the problem, nor do they permit ready control of the water drainage.

The object of my invention is to provide a stationary drainage element in substitution for the revolving table rolls whereby kick-up may be diminished or substantially eliminated without objectionable impairment of the drainage capacity.

A further object of my invention is to provide such an element which is adjustable in order to allow the drainage capacity to be varied to suit the varying stock and machine conditions.

A further object of my invention is the provision of an improved form of suction box incorporating my drainage element.

My invention consists broadly in the provision of a stationary drainage element adapted to support the wire and extending across the machine transversely of the direction of machine travel; said element having an acute angled leading or scraping edge, a flat portion in contact with the wire, and a trailing portion diverging from the wire and so dimensioned and proportioned as to effect drainage from the web while substantially reducing or eliminating kick-up. A further embodiment of the invention contemplates adjustability of the angle of divergence of the trailing portion with the wire whereby the amount of drainage may be varied and controlled in accordance with stock and machine conditions.

My invention may be understood by reference to the accompanying drawings in which Fig. 1 is a schematic cross-section of a drainage element constructed so as to embody features of this invention and Fig. 2 is a cross-section of a drainage element constructed according to a second embodiment of my invention. Fig. 3 is a vertical cross-section taken through a suction box constructed so as to embody features of the further embodiment of my invention; Fig. 4 is a plan view partly broken away of a suction box cover embodying features of the invention in which the drainage elements run transversely and at right angles to the direction of wire travel; and Fig. 5 is a further plan view similar to Fig. 4 in which the drainage elements run transversely to the direction of wire travel at an angle other than a right angle.

Referring to Fig. 1, 1 is a Fourdrinier wire of a paper machine which is travelling from left to right as viewed in the drawing. A drainage element which is indicated generally at 2 extends transversely across the width of the wire and may be supported in any suitable manner.

The leading edge 3 acts as a scaper to remove water clinging to the underside of the wire. For this reason the leading edge should be formed at an acute angle. It has been found in general practice that an angle of approximately 30° will effect the scraping in a satisfactory manner. Where a scraping device is used ahead of the drainage element the acute angle of the leading edge may be dispensed with. The drainage element is adapted to support the wire and to effect drainage therefrom. To these ends the upper surface of the drainage element comprises a flat portion 4 in contact with the wire and a trailing portion 5 which diverges from the wire. The length of the flat portion 4 is not critical. It should, however, be of sufficient length to provide the necessary support for the wire and to effect the sealing function which will be described in detail hereinafter.

The length of the trailing portion 5 and the magnitude of the angle of divergence between the wire and the said trailing portion are both critical. For a given length of trailing portion, a given machine speed, and a given stock condition, the volume of drainage is substantially proportional to the magnitude of the angle up to a maximum critical angle of approximately 5° beyond which drainage ceases. Although theoretically the lower limit to the angle of the trailing portion is zero, wear of the surface contour makes it difficult to maintain angles less than approximately 1°. In addition, since angles less than 1° produce very small drainage capacities for the element, it is advisable to maintain the angle in the range of approximately 1° to approximately 5°. For a given stock, increasing the length of the trailing portion increases the drainage up to a point where the drainage resistance of the stock becomes controlling and thereafter very little further drainage occurs with further increase of length of the trailing portion. The maximum length of trailing portion for a given angle decreases according to the position of the element along the direction of machine travel. This length decreases as the distance from the slice increases. In practice it has been found that the length of training portions should be maintained less than approximately 6 inches. For a given stock and a given length of trailing portion, drainage also increases as machine speed increases. The practical limitations of the speed-drainage relation are determined by the point at which the suction developed in the drainage zone is sufficient to cause cavitation and by the extent of kick-up as hereafter discussed. It will, of course, be recognized that the drainage capacity of my invention is influenced by the characteristics of the stock being drained. The operation is one of filtration and the properties of any particular stock which influence its filterability will similarly influence the application of my invention.

The trailing portion acts to create a zone of suction under the wire. This suction causes drainage of water through the wire from the stock on top. If a sealing means is not provided at the leading edge of element 2, this suction will also draw air into the nip over the leading edge, thereby causing a loss of drainage capacity. In my invention sealing is provided by two means: first, the scraping or leading edge 3 causes water carried on the underside of the wire to flow down over the scraping edge, thus preventing air being drawn into the nip; secondly, the provision of the flat portion 4 in contact with the wire assists in providing a seal against the entry of air. A ½ inch flat portion will generally be found to be satisfactory except that, where the rate of drainage is high, the sealing action provided by the flow of water down over the scraping edge will be adequate so that the flat portion may be reduced or dispensed with.

The above remarks describe generally the drainage characteristics obtained by the use of my invention. At high speeds modifications in the use of my invention are required to minimize kick-up. In general, the probability of kick-up increases as a function of the length of the trailing portion 5, the angle of divergence between the trailing portion and the wire and the machine speed. Kick-up is also influenced by the condition of the stock above the wire when this passes over the leading edge of the drainage element. Kick-up tends to be cumulative and any pre-existing disturbance will become further accentuated under conditions conducive to kick-up. It is recognized that extensive kick-up occurs in current operating practice over and following certain drainage elements in common use on high speed Fourdrinier paper machines. On any given machine, therefore, some degree of kick-up can be tolerated and, in practice, is tolerated. Diminution of kick-up is, however, desirable and the precise details of my invention will be determined by the factors hereinbefore discussed having regard to the extent of kick-up which is operationally acceptable.

By way of example and to indicate dimensions and other conditions which I have found to give a satisfactory result for a newsprint machine running with a headbox stock consistency of 0.6%, a stationary element having a trailing portion four inches long may be used with an angle of divergence between the wire and the surface of the trailing portion up to 2½° (measured when the wire is stationary), at speeds of approximately 1,500 feet per minute with negligible kick-up. With the same stock and machine speeds of the order of 2,500 feet per minute, the maximum angle which may be used without significant kick-up occurring is approximately 1¾° similarly measured. A stationary element having a trailing portion 1½ inches long and an angle of divergence of 3° may be used at machine speeds up to 2,000 feet per minute with similar stock without producing significant kick-up.

It will be appreciated that the embodiment of my invention described thus far must be specifically designed to suit the operating conditions on a given paper machine. The angle of divergence of the trailing portion 5 from the wire must be predetermined, as already pointed out, to suit given stock consistency and given machine operating speed. Once a drainage element as illustrated in Fig. 1 has been designed and installed under particular operating conditions, the rate of drainage effected by such unit is not subject to adjustment. The embodiment of my invention illustrated in Fig. 2 possesses the added advantage of permitting adjustability of the angle of divergence of the trailing portion from the wire. It will be appreciated that such an element having an adjustable angle may be adapted to varying stock conditions and machine speeds encountered in any given installation and that the rate of drainage of the elements may be varied through a corresponding adjustment of this angle. Referring now to Fig. 2, 1 is the Fourdrinier wire which as shown is travelling from left to right. The drainage element which forms this invention is indicated generally at 2 in which the flat portion 4 provides the necessary support for the wire and assists in the sealing effect hereinbefore described. The flat portion 4 is provided with an acute angled leading edge 3, which acts as a scraper removing water adhering to the underside of the wire. The trailing portion 5 is attached to the supporting beam 6 by means of a hinged connection 7 and a hinge pin 8, which is fixedly secured to the support 6. The flat portion 4 is also fixedly secured to the supporting beam 6 by means of screws 9. The flat portion 4 may be attached to the beam 6 in the manner described, or may be integrally formed therewith. The trailing portion 5 at its forward edge 10 is curved in the form of an arc, of which the centre is the centre of the hinge pin 8 and is adapted to articulate with a similar contour 11 on the rearward end of the flat portion 4. It is desirable to make the surfaces 10 and 11 smooth, so that they may provide mutual sliding contact, thus preventing the ingress of air between the surfaces 10 and 11. If air were permitted to enter the space between these two surfaces, it would reduce the efficiency of drainage. The rear-

ward end 12 of the trailing portion 5 is preferably rounded. This assists in drawing the water drained by the trailing portion 5 downward away from the wire, thus assisting in its subsequent removal by a following scraper.

Referring to the further embodiment of my invention, it has been recognized in the past that it is desirable to keep to a minimum the bearing area of a suction box upon the underside of the Fourdrinier wire. A limiting factor in this regard has been the necessity of providing adequate structural strength in the suction box top. In addition, the rate of drainage from a suction box is a function of the vacuum applied. In order to obtain an increased drainage rate, it has in the past been necessary to apply a higher vacuum and this higher vacuum increases the rate at which the underside of the wire is worn away by the stationary top of the suction box.

The further embodiment of my invention consists broadly in the provision of a suction box having a plurality of drainage elements extending transversely across the Fourdrinier wire; at least one, and preferably more or all of the said drainage elements being dimensioned and arranged so that the passage of the wire over the drainage element surfaces produces a suction effect which supplements the drainage caused by the vacuum applied to the suction box. The invention may be better understood from a consideration of the following detailed description taken in conjunction with Figs. 3 to 5 of the attached drawings. In Figs. 3 to 5 of the drawings, 21 represents a Fourdrinier wire which is travelling from left to right. The suction box is indicated generally as at 22 and is connected by way of an outlet 23 to a source of vacuum. The forward portion of the top of the box comprises a flat portion 24 adapted to support the wire 21, together with a trailing portion 25 which acts in manner as hereinbefore described. The rearward portion of the top of the box comprises a flat portion 26. Between these two extremities of the suction box are interspaced a plurality of drainage elements 28*a*, 28*b*, etc. These drainage elements extend transversely to the direction of wire travel and across the machine. Each drainage element consists of a leading edge 29 which acts as a scraper to remove water adhering to the underside of the wire, a flat portion 30 which serves to support the wire and to effect a seal in a manner as hereinbefore described, and a trailing portion 31 diverging from the wire. The leading edge 29 may be inclined to the vertical making an acute angle with the direction of wire travel. The length of the flat portion 30 is not critical. It should, however, be of sufficient length to provide the necessary support for the wire and to provide the sealing effect. In order to provide lateral rigidity to the suction box top bridges 27 may be located at appropriate intervals between adjacent drainage elements. These should preferably be recessed below the level of the wire. The length of the trailing portion 31 and the angle of divergence between the trailing portion and the wire are critical and must be carefully chosen. For angles of up to 5° (measured when the wire is stationary), the supplementary drainage provided by this diverging portion is substantially proportional to the magnitude of the angle and to the length of this trailing portion 31. Depending upon the amount of supplementary drainage required, the angle will vary from 0 to about 5°. Above 5° the supplementary effect of the trailing portion of the drainage element on the drainage is lost. The useful length of trailing portion is dependent upon the consistency of the stock on the wire above the suction box. As the consistency increases, the useful length of the trailing portion decreases. For the first box in a conventional Fourdrinier machine, where the consistency is of the general order of 2%, a length of ⅜ to ½ of an inch is the maximum useful length.

It will be appreciated that the entry of air into the zone between the trailing portion 31 and the underside of the wire 21 will reduce the supplementary drainage effect.

The entry of such air is, in accordance with my invention, precluded by two means. First, water adhering to the underside of the wire is scraped off by the leading edge 29 of each drainage element and then flows down the leading edge, providing a seal. Secondly, the flat portion 30 of each drainage element 28*a*, 28*b*, etc. is of sufficient length to provide a restriction to air flow.

The spacing of the drainage elements is determined by the extent to which drainage resulting from the suction action of the applied vacuum is desired. The separation between the drainage elements determines the area over which the applied vacuum is operative. The relative proportions of drainage caused by the two mechanisms, i.e., the applied vacuum and the supplementary suction can, therefore, be varied by adjusting the spacing of the drainage elements and the length of the trailing portion.

In a conventional slotted suction box the dimensions of the grid bars and their separation is determined by the need to provide sufficient rigidity in the drainage elements and to prevent excessive deflection of the wire over the slots. In such a suction box the whole width of the top of each drainage element bears against the underside of the wire and its dimension is determined by structural requirements. In my invention only a small part of the total width of the drainage elements which serve as grid bars bears against the underside of the wire. Because of the supplementary drainage effect of the trailing portions, less applied vacuum is required to achieve the same over-all drainage as would be needed without use of the trailing portion and, therefore, the tendency of the wire to be drawn downwards between the supporting flat surfaces for the same over-all drainage is reduced.

When in the specification and claims I use the expression "transversely of the direction of wire travel," I mean to include not merely installations in which the drainage elements are strictly at right angles to the direction of wire travel, for example as shown in Fig. 4, but also installations in which the drainage elements are at angles other than right angles, as for example as illustrated in Fig. 5.

While I have described my invention in the embodiments mentioned above, it is to be understood, however, that these are given by way of illustration only and are not to be construed as limitations of my invention. Such embodiments of my invention, therefore, as come within the scope and purview of the appended claims are to be considered as part of my invention.

This application is a continuation-in-part of my applications Serial Nos. 555,643 and 555,719, both filed December 27, 1955, both now abandoned.

What I claim as my invention is:

1. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having a trailing portion diverging from the said wire at an angle therefrom greater than 0°, but not greater than 5°, said angle being measured when the wire is not in motion.

2. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge and a trailing portion diverging from the said wire at an angle therefrom greater than 0°, but not greater than 5°, said angle being measured when the wire is not in motion.

3. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of machine travel and having a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom greater than 0°, but not greater than 5°, said angle being measured when the wire is not in motion.

4. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle greater than 0°, but not greater than 5°, said angle being measured when the wire is not in motion.

5. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom, measured when the wire is not in motion, selected from within the range of 5° to 1°, smaller angles being selected as the speed of the machine increases.

6. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom in the range 5° to 1°, measured when the wire is not in motion, the magnitude of the angle diminishing as the speed of the machine increases in which the length of the trailing portion is not more than six inches.

7. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom greater than 0°, but not greater than 5°, and said angle being measured when the wire is not in motion in which the length of the flat portion is sufficient to provide a substantial seal against the entry of air into the zone lying between the Fourdrinier wire and the trailing portion of the drainage element.

8. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom in the range 5° to 1°, measured when the wire is not in motion, the magnitude of the angle diminishing as the speed of the machine increases in which the length of the flat portion is sufficient to provide a substantial seal against the entry of air into the zone lying between the Fourdrinier wire and the trailing edge of the drainage element.

9. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom in the range 5° to 1°, measured when the wire is not in motion, the magnitude of the angle diminishing as the speed of the machine increases in which the length of the trailing portion is not more than six inches in which the length of the flat portion is sufficient to provide a substantial seal against the entry of air into the zone lying between the Fourdrinier wire and the trailing edge of the drainage element.

10. A stationary drainage element for a paper machine disposed in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel and having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom greater than 0°, but not greater than 5°, said angle being measured when the wire is not in motion, the said trailing portion being adapted to articulate to provide an angle of divergence of variable magnitude.

11. A suction box for a Fourdrinier paper machine, comprising in combination means for withdrawing air from said box to create a sub-atmospheric pressure therein and supplementary drainage-promoting means comprising a plurality of stationary drainage elements secured therein in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel, said drainage elements having a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom greater than 0°, but not greater than 5°, said angle being measured when the wire is not in motion.

12. A suction box for a Fourdrinier paper machine, a plurality of stationary drainage elements secured therein in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel, said drainage elements having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom greater than 0°, but not greater than 5°, said angle being measured when the wire is not in motion.

13. In a suction box for a Fourdrinier paper machine, a plurality of stationary drainage elements secured therein in supporting relationship to the Fourdrinier wire and extending across the machine transversely of the direction of wire travel, said drainage elements having an acute angled leading edge, a flat portion in engagement with the Fourdrinier wire and a trailing portion diverging from the said wire at an angle therefrom (measured when the wire is not in motion) greater than 0°, but not greater than 5°, and of a length not greater than one-half inch.

No references cited.