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(54) **APPARATUS AND METHOD OF GENERATING STOCK TURBULENCE IN A FOURDRINIER
FORMING SECTION**

VORRICHTUNG UND VERFAHREN ZUR ERZEUGUNG VON STOFFTURBULENZ IM
BLATTBILDNER EINER LANGSIEBPAPIERMASCHINE

APPAREIL ET PROCEDE DE PRODUCTION DE TURBULENCES DE PATE DANS UNE SECTION
DE MISE EN FEUILLE A TABLE PLATE

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US-A- 3 922 190 **US-A- 4 687 549**

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Description

Field of the Invention

[0001] The present invention relates to an apparatus and method for generating stock turbulence in the forming section of an open surface paper making machine. More specifically, the present invention relates to an apparatus and method for generating sufficient turbulence in the stock layer of an open surface forming section of a papermaking machine to assist in deflocculating a relatively thick stock layer carried on a relatively slowly moving forming fabric. This invention thus finds application in the manufacture of relatively heavy paper, pulp and board products. Further, the apparatus can be adjustable, so that the amount of turbulence imparted into the stock layer may be controlled and optimized to suit the grade of product being made.

Background of the Invention

[0002] In a conventional open surface forming section, an aqueous stock, containing both paper making fibers and other paper making solids in amounts of from about 0.1% to about 1.5% by weight, is fed from a headbox slice onto a horizontal moving forming fabric. In such a forming section, after receiving the stock from the headbox slice, the moving forming fabric is supported by a forming board, followed by a series of drainage boxes. The drainage boxes commonly include dewatering devices such as blades and foils mounted on the drainage box in contact with the machine side of the forming fabric. In some modern slow speed machines table rolls are also still used as dewatering and turbulence generating devices. The forming section can also include other devices intended to generate at least some turbulence within the stock, such as formation showers. As the stock on the open surface forming fabric moves through the forming section, water is removed from the stock until an incipient paper web is formed which contains from about 75% to about 85% water. The remainder of the water is removed in subsequent parts of the papermaking machine.

[0003] The thickness of the stock layer deposited from the head box slice onto the forming fabric is determined by the machine speed, the water content of the stock delivered from the head box, and the basis weight of the paper or board product being manufactured. Heavier grade products, such as linerboard, corrugating medium, market pulp grades, and paperboard products, require a greater initial stock thickness than lighter grades, such as newsprint.

[0004] To provide an acceptable paper product, it is important that the paper making solids, including the paper making fibers, be thoroughly mixed and dispersed as randomly as possible in the stock leaving the headbox slice. In practice this is almost impossible to achieve: a proportion of the paper making fibers tend to

flocculate in the stock and are deposited as flocs onto the forming fabric. Flocculation will continue in the stock on the forming fabric unless steps are taken to generate turbulence within the stock. Once an incipient paper web is formed it is essentially impossible to disperse any remaining flocs. Thus, what occurs in the stock on the forming fabric to convert it from a dilute solution of fibers and other solids into an incipient paper web is of vital importance to the papermaker.

[0005] Numerous methods have been proposed to randomize fiber distribution in the stock in the forming section. Most of these methods involve creating a level of turbulence within the stock to disperse flocs. For example, it is known to impart a rapid transverse vibrating motion to the forming fabric adjacent to the headbox, so as to apply a destructive shear force into the flocs and thereby redistribute the paper making fibers. Formation showers, table rolls, and various air and water jets, located either above or below the forming fabric, have also been used to create turbulence in the stock layer. The amount of energy required to impart a desirable level of turbulence into the stock is generally a function of stock layer thickness, machine speed, and the type of furnish present in the stock.

[0006] A common means of creating turbulence within the stock on an open surface moving forming fabric is to locate dewatering elements (such as foils, agitator blades and the like) in supporting contact with the machine side of the moving forming fabric. Devices of this type are described by Wrist, US 2,928,456; Sepall, US 3,573,159; Johnson, US 3,874,998; Saad, US 4,420,370; Kallmes, US 4,687,549 and US 4,838,996; and Fuchs, US 4,789,433. Foils have a leading edge that skims liquid from the forming fabric; the trailing portion is declined downwards at an angle of from about 1° to about 8°, and serves to provide a suction effect which withdraws liquid from the stock and causes the fabric to deflect sufficiently to induce at least some turbulence within the stock.

[0007] Agitator blades are profiled so that some water is withdrawn and then redirected back through the forming fabric into the fluid stock layer. A carefully profiled cross-machine direction channel is located in the blade surface to achieve this; the water thereby redirected back through the forming fabric creates turbulence in the stock on the fabric, which provides a deflocculating effect and serves to randomize the solids distribution.

[0008] Another means of inducing agitation is disclosed by Johnson, US 4,140,573. In this device, at least one of the dewatering elements on a low vacuum dewatering box are lowered a small amount relative to those on either side so that, as the fabric passes over the sequence of elements, it is pulled down a small amount by the dewatering box vacuum and then released, causing some turbulence within the stock.

[0009] An alternative means of inducing stock turbulence is described by Cabrera y Lopez Caram, US 5,830,322. In this device a pair of fabric supporting ele-

ments are used, a primary element with a declining surface together with a trailing element with a horizontal surface. Drainage of water from the stock is controlled by restricting the size of a cross machine direction drainage gap between the two elements. The primary element declining surface is configured to impart turbulence into the stock above the drainage gap, without downwardly deflecting the forming fabric into the drainage gap, utilizing blade profiles substantially as described by Fuchs, US 4,789,433 and by Kallmes, US 4,838,996. The apparatus relies on fluid flow into and out of the drainage gap and on the shape of the declining surface of the primary element within the drainage gap, to cause turbulence within the stock after the fluid has been returned through both the forming fabric and any incipient paper mat formed thereon to the stock.

[0010] Other stock agitating devices are described by Cowan, US 3,922,190; Marx, Jr., US 4,999,086; Hansen et al., US 5,011,577; Hansen, US 5,089,090; and Neun, US 5,681,430.

[0011] However, in situations where the paper product being made requires that the forming fabric moves at a relatively slow speed, and carries a relatively thick stock layer, for example in the production of heavy basis weight products, it becomes more difficult to generate the desired levels of turbulence within the stock. As machine speed decreases, and stock thickness increases, in the manufacture of heavy basis weight products, it becomes increasingly difficult to create an effective amount of turbulence within the stock, and hence to improve formation. It is thus found that for open surface forming sections in which the forming fabric is moving at speeds of less than about 400 m/min, carrying stock layers whose initial thickness is greater than about 2.0cm at the head box slice, and producing heavier grade paper products with basis weights in excess of about 160 gsm, there is still a need for a device that is capable of generating an effective level of turbulence within the stock sufficient to cause at least some deflocculation within the stock. It would also be a considerable advantage if such a device could be readily adjustable so that the level of turbulence can be matched to the paper maker's requirements.

[0012] An additional problem occurs with stock compositions using a furnish having a high content of relatively short fibers or recycled materials. In these stocks, an almost impenetrable mat can be formed on the paper side of the forming fabric surface, effectively sealing the fabric and preventing adequate drainage of the stock; a phenomenon commonly referred to as "sheet sealing". A need therefore exists for a dewatering device capable of at least alleviating drainage restrictions arising from this phenomenon

[0013] An apparatus for generating turbulence in the stock on a forming fabric with the features of the preamble of claim 1 and a method having the features of the preamble of claim 10 are described in US-A-3,922,190.

SUMMARY OF THE INVENTION

[0014] The present invention seeks to provide an apparatus and a method for generating stock turbulence sufficient to cause at least some stock deflocculation, and to improve formation in an open surface paper making machine forming section in which the stock layer is relatively thick, and in which the forming fabric moves at a relatively low speed. This invention thus seeks to improve formation in open surface papermaking machines which are used to make relatively heavier basis weight products such as board stock and the like. This invention also seeks at least to alleviate, if not eliminate, sheet sealing by generating sufficient turbulence within the stock so as to redistribute the fibre mat forming a more or less impenetrable layer on the paper side of the forming fabric. This invention consequently is of particular relevance to the use of stock compositions containing a significant content of relatively short fibers, or of recycled materials.

[0015] Further, in one particular embodiment, this invention seeks to provide an adjustable apparatus for generating a controllable level of stock turbulence sufficient to cause at least some stock deflocculation, and to improve formation in an open surface paper making machine forming section in which the stock layer is relatively thick, and in which the forming fabric moves at a relatively low speed.

[0016] In the context of this invention, a "relatively low speed" refers to an open surface forming fabric that is moving through the forming section at a linear speed of less than about 400m/min; a "relatively heavier basis weight product", and a "relatively thick stock layer", each refer to an open surface forming fabric machine that is being used to make a product with a finished basis weight over about 160 gsm, which will generally require a stock layer more than about 2.0cm thick adjacent the headbox slice. It should also be noted that although this invention is concerned with the manufacture of products with a relatively high basis weight it is not so limited, and under some circumstances is of benefit with lighter products, and at higher machine speeds.

[0017] The above object is achieved with an apparatus having the features of claim 1. Preferred embodiments form the subject matter of the subclaims.

[0018] Preferably, the at least one intermediate dewatering element located between the lead-in dewatering element and the riser element and spaced from each other dewatering element by a gap, is adjustably attached to the dewatering box permitting location of the or each declining surface thereof in the desired second plane, and permitting movement to a different desired second plane. In this embodiment, as is set forth in more detail below,

the included angle between the first and second planes instead of being determined by the angle to which the intermediate element declining surface is cut, is determined by the setting of the adjustable attachment to the

dewatering box. In this embodiment, since the lead-in element is not adjustably mounted, it is preferred that its declining trailing surface is arcuate.

[0019] In an alternative preferred embodiment, the apparatus further includes a drainage restricting element, which is interposed between the riser element and the adjacent intermediate element, having a fabric supporting surface comprising in sequence:

a doctoring leading edge; and
an upwardly inclined surface;

wherein the attachment of the drainage restricting element to the dewatering box is constructed and arranged to locate the upwardly inclined surface at an angle to the second plane so as to provide a shallow "V" angle therebetween conforming to the inclined surface of the riser element. In this embodiment, the attachment of the drainage restricting element to the dewatering box can be chosen from the group consisting of a fixed attachment, an adjustable attachment, and a second adjustable attachment incorporated into a first adjustable attachment for the intermediate elements.

[0020] Preferably, all of the intermediate fabric supporting elements are of the same width in the machine direction. Alternatively, all of the intermediate fabric supporting elements are not of the same width in the machine direction.

[0021] Preferably, the or each intermediate fabric supporting element has a substantially flat declining surface. Alternatively, at least one intermediate element has an agitator blade profile.

[0022] The above object is also achieved with a method having the features of claim 10. The subclaims are directed to preferred embodiments.

[0023] Preferably, the desired level of turbulence is created and controlled by at least one adjustable intermediate dewatering element located between the lead-in dewatering element and the riser element which is adjustably attached to the dewatering box permitting location of the or each declining surface thereof in the second plane; and, the level of turbulence is controlled by adjusting the adjustable intermediate supporting element to a desired second plane location.

[0024] More preferably, the desired level of turbulence is created by an apparatus further including a drainage restricting element, which is interposed between the riser element and the adjacent intermediate element, having a fabric supporting surface comprising in sequence:

a doctoring leading edge; and
an upwardly inclined surface;

wherein the attachment of the drainage restricting element to the dewatering box is constructed and arranged to locate the upwardly inclined surface at an angle to the second plane so as to provide a shallow "V" angle there-

between in conformance with the inclined surface of the riser element.

[0025] Most preferably, the desired level of turbulence is created and controlled by:

- (i) at least one adjustable intermediate dewatering element located between the lead-in dewatering element and the riser element which is adjustably attached to the dewatering box permitting location of the or each declining surface thereof in the second plane; and
- (ii) a drainage restricting element, which is interposed between the riser element and the adjacent intermediate element, having a fabric supporting surface comprising in sequence:

a doctoring leading edge; and
an adjustable upwardly inclined surface;

wherein the level of turbulence is controlled by:

- (a) adjusting the adjustable intermediate supporting element to a desired second plane location; or
- (b) adjusting the drainage restricting element to a different location; or
- (c) adjusting both the adjustable intermediate supporting element to a desired second plane location, and adjusting the drainage restricting element to a different location.

[0026] Preferably, the angle between the first and second planes is from greater than 0° to about 10°.

[0027] One advantage that has been found with the apparatus of this invention is that with relatively thick stock layers once a desired level of turbulence has been induced in the stock, it is less difficult to maintain a desired level of turbulence further along the forming section. Hence, although the known devices are not always capable generating an acceptable level of turbulence, they are sufficient to maintain that level of turbulence once it has been generated. The present invention thus can be used to optimize the performance of these prior art devices.

[0028] As a consequence of this, the shape of the exit surface on the riser blade will be determined by what follows the dewatering device of this invention in the forming section. For example, if it is immediately followed by a second set of the same elements so that the riser element is both the last element on one set, and the first element in the next set, the exit surface of the riser blade will be the same shape as that of the corresponding part of a lead-in element, so that it will have a substantially horizontal intermediate surface, and a declining trailing surface in the same second plane as the following elements. Alternatively, if it is followed by an undrained gap, or by a drainage box equipped with foils, the exit surface of the riser blade will be generally shaped as a foil blade, with a foiling angle generally of

from about 0.5° to about 5°.

Brief Description of the Drawings

[0029] The present invention will now be described with reference to the attached Figures, wherein:

Figure 1 shows schematically a cross section in the machine direction of a stock turbulence generating unit in accordance with a first embodiment of the present invention;

Figures 2, 3 and 4 show cross sections of the fabric supporting elements used in Figure 1;

Figures 5 and 6 show alternative element arrangements to that shown in Figure 1;

Figure 7 shows schematically a cross section in the machine direction of a stock turbulence generating unit incorporating two sets of fabric supporting elements;

Figure 8 shows schematically an intermediate element including an agitator blade profile;

Figures 9 and 10 show schematically partially sectioned a stock turbulence generating unit in accordance with a second embodiment of the present invention;

Figures 11 and 12 show details of the pivot and adjustment device used in Figures 10 and 11;

Figure 13 shows schematically a cross section of the unit of Figures 9 - 12;

Figure 14 shows schematically a cross section in the machine direction of a stock turbulence generating unit in accordance with a third embodiment of the present invention;

Figure 15 shows a cross section of the drainage restriction element shown in Figure 14; and

Figure 16 shows alternative intermediate element arrangements applicable to Figures 1, 7 and 14 including agitator blade profiles for the intermediate elements.

Detailed Description

[0030] In the context of this invention, the following directional terms have the meanings given:

"machine direction" means a direction along the machine substantially parallel with the direction of travel of the forming fabric;

"cross machine direction" means a direction substantially perpendicular to the machine direction generally parallel to the plane of the forming fabric;

"upstream" refers to a direction closer to the headbox from a given point in the machine direction;

"downstream" refers to a direction further from the headbox in the machine direction;

"leading" refers to an upstream element edge;

"trailing" refers to a downstream element surface or edge;

"paper side" refers to the face of the forming fabric upon which the stock is deposited, and the paper web is formed; and

"machine side" refers to the side of the forming fabric in contact with the fabric supporting elements, and thus is the other side from the paper side.

[0031] In all of the schematic dewatering box cross sections shown in the Figures, the fabric supporting elements all extend in the cross machine direction for the full width of the forming fabric. Additionally, all of the angles shown have been enlarged for clarity.

[0032] In Figure 1 is shown a first embodiment of this invention. In both this Figure and later Figures most of the other conventional parts of a forming section, such as the headbox, headbox slice, breast roll, a forming board (if present), a forming shower or showers, and any other drainage or formation devices are not shown. The stock turbulence generating device 1 includes a dewatering box 2, which is provided with a hydraulically sealed drain 3 at the bottom, through which the water 3A drained from the stock escapes. Dewatering box 2 is attached by the pipe 4 to a vacuum source which provides a controlled reduced pressure in the range of from ambient pressure to about 7.5 kPa below ambient pressure.

[0033] A desired level of turbulence is generated in the stock by the set of fabric supporting elements 5, 6, 7 and 8, which are mounted onto the top rail of the dewatering box 2 using a conventional T-bar arrangement, as at 9A, 9B and 9C. In combination, the spacing of the T-bars and the widths of the elements determines the widths of the drainage gaps 10, 11, and 12. These gaps are sealed at their lateral edges with end deckles (not shown). In the illustrated embodiment, gaps 10 and 11 are the same width and gap 12 is wider. The factors influencing the choice of gap widths is discussed below. The elements 5, 6, 7 and 8 can be formed from high density polyethylene, with inserted ceramic wear surfaces, or any other material appropriate for forming fabric support surfaces. Within the set of fabric supporting elements shown, element 5 is the lead-in blade, element 8 is the riser blade, and elements 6 and 7 are the intermediate blades.

[0034] The forming fabric 13 moves in the direction of the arrow A with its machine side in contact with the supporting elements 5 - 8. Over the gap 12, the forming fabric 13 rises from the last intermediate element 7 onto the riser element 8. This vertical movement of the forming fabric, and of the incipient paper web and stock carried by it, induces turbulence within the stock adjacent to, and downstream of, the exit surface of the riser element 8.

[0035] The cross section of the lead-in element 5 is shown in Figure 2. This includes a doctoring leading edge 14, a flat intermediate surface 15, and a declining trailing surface 16. In this embodiment, the trailing surface is substantially flat, and is at an angle of inclination

α , relative to the surface 15. The element is mounted onto the T-bar 9A so that the surface 15 is substantially horizontal. The doctoring leading edge 14 removes at least some of water that has drained through the forming fabric upstream of the lead-in element.

[0036] The cross section of the riser element 8 is shown in Figure 3. This includes a doctoring leading edge 17, an inclined surface 18, an exit surface 19, and a portion 20 comprising the junction between the inclined and exit surfaces. As shown, the portion 20 is the apex at the junction of the two surfaces 18, 19 on either side; alternative shapes are a short horizontal surface, and a curved surface. The underlying requirement for the portion 20 of the riser element is that it provide a continuum of support for the forming fabric moving and bending over it, and that together with the substantially horizontal surface 15 of the lead-in element it defines the first plane, below which the fabric is deflected during its passage over the intermediate elements. The exact shape of the portion 20 is chosen based on the constructional materials used, and the desired lengths of the inclined surface 18 and the exit surface 19. The inclined surface 18 is at an angle β , which is measured between the inclined surface and the first plane defined by the surface 15 on the lead-in element, and the portion 20 of the riser element. The shape of the exit surface 19 is discussed below.

[0037] In Figure 1, two intermediate elements 6 and 7 are shown, which are generally the same. The cross sections of these are generally the same, and that of intermediate element 6 is shown in Figure 4. This includes a doctoring leading edge 21, a declining surface 22, and a trailing edge 23. The set of three elements comprising the lead-in element and the two intermediate elements supported by the T-bars 9C are spaced apart so that the surface 16 and the two surfaces 22 are in a common second plane at the angle α relative to the first plane.

[0038] In the apparatus of this embodiment of this invention, as shown in Figure 1, as fabric 13 moves over the dewatering box 2, the machine side of fabric 13 first engages leading edge 14 of lead-in element 5 which skims liquid from the machine side of fabric 13. The forming fabric 13 continues downstream and passes over, in succession, inclined surface 16, gap 10, inclined surface 22 and trailing edge 23 of intermediate element 6, gap 11, inclined surface 22 and trailing edge 23 of intermediate element 7, gap 12, and finally leading edge 17, and surfaces 18, 20, and 19 (in that order) of riser element 8. The fabric is pulled down onto the surface 16 and the two surfaces 22 in sequence by the controlled low vacuum in the dewatering box so as to form a fluid seal on these surfaces. Finally, the forming fabric rises upwardly over the gap 12 and the surfaces of the riser element 8. This upward movement generates turbulence in the stock in the vicinity of the riser element 8.

[0039] In this embodiment, the value chosen for the angle α is determined by the machine characteristics,

which includes the overall separation of the lead-in and riser elements, the number of intervening intermediate elements, the machine speed, the thickness of the stock layer, and the level of turbulence desired in the product being made. Consequently, the value of α determines the vertical distance through which the forming fabric must rise from the locus where it loses contact with the last intermediate element, which is at or near to the trailing edge 23 of this element, to the doctoring leading edge 17 of the riser element. Generally, α is in the range of from about 0.25° to about 10° . For most purposes it has been found that α is less than 6° and often is in the range of from about 2° to about 4° . The gap widths between each of the elements making up the set, in combination with the applied vacuum, and the properties of the stock and of the furnish in the stock also affect both the amount of drainage that occurs, and the amount of turbulence that is generated. The level of applied vacuum in combination with the gap widths must be sufficient to ensure that the forming fabric is in hydraulic contact with the fabric supporting surfaces of all of the elements. The actual value of the applied vacuum also influences the level of turbulence, since it influences the transition of the forming fabric from the last intermediate element onto the riser element. At this point, the forming fabric has a shallow "V" shape, which is sharper or flatter depending at least in part on the vacuum applied. The actual values chosen for α , and of the other identified variables, will be determined by the amount of turbulence that is desired in the stock at that point in the forming section; some experimentation may be required to determine optimum values for a given set of paper making conditions.

[0040] The shape of the exit surface 19 of the riser element 8 depends to a large extent on what follows this element downstream in the forming section, for which there are several choices. The riser element may be followed, for example, by another identical stock turbulence generating unit, an uncontrolled drainage gap, by a set of foils, or by an Isoflo (trade mark) drainage unit. When the next drainage unit is another more or less identical unit contiguous with, or even mounted on the same drainage box as the preceding unit, the riser element becomes common to both units. The exit surface of the riser element is then profiled as if it is a lead-in element, so that it matches the chosen value of α for the following unit, which may not be the same as that of the preceding unit. When the riser element is followed by a gap, or a foil unit, it appears to be sufficient to use an exit surface that is either substantially horizontal, or is downwardly inclined at more or less the same angle as is used for a conventional foil blade, that is up to about 5° , without an intervening short horizontal surface.

[0041] The inclined surface of a riser element, as at 18 in Figure 3, is generally at a fairly steep rising angle, as it defines the path of the rising forming fabric as shown in Figure 1. The angle β shown in Figure 3 will generally be in the range of from about 0° to about 30° .

In practice, an angle of from about 10° to about 20° is often sufficient. The value of the angle β is determined by the vertical displacement of the forming fabric as it rises from the declining surface 22 of the last intermediate element to the surface 20 of the riser element. The value of β should be selected to minimize fabric deflection with a low vacuum level. If in operation the fabric deflection is, or becomes greater than this, it is found that the forming fabric still engages with and follows the shape of this surface. However, some experimentation may be necessary to determine the optimum value of β for a given set of machine conditions.

[0042] Further, it appears that once a desired level of turbulence has been created in the stock by the apparatus of this invention it is easier to induce turbulence in the stock downstream in the forming section, thus facilitating the use downstream of subsequent turbulence generating devices. This enhances the operation of subsequent conventional deflocculation and dewatering devices and improves the formation in the product being produced. In a similar fashion, it is observed that the apparatus of this invention will enhance a lower level of turbulence created in the stock by an upstream device, such as a formation shower.

[0043] While the embodiment described above is applicable when the fabric speed is 400 m/min or less and the stock relatively thick, for example 2.0cm or more adjacent the head box slice, for manufacturing paper products whose basis weights is 160 gsm or greater, it is contemplated that the present invention will also provide advantages in other circumstances, such as higher fabric speeds and/or thinner stock layers.

[0044] Unexpectedly, it has been discovered that, once fabric 13 is running at machine speed over the dewatering box 1 under an applied vacuum, it will often continue to follow the path defined by the supporting elements 5, 6, 7 and 8 even if the vacuum is reduced. This permits a reduction in the amount of drainage over the dewatering box 2. This provides an additional benefit in reducing any tendency for sheet sealing.

[0045] In the embodiment shown in Figure 1, the unit shown has two intermediate dewatering elements 6 and 7. Depending on the machine characteristics and the product being made, other configurations can be used. Figure 5 shows one intermediate dewatering element 6 between a lead-in element 5 and a riser element 8 and Figure 6 shows a configuration using five intermediate elements 24, 25, 26, 27 and 28, in which all five intermediate elements are arranged to be in the second plane at a common angle α to the first plane. It is also shown in Figure 6 that the intermediate elements need not all be the same width.

[0046] It is also possible to utilize this invention with two dewatering units in sequence, with the riser element of the first unit also serving as the lead-in element of the second one. This arrangement is shown in Figure 7. The first set of elements includes a lead-in element 5, and two intermediate elements 29 and 30. The second set

of elements includes again two intermediate elements 32 and 33, and a riser element 8. The central element 31 functions as riser for the first set, and lead-in element for the second set. Its upstream inclines surface 18 is shaped to conform to a riser element, and its downstream declining trailing surface is shaped to conform to a lead-in element. This arrangement also can be set up in two different ways:

- (i) a single dewatering box 2 can be used, with a single vacuum supply 4, as shown essentially in Figure 1; or
- (ii) a dewatering box with two hydraulically separate compartments 2A and 2B, separated by wall 34, each of which have their own vacuum supplies 4A and 4B, as shown in Figure 7.

In this latter arrangement, the vacuum applied to the two compartments need not be the same. It is also possible that the angles α_1 and α_2 , both of which are measured relative to the first plane as shown in Figure 7, need not be the same, depending on the level of turbulence desired in each unit.

[0047] In the embodiments shown, the intermediate elements have an essentially planar forming fabric supporting surface. In certain circumstances, depending on both the machine characteristics, the stock characteristics, and the product being made, it has been found desirable to cause more turbulence in the stock than is caused by utilizing planar forming fabric supporting surfaces on the intermediate elements in the second plane. As is shown in Figure 8 an intermediate element with a so-called agitator blade profile with a single channel 35 can be used to induce additional turbulence. Agitator blades having this surface profile are described, for example, by Johnson in US 3,874,998; other profiles are known and used. It appears that an agitator blade profile can enhance the turbulence effects provided by the turbulence generating unit of this invention.

[0048] In a similar fashion, it is also contemplated within this invention for the dewatering device to share a common dewatering box with a different dewatering device, such as an Isoflo(trade mark), agitator blades, or a set of foil blades.

EXPERIMENTAL TRIAL

[0049] In an experimental trial a stock turbulence generating unit according to the present invention was located downstream of a formation shower in an open surface forming section of a paper machine. The unit used was that shown in Figure 7, but without the internal dividing wall 34, and only a single vacuum supply. Two suction boxes provided with covers substantially as described by Johnson in U.S. 4,140,573 were located immediately downstream of the unit. The machine speed of the forming section was approximately 320 m/min, and the paper board product had a basis weight of ap-

proximately 299 gsm. The lead-in element was 38.1 mm wide, with a declining surface 8.5 mm wide. The two intermediate elements were the same in each pair, and had a declining surface width of 150.9 mm. The drainage gap between each of the elements was 9.5 mm, except for the gap downstream of each of the last intermediate elements, which was 12.7 mm. In both sets of elements, the value of α was 2° . The dewatering element acting as a common lead-in and riser element at the middle of the set had an inclined surface 9.5 mm wide, and the value of the angle β was 5° . The downstream exit surface of this common element was substantially flat, and inclined downwardly at 2° , thus matching the value of α . The exit surface of the second riser blade was horizontal. All of the element widths and the element separation gaps are measured in the machine direction.

[0050] During the trial, the vacuum level applied by the suction box was varied from ambient pressure to about 5 kPa below ambient pressure. It was found that when the formation shower located upstream was turned off, the visual appearance of the stock as it passed over the turbulence generating unit did not indicate any increased activity within the stock. However, it was found that both the drainage of the incipient sheet and quality of the resulting paper product, as evidenced by its formation and smoothness, improved as compared to its quality before the unit was installed. This indicated that the unit was effective in generating turbulence within the stock, and in preventing sheet sealing, despite the fact that the formation shower had been turned off.

[0051] When the formation shower was turned on, the visual appearance of the stock as it passed over the stock turbulence generating unit changed dramatically, indicating an increased level of stock activity. This shows that the stock turbulence generating unit of this invention is effective both in imparting turbulence into the stock so as to improve formation and prevent sheet sealing, and can enhance the performance of other drainage and turbulence generating devices.

[0052] In the embodiment described above, the location of the intermediate elements is determined by fixed structures, and the cross sectional profile of the intermediate elements determines the value of α . Since the value of α is never very large, this construction requires precision machining and installation of the intermediate elements in order to provide a set of surfaces accurately located in the second plane.

[0053] In a second embodiment of this invention, instead of mounting each intermediate element directly onto the structure of the dewatering box, each intermediate element is adjustably mounted onto the structure of the dewatering box. It is then feasible to control the value of α by moving the whole intermediate element to provide an appropriate declining angle for the declining surface by adjusting the adjustable mounting, instead of constructing the element to provide the required fixed declining angle. In this configuration, where more than

one intermediate element is used, it is preferred that all of the intermediate elements are mounted onto a single adjustable mounting at the desired machine direction separation with their forming fabric supporting surfaces in a common plane. The desired value of α is then obtained by adjusting the mounting, or mountings, as required.

[0054] In addition to greatly simplifying the construction of the turbulence generating unit, as all of the intermediate elements can be fabricated to essentially the same dimensions, this configuration has the added advantage that the value of α can be readily changed so as to alter the level of generated turbulence. This can be required for several reasons, such as a change in product, a change in furnish for the same product, and less than perfect mixing in the headbox causing problems on the forming fabric. Thus in addition to providing a means to generate turbulence within the stock on the forming fabric, this embodiment of this invention additionally provides a means whereby the level of turbulence created can be controlled, and either enhanced or diminished as paper making conditions require.

[0055] This embodiment of this invention is shown in Figures 9 - 13. In the Figures 9 - 12 the forming fabric is omitted for clarity.

[0056] Referring first to Figures 9 and 10, which show partially cut away three quarter views of the unit, the unit includes a single dewatering box 2 supporting a lead-in element 5, three intermediate elements 35, 36 and 37 of which the middle one 36 is narrower than the other two, and a riser element 8. The lead-in element 5 and the riser element 8 are supported by T-bar structures 9A and 9B, both of which are directly supported by the frame 38 on the top of the dewatering box 2. The three intermediate elements are supported by similar T-bar structures 9C, each of which is mounted onto an adjustable supporting frame 40. At its upstream end, adjacent the lead-in element 5, the adjustable frame 40 is supported by a pivot assembly 41. At its downstream end, the adjustable frame 40 is provided with a vertical adjustment assembly 42, which in its turn is controlled by the adjustment bar 43 which is moved in the directions shown by arrow B by means of the handle 44. The adjustment bar 43 is supported by suitable bearing surfaces (not shown) on the beam 45 carried by the supporting framework of the dewatering box top shown generally as 46.

[0057] The upstream pivot is shown in more detail in Figure 11. The frame 40 pivots through a small arc (which provides sufficient angular movement to obtain any desirable value for α) about rod 47 which is supported by the wall of the dewatering box 2, as at 50. The frame 40 is attached to the rod 47 by means of an adjustable bearer block 48 carried by a bracket 49. The bearer block is held in place by the lockbolt 51 which passes through the slot 52. This form of attachment allows fine control of the location of the surface of element 35 relative to the declining surface of the lead-in element

5. Figure 12 shows only one pivot assembly; in practice there will be at least two, and often more, so that the upstream end of frame 40 is adequately supported for the full width of the forming section.

[0058] The downstream vertical adjustment assembly is shown in more detail in Figure 12. The vertical adjustment assembly 42 is attached to the downstream face of the frame 40 by the bolts 53 and 54 which are provided with enlarged holes 53A and 54A. The assembly 42 also includes an angled slot 55, into which is fitted a captive pin 56. The outer end of the pin 56 engages into the aperture 57 in the adjustment bar 43. As a result, horizontal movement of the bar 43 in the directions of arrow B causes vertical movement of the frame 40 in the directions of arrow C. The enlarged holes 53A, 54A are provided to permit fine adjustment of the assembly 42 relative to the frame 40 so that the same value of α is obtained across the full width of the forming section. If desired, the bar 43 can be locked in a particular setting by using any appropriate locking mechanism. Figure 12 shows only one adjustment assembly; in practice there will be at least two, and often more, so that the downstream end of frame 40 is adequately supported for the full width of the forming section.

[0059] It is also contemplated that other vertical adjustment means are useable: for example, the adjustment bar 43 can be replaced by a screw thread system, which can be motorized, and the whole adjustment means can be replaced by a hydraulic or pneumatic system. If the vertical adjustment means is to be freely operable, the fact that it is placed in an environment where it can be clogged with solids from the stock should be borne in mind.

[0060] The cross section of the unit of Figures 9 - 12 is shown schematically in Figure 13. The lead-in and riser elements 5 and 8 are supported by their T-bars 9A and 9B attached directly to the dewatering box 38. The three intermediate elements 35, 36 and 37 are each supported by T-bars 9C carried on the subframe 40. The subframe 40 is supported at its upstream end by the rod 47, about which it rotates to provide the required value for α . It is supported at its downstream end by the adjustment assembly 42 controlled by the adjusting bar 43. The actual value for α is determined by the position of the adjustment bar 43 relative to the vertical adjustment assembly 42.

[0061] In this arrangement, although the intermediate elements are adjustable to any desired value for α , the lead-in element is still fixed, and is unadjustable, so that its declining trailing surface is at a constant angle. In some circumstances, it has been found that this can result in the forming fabric deflection over the trailing edge of the lead-in element, which is not desirable for several reasons. It is therefore preferred that in this arrangement, as indicated at 70 (see also Figure 10), the lead-in element has an arcuate trailing edge.

[0062] It can thus be seen that in this preferred embodiment, rather than adjust each intermediate element

individually to obtain the desired value of α , which requires either precise machining and installation, or precise individual vertical and angular adjustment, the set of intermediate elements are made all the same, and are mounted onto the subframe so that all of their forming fabric engaging surfaces are in a common plane, which is conveniently substantially parallel to the frame itself. When the frame is installed, after making any required adjustments by means of the bolts 51, 53 and 54, a desired value for α is obtained by moving the bar 43 to the required position, which inclines the surfaces of the intermediate elements to the desired position determining the second plane.

[0063] In a further embodiment, a fourth drainage restricting element is included in the dewatering device, located in the gap between the riser element and the immediately preceding upstream intermediate element. In certain configurations, particularly where the inter-element spacing is chosen to be relatively large, or the value of α combined with the machine direction length of the unit provides relatively high vertical distance between the last intermediate element and the doctoring leading edge of the riser element, a significant length of the forming fabric can be exposed to vacuum assisted drainage between the point where the machine side of the forming fabric loses contact with the last intermediate element adjacent its trailing edge, and the leading doctoring edge of the riser element. This allows an excessive amount of water to be withdrawn from the stock at this point. This can be controlled by insertion of a fourth drainage restricting element in this gap, with a fabric supporting surface that is upwardly angled to be in supporting contact with the forming fabric, so that the intermediate element supporting surfaces and the drainage restricting element supporting surface form a shallow "V" which supports the machine side of the forming fabric, and which limits the area of the machine side of the forming fabric exposed to vacuum assisted drainage at this point.

[0064] There are several options for the construction of the additional drainage restricting element; for example:

- (a) it can be unadjustably mounted, more or less as described above for the other elements; or
- (b) it can be adjustably mounted; or
- (c) it can be adjustably mounted onto a subframe supporting a set of intermediate elements.

[0065] For the same reasons as set out above for the intermediate elements, it is preferred that the additional drainage restricting element is adjustably mounted. More preferably, more or less the same subframe assembly as that described for the intermediate elements is used for the additional drainage restricting element.

[0066] In Figure 14 is shown a schematic cross section embodying a drainage restriction element. The lead-in and riser elements 5 and 8 are supported by their

T-bars 9A and 9B. The three intermediate elements 35, 36 and 37 are each supported by T-bars 9C carried on the first subframe 40. The first subframe 40 is supported at its upstream end by the rod 47, about which it rotates to provide the required value for α . It is supported at its downstream end by the adjustment assembly 42 and the adjusting bar 43. The actual value for α is determined by the position of the adjustment bar 43 relative to the vertical adjustment assembly 42. The drainage restriction element 55 is supported by a T-bar 9D carried by a second subframe 56, which is rotatably supported at its downstream end (in much the same fashion as the first subframe 40) by the rod 57. The angular position of the drainage restriction element, indicated by the angle γ between the surface 61 and the first plane, is controlled by the vertically adjustable upstream mounting 58 for the second subframe 56. A similar arrangement to that described for the first subframe is conveniently used. In most cases, the angles β and γ will be more or less the same.

[0067] The cross section of the drainage restriction element is shown in Figure 15. The upstream face 59 includes a doctoring leading edge 60, which is followed by an upwardly inclined surface 61, which terminates in a trailing edge 62. The element is suitably supported by a T-bar as at 9D. The value of the angle δ is chosen to allow a value for the angle γ which provides a smooth transition of the moving forming fabric from the locus at which it loses contact with the last intermediate element 37 onto the inclined surface of the riser element 8. Depending on the form of mounting used for the drainage restriction element, the angle δ can be quite small, and can be zero, so that the upwardly inclined surface is substantially perpendicular to the upstream face 59. As noted above, the point at which the forming fabric loses contact with the element 37 depends *inter alia* on the level of vacuum applied to the dewatering box.

[0068] Figure 16 shows schematically alternative intermediate element profiles to those shown in Figures 1, 7 and 14. Figure 16 shows a seven element set. The first set of elements comprises a lead-in element 5, and two intermediate elements 63, 64 each of which have an agitator blade profile. The central element 31 is both riser element for the first set, and lead-in element for the second set. The second set comprises two intermediate elements 65 and 66, followed by a riser element 8. The elements 65 and 66 have a substantially planar surface. As shown, the two sets are placed over a divided dewatering box 2 with separate drainage spaces 2A and 2B to which the same, or a different, level of vacuum can be applied. It is also contemplated that the elements 63 and 64 can form the second set, with elements 65 and 66 forming the first set. From this it can be seen that combinations of element profiles can be used to generate a desired level of turbulence within the stock.

[0069] The present invention provides a number of advantages over the prior art. The stock turbulence generating unit can be used to advantage to dewater and

deflocculate thick and/or heavy grade stocks while applying low vacuum pressure, or, in some circumstances, minimal vacuum once the section is operating. The ability to diminish the applied level of vacuum significantly reduces drainage and sheet sealing during passage of the stock over the unit. The turbulence generated throughout the stock thickness can also be used to enhance the even and efficient deflocculation of the stock by other agitation devices located both upstream and downstream of the unit.

Claims

1. Apparatus for generating turbulence in the stock on a forming fabric in an open surface forming section of a paper making machine, the forming section including a relatively slowly moving forming fabric having a paper side and a machine side, a relatively thick stock layer on the paper side thereof, the apparatus comprising a dewatering box means (1) located beneath the forming fabric (13) connected to a controlled vacuum supply means (4) operable to create a reduced pressure within the dewatering box (2), and a plurality of forming fabric supporting dewatering elements (5,6,7,8) carried by the dewatering box (2) at different levels,

characterised in that

the forming fabric (13) supporting elements (5,6,7,8) consist essentially of:

- (i) a lead-in dewatering element (5) having a fabric supporting surface comprising in sequence:

a doctoring leading edge (14);
a substantially horizontal intermediate surface (15); and
a declining trailing surface (16);

- (ii) a riser dewatering element(8) having a fabric supporting surface comprising in sequence:

a doctoring leading edge (17);
an upwardly inclined surface (18);
an exit surface (19); and
a portion (20) comprising the junction of the upwardly inclined surface (18) and the exit surface (19); and

- (iii) at least one intermediate dewatering element (6,7) located between the lead-in dewatering element (5) and the riser element (8) and spaced from each other dewatering element (6,7) by a gap (10,11,12), the or each intermediate element (6,7) having a fabric supporting surface comprising in sequence:

a doctoring leading edge (21);
a declining surface (22); and
a trailing edge (23);

wherein:

(a) the portion (20) of the riser element (8) located at the junction of the inclined surface (18) and the exit surface (19) is chosen from an apex at the junction of the inclined surface (18) and the exit surface (19), a short substantially horizontal surface linking the inclined surface (18) and the exit surface (19), and a curved surface linking the inclined surface (18) and the exit surface (19);

(b) the intermediate surface (15) of the lead-in dewatering element (5), and the portion (20) of the riser element (8) comprising the junction of the inclined surface (18) and the exit surface (19) define a first plane;

(c) the declining trailing surface(s) (22) of the, or each, intermediate dewatering element(s) (6,7) define a second plane inclined at a pre-selected downward trailing angle (α) with respect to the first plane; and

(d) the doctoring leading edge (17) of the riser element (8) is located above the trailing edge (23) of the adjacent intermediate dewatering element (7), such that movement of the forming fabric from the trailing edge (23) of the adjacent intermediate dewatering element (7) to the doctoring leading edge (17) of the riser element (8) results in a vertical movement of the forming fabric (13), and of both the incipient paper web and the stock carried on the forming fabric (13).

2. Apparatus according to Claim 1 wherein the at least one intermediate dewatering element (6,7) located between the lead-in dewatering element (5) and the riser element (8) and spaced from each other dewatering element by a gap (10,11,12), is adjustably attached (42,43,44) to the dewatering box (2) permitting location of the or each declining surface (35,36,37) thereof in the desired second plane, and permitting movement to a different desired second plane.

3. Apparatus according to Claims 1 or 2 further including a drainage restricting element, which is interposed between the riser element (8) and the adjacent intermediate element (37), having a fabric supporting surface comprising in sequence:

a doctoring leading edge; and
an upwardly inclined surface (55);

wherein the attachment (56,57,58) of the drainage restricting element to the dewatering box (2) is constructed and arranged to locate the upwardly inclined surface at an angle to the second plane so as to provide a shallow "V" angle therebetween conforming to the inclined surface (18) of the riser element (8).

constructed and arranged to locate the upwardly inclined surface at an angle to the second plane so as to provide a shallow "V" angle therebetween conforming to the inclined surface (18) of the riser element (8).

4. Apparatus according to Claim 3 wherein the attachment (56,57,58) of the drainage restricting element to the dewatering box is chosen from the group consisting of a fixed attachment, an adjustable attachment, and a second adjustable attachment incorporated into a first adjustable attachment (42,43,44) for the intermediate elements.

5. Apparatus according to Claims 1, 2 or 3 wherein all of the intermediate fabric supporting elements (6,7) are either of the same width, or not all of the same width, in the machine direction.

6. Apparatus according to Claims 1, 2 or 3 wherein the or each intermediate fabric supporting element (6,7) has a substantially flat declining surface or an agitator blade profile (35).

7. Apparatus according to claims 1, 2 or 3 wherein the downward trailing angle (α) between the first plane and the second plane is from about 0.25° to about 10°.

8. Apparatus according to Claims 1, 2 or 3 consisting essentially of:

(i) a lead-in dewatering element (5) having a fabric supporting surface comprising in sequence:

a doctoring leading edge (14);
a substantially horizontal intermediate surface (15); and
a declining trailing surface (16);

(ii) a combined riser and lead-in dewatering element (31) having a fabric supporting surface comprising in sequence:

a doctoring leading edge;
an upwardly inclined surface;
a declining trailing surface; and
a substantially horizontal intermediate surface joining the upwardly inclined surface and the declining trailing surface; and

(iii) at least one first intermediate dewatering element (29,30) located between the lead-in dewatering element (5) and the combined riser and lead-in element (31) and spaced from each other dewatering element by a gap, the or each first intermediate element(s) (29,30) having a

fabric supporting surface comprising in sequence:

a doctoring leading edge;
a declining surface; and
a trailing edge;

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(iv) a riser dewatering element (8) having a fabric supporting surface comprising in sequence:

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a doctoring leading edge (17);
an upwardly inclined surface (18);
an exit surface (19); and
a portion (20) comprising the junction of the upwardly inclined surface (18) and the exit surface (19);

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(v) at least one second intermediate dewatering element (32,33) located between the combined riser and lead-in dewatering element (31) and the riser element (8) and spaced from each other dewatering element by a gap, the or each intermediate element(s) (32,33) having a fabric supporting surface comprising in sequence:

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a doctoring leading edge (21);
a declining surface (22); and
a trailing edge (23); and

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(vi) either:

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- a single dewatering box (2) supporting the plurality of forming fabric (13) supporting elements (5,29,30,31,32,33,8) and connected to a single vacuum supply means (4), or
- a dewatering box (2) including a first compartment (2B) beneath the lead-in element (13), the at least one first intermediate element (29,30) and the combined riser and lead-in element (31) provided with a vacuum supply means (4B) together with
- a second compartment (2A) beneath the combined riser and lead-in element (31), the at least one second intermediate element (32,33) and the riser element (8) provided with a vacuum supply means (4A);

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wherein:

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(A) the intermediate surface of the lead-in dewatering element (5), the intermediate surface of the combined riser and lead-in element (31) and the portion (20) of the riser element (13) comprising the junction of the inclined surface (18) and the exit surface (19) define a first plane;

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(B) the declining trailing surface(s) (22) of the

at least one first intermediate dewatering element(s) (29,30) define a first second plane inclined at a pre-selected downward trailing angle (α_1) with respect to the first plane; and
(C) the declining trailing surface(s) (22) of the at least one second intermediate dewatering element(s) (32,33) define a second second plane inclined at a pre-selected downward trailing angle (α_2) with respect to the first plane.

9. Apparatus according to Claim 8 wherein the angle (α_1) between the first plane and the first second plane is the same as, or different to, the angle (α_2) between the first plane and the second second plane.

10. A method for creating a desired level of turbulence in a stock layer carried on a forming fabric (13) in an open surface forming section of a papermaking machine, consisting essentially of moving the forming fabric (13) carrying the stock over at least one dewatering box means (1) carrying a plurality of fabric supporting elements beneath (5,6,7,8), and in supportive contact with, the forming fabric (13), and applying a controlled vacuum supply (4) to create a controlled reduced pressure in the dewatering box (2),

characterised in that

the dewatering fabric supporting elements (5,6,7,8) consist essentially of:

(i) a lead-in dewatering element (5) having a fabric supporting surface comprising in sequence:

a doctoring leading edge (14);
a substantially horizontal intermediate surface (15); and
a declining trailing surface (16);

(ii) a riser dewatering element(8) having a fabric supporting surface comprising in sequence:

a doctoring leading edge (17);
an upwardly inclined surface (18);
an exit surface (19); and
a portion (20) comprising the junction of the upwardly inclined surface (18) and the exit surface (19); and

(iii) at least one intermediate dewatering element (6,7) located between the lead-in dewatering element (5) and the riser element(8) and spaced from each other dewatering element (6,7) by a gap (10,11,12), the or each intermediate element (6,7) having a fabric supporting surface comprising in sequence:

a doctoring leading edge (21);
a declining surface (22); and
a trailing edge (23);

wherein:

- (a) the portion (20) of the riser element located (8) at the junction of the inclined surface (18) and the exit surface (19) is chosen from an apex at the junction of the inclined surface and the exit surface, a short substantially horizontal surface linking the inclined surface (18) and the exit surface (19), and a curved surface linking the inclined surface (18) and the exit surface (19);
- (b) the intermediate surface (15) of the lead-in dewatering element, and the portion (20) of the riser element (8) comprising the junction of the inclined surface (18) and the exit surface (19) define a first plane;
- (c) the declining surface(s) (22) of the, or each, intermediate dewatering element(s) (6,7) define a second plane inclined at a pre-selected downward trailing angle (α) with respect to the first plane; and
- (d) the doctoring leading edge (17) of the riser element (18) is located above the trailing edge (23) of the adjacent intermediate dewatering element (7),

such that movement of the forming fabric from the trailing edge (23) of the adjacent intermediate dewatering element (7) to the doctoring leading edge (17) of the riser element (8) results in a vertical movement of the forming fabric (13), and of both the incipient paper web and the stock carried on the forming fabric (13).

11. A method according to Claim 10 wherein the desired level of turbulence is created and controlled by at least one adjustable intermediate dewatering element (6,7) located between the lead-in dewatering element (5) and the riser element (8) which is adjustably attached (42,43,44) to the dewatering box (2) permitting location of the or each declining surface (35,36,37) thereof in the second plane; and the level of turbulence is controlled by adjusting the adjustable intermediate supporting element to a desired second plane location.

12. A method according to Claims 10 or 11 wherein the apparatus further includes a drainage restricting element (55), which is interposed between the riser element (8) and the adjacent intermediate element (37), having a fabric supporting surface comprising in sequence:

a doctoring leading edge; and

an upwardly inclined surface;

wherein the attachment of the drainage restricting element to the dewatering box (2) is constructed and arranged to locate the upwardly inclined surface (55) at an angle to the second plane so as to provide a shallow "V" angle therebetween in conformance with the inclined surface of the riser element.

13. A method according to Claims 10, 11 or 12 wherein the desired level of turbulence is created and controlled by:

(i) at least one adjustable intermediate dewatering element (6,7) located between the lead-in dewatering element (5) and the riser element (8) which is adjustably attached (42,43,44) to the dewatering box (2) permitting location of the or each declining surface (35,36,37) thereof in the second plane; and

(ii) a drainage restricting element, which is interposed between the riser element and the adjacent intermediate element, having a fabric supporting surface comprising in sequence:

a doctoring leading edge; and
an adjustable upwardly inclined surface;

wherein the level of turbulence is controlled by:

- (a) adjusting the at least one adjustable intermediate supporting element(s) to a desired second plane location; or
- (b) adjusting the drainage restricting element to a different location; or
- (c) both adjusting the at least one adjustable intermediate supporting element(s) to a desired second plane location, and adjusting the drainage restricting element to a different location.

14. The method of claims 10 or 13 wherein the forming fabric moves at a speed equal to or less than about 400 m/min.

Patentansprüche

1. Vorrichtung zum Erzeugen von Turbulenz im Stoff auf einem Formungsgewebe in einem offenflächigen Formungsabschnitt einer Papierherstellungsmaschine, wobei der Formungsabschnitt ein sich relativ langsam bewegendes Formungsgewebe mit einer Papierseite und einer Maschinenseite und einer relativ dicken Stoffschicht auf seiner Papierseite umfaßt, wobei die Vorrichtung eine unter dem Formungsgewebe (13) befindliche Entwässerungs-

kasteneinrichtung (1) umfaßt, die mit einer Einrichtung (4) zur kontrollierten Zufuhr von Vakuum verbunden ist, die betätigt werden kann, um einen verminderten Druck in dem Entwässerungskasten (2) zu erzeugen, und in verschiedenen Ebenen mehrere das Formungsgewebe tragende Entwässerungselemente (5, 6, 7, 8), die von dem Entwässerungskasten getragen werden, **dadurch gekennzeichnet, daß** die das Formungsgewebe (13) tragenden Elemente (5, 6, 7, 8) im wesentlichen aus folgendem bestehen:

(i) einem vorderen Entwässerungselement (5) mit einer Gewebeauflagefläche, das nacheinander folgendes umfaßt:

eine vordere Abstreichkante (14);
eine im wesentlichen horizontale mittlere Fläche (15); und
eine abfallende hintere Fläche (16);

(ii) ein Steigrohrentwässerungselement (8) mit einer Gewebeauflagefläche, das nacheinander folgendes umfaßt:

eine vordere Abstreichkante (17);
eine nach oben geneigte Fläche (18);
eine Austrittsfläche (19); und
einen Abschnitt (20) mit dem Übergang zwischen der nach oben geneigten Fläche (18) und der Austrittsfläche (19); und

(iii) mindestens ein mittleres Entwässerungselement (6, 7), das sich zwischen dem vorderen Entwässerungselement (5) und dem Steigrohrelement (8) befindet und von jedem anderen Entwässerungselement (6, 7) durch einen Spalt (10, 11, 12) beabstandet ist, wobei das bzw. jedes mittlere Element (6, 7) eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt:

eine vordere Abstreichkante (21);
eine abfallende Fläche (22); und
eine Hinterkante (23);

wobei:

(a) der am Übergang zwischen der geneigten Fläche (18) und der Austrittsfläche (19) befindliche Abschnitt (20) des Steigrohrelements (8) ausgewählt ist aus einer Spitze am Übergang zwischen der geneigten Fläche (18) und der Austrittsfläche (19), einer kurzen im wesentlichen horizontalen Fläche, die die geneigte Fläche (18) und die Austrittsfläche (19) verbindet, und einer gekrümmten Fläche, die die geneigte

Fläche (18) und die Austrittsfläche (19) verbindet;

(b) die mittlere Fläche (15) des vorderen Entwässerungselements (5) und der Abschnitt (20) des Steigrohrelements (8) mit dem Übergang zwischen der geneigten Fläche (18) und der Austrittsfläche (19) eine erste Ebene bilden;

(c) die abfallende(n) hintere(n) Fläche(n) (22) des bzw. jedes mittleren Entwässerungselements (6, 7) eine zweite Ebene bildet (bilden), die in einem vorgewählten, nach unten gerichteten Winkel (α) zu der ersten Ebene geneigt ist; und

(d) die vordere Abstreichkante (17) des Steigrohrelements (8) über der Hinterkante (23) des angrenzenden mittleren Entwässerungselements (7) liegt, so daß die Bewegung des Formungsgewebes von der Hinterkante (23) des angrenzenden mittleren Entwässerungselements (7) zur vorderen Abstreichkante (17) des Steigrohrelements (8) in einer vertikalen Bewegung des Formungsgewebes (13) und sowohl des Anfangs der Papierbahn als auch des auf dem Formungsgewebe (13) getragenen Stoffes resultiert.

2. Vorrichtung nach Anspruch 1, wobei das mindestens eine mittlere Entwässerungselement (6, 7), das sich zwischen dem vorderen Entwässerungselement (5) und dem Steigrohrelement (8) befindet und von jedem anderen Entwässerungselement durch einen Spalt (10, 11, 12) beabstandet ist, verstellbar an dem Entwässerungskasten (2) befestigt ist (42, 43, 44), so daß die bzw. jede abfallende Fläche (35, 36, 37) desselben in der gewünschten zweiten Ebene liegen kann und zu einer anderen gewünschten zweiten Ebene bewegt werden kann.
3. Vorrichtung nach Anspruch 1 oder 2, die ferner ein zwischen dem Steigrohrelement (8) und dem angrenzenden mittleren Element (37) angeordnetes, die Entwässerung einschränkendes Element umfaßt, das eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt:

eine vordere Abstreichkante; und

eine nach oben geneigte Fläche (55);

wobei die Befestigung (56, 57, 58) des die Entwässerung einschränkenden Elements an dem Entwässerungskasten (2) so konstruiert und ausgelegt ist, daß die nach oben geneigte Fläche in einem Winkel zur zweiten Ebene angeordnet ist, um in

Übereinstimmung mit der geneigten Fläche (18) des Steigrohrelements (8) einen flachen V-förmigen Winkel dazwischen bereitzustellen.

4. Vorrichtung nach Anspruch 3, wobei die Befestigung (56, 57, 58) des die Entwässerung einschränkenden Elements an dem Entwässerungskasten aus der Gruppe ausgewählt ist, die aus einer festen Befestigung, einer verstellbaren Befestigung und einer zweiten verstellbaren Befestigung besteht, die in eine erste verstellbare Befestigung (42, 43, 44) für die mittleren Elemente eingebaut ist. 5
5. Vorrichtung nach Anspruch 1, 2 oder 3, wobei alle mittleren Gewebeauflageelemente (6, 7) entweder in Maschinenrichtung gleich breit sind oder nicht alle gleich breit sind. 10
6. Vorrichtung nach Anspruch 1, 2 oder 3, wobei das bzw. jedes mittlere Gewebeauflageelement (6, 7) eine im wesentlichen ebene abfallende Fläche oder ein Rührschaufelprofil (35) hat. 20
7. Vorrichtung nach Anspruch 1, 2 oder 3, wobei der nach unten gerichtete Winkel (α) zwischen der ersten Ebene und der zweiten Ebene von etwa 0,25° bis etwa 10° beträgt. 25
8. Vorrichtung nach Anspruch 1, 2 oder 3, die im wesentlichen aus folgendem besteht: 30
 - (i) einem vorderen Entwässerungselement (5) mit einer Gewebeauflagefläche, das nacheinander folgendes umfaßt: 35
 - eine vordere Abstreichkante (14);
 - eine im wesentlichen horizontale mittlere Fläche (15); und
 - eine abfallende hintere Fläche (16); 40
 - (ii) einer Kombination (31) aus Steigrohr- und vorderem Entwässerungselement, die eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt: 45
 - eine vordere Abstreichkante;
 - eine nach oben geneigte Fläche;
 - eine abfallende hintere Fläche; und
 - eine im wesentlichen horizontale mittlere Fläche, die die nach oben geneigte Fläche und die abfallende hintere Fläche verbindet; und 50
 - (iii) mindestens einem ersten mittleren Entwässerungselement (29, 30), das sich zwischen dem vorderen Entwässerungselement (5) und der Kombination (31) aus Steigrohr- und vorderem Element befindet und von jedem anderen 55

Entwässerungselement durch einen Spalt beabstandet ist, wobei das bzw. jedes erste mittlere Element (29, 30) eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt:

- eine vordere Abstreichkante;
- eine abfallende Fläche; und
- eine Hinterkante;

(iv) einem Steigrohrentwässerungselement (8) mit einer Gewebeauflagefläche, das nacheinander folgendes umfaßt:

- eine vordere Abstreichkante (17);
- eine nach oben geneigte Fläche (18);
- eine Austrittsfläche (19); und
- einen Abschnitt (20) mit dem Übergang zwischen der nach oben geneigten Fläche (18) und der Austrittsfläche (19);

(v) mindestens einem zweiten mittleren Entwässerungselement (32, 33), das sich zwischen der Kombination (31) aus Steigrohr- und vorderem Entwässerungselement und dem Steigrohrelement (8) befindet und von jedem anderen Entwässerungselement durch einen Spalt beabstandet ist, wobei das bzw. jedes mittlere Element (32, 33) eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt:

- eine vordere Abstreichkante (21);
- eine abfallende Fläche (22); und
- eine Hinterkante (23); und

(vi) entweder:

- einem einzigen Entwässerungskasten (2) der die mehreren das Formungsgewebe (13) tragenden Elemente (5, 29, 30, 31, 32, 33, 8) trägt und mit einer einzigen Einrichtung (4) zum Zuführen von Vakuum verbunden ist, oder
- einem Entwässerungskasten (2) mit einer ersten Kammer (2B) unter dem vorderen Element (13), wobei das mindestens eine erste mittlere Element (29, 30) und die Kombination (31) aus Steigrohr- und vorderem Element mit einer Einrichtung (4B) zum Zuführen von Vakuum versehen sind, zusammen mit
- einer zweiten Kammer (2A) unter der Kombination (31) aus Steigrohr- und vorderem Element, wobei das mindestens eine zweite mittlere Element (32, 33) und das Steig-

rohrelement (8) mit einer Einrichtung (4A) zum Zuführen von Vakuum versehen sind;

wobei:

(A) die mittlere Fläche des vorderen Entwässerungselements (5), die mittlere Fläche der Kombination (31) aus Steigrohr- und vorderem Element und der Abschnitt (20) des Steigrohrelements (13) mit dem Übergang zwischen der geneigten Fläche (18) und der Austrittsfläche (19) eine erste Ebene bilden;

(B) die abfallende(n) hintere(n) Fläche(n) (22) des mindestens einen ersten mittleren Entwässerungselements (29, 30) eine erste zweite Ebene bilden, die in einem vorgewählten nach unten gerichteten Winkel (α_1) zu der ersten Ebene geneigt ist; und

(C) die abfallende(n) hintere(n) Fläche(n) (22) des mindestens einen zweiten mittleren Entwässerungselements (32, 33) eine zweite Ebene bilden, die in einem vorgewählten nach unten gerichteten Winkel (α_2) zu der ersten Ebene geneigt ist.

9. Vorrichtung nach Anspruch 8, wobei der Winkel (α_1) zwischen der ersten Ebene und der ersten zweiten Ebene gleich ist wie oder anders als der Winkel (α_2) zwischen der ersten Ebene und der zweiten zweiten Ebene.

10. Verfahren zum Erzeugen eines gewünschten Grades an Turbulenz in einer Stoffschicht, die auf einem Formungsgewebe (13) in einem offenflächigen Formungsabschnitt einer Papierherstellungsmaschine getragen wird, wobei im wesentlichen das den Stoff tragende Formungsgewebe (13) über mindestens eine Entwässerungskasteneinrichtung (1) bewegt wird, die mehrere Gewebeauflageelemente (5, 6, 7, 8) unter und in stützendem Kontakt mit dem Formungsgewebe (13) trägt, und wobei eine kontrollierte Vakuumzufuhr (4) angewandt wird, um einen kontrollierten verminderten Druck in dem Entwässerungskasten (2) zu erzeugen, **dadurch gekennzeichnet, daß** die entwässernden Gewebeauflageelemente (5, 6, 7, 8) im wesentlichen aus folgendem bestehen:

(i) einem vorderen Entwässerungselement (5) mit einer Gewebeauflagefläche, das nacheinander folgendes umfaßt:

eine vordere Abstreichkante (14);
eine im wesentlichen horizontale mittlere Fläche (15); und
eine abfallende hintere Fläche (16);

(ii) einem Steigrohrentwässerungselement (8) mit einer Gewebeauflagefläche, das nacheinander folgendes umfaßt:

eine vordere Abstreichkante (17);
eine nach oben geneigte Fläche (18);
eine Austrittsfläche (19); und
einen Abschnitt (20), der den Übergang zwischen der nach oben geneigten Fläche (18) und der Austrittsfläche (19) umfaßt; und

(iii) mindestens einem mittleren Entwässerungselement (6, 7), das sich zwischen dem vorderen Entwässerungselement (5) und dem Steigrohrelement (8) befindet und von jedem anderen Entwässerungselement (6, 7) durch einen Spalt (10, 11, 12) beabstandet ist, wobei das bzw. jedes mittlere Element (6, 7) eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt:

eine vordere Abstreichkante (21);
eine abfallende Fläche (22); und
eine Hinterkante (23);

wobei:

(a) der am Übergang zwischen der geneigten Fläche (18) und der Austrittsfläche (19) befindliche Abschnitt (20) des Steigrohrelements (8) ausgewählt ist aus einer Spitze am Übergang zwischen der geneigten Fläche und der Austrittsfläche, einer kurzen im wesentlichen horizontalen Fläche, die die geneigte Fläche (18) und die Austrittsfläche (19) verbindet, und einer gekrümmten Fläche, die die geneigte Fläche (18) und die Austrittsfläche (19) verbindet;

(b) die mittlere Fläche (15) des vorderen Entwässerungselements und der Abschnitt (20) des Steigrohrelements (8) mit dem Übergang zwischen der geneigten Fläche (18) und der Austrittsfläche (19) eine erste Ebene bilden;

(c) die abfallende(n) Fläche(n) (22) des bzw. jedes mittleren Entwässerungselements (6, 7) eine zweite Ebene bilden, die in einem vorgewählten nach unten gerichteten Winkel (α) zu der ersten Ebene geneigt ist; und

(d) die vordere Abstreichkante (17) des Steigrohrelements (8) über der Hinterkante (23) des angrenzenden mittleren Entwässerungselements (7) liegt, so daß die Bewegung des Formungsgewebes von der Hinterkante (23) des angrenzenden mittleren Entwässerungselements (7) zur vorderen Abstreichkante (17) des

Steigrohrelements (8) in einer vertikalen Bewegung des Formungsgewebes (13) und sowohl des Anfangs der Papierbahn als auch des auf und sowohl des Anfangs der Papierbahn als auch des auf dem Formungsgewebe (13) getragenen Stoffes resultiert.

11. Verfahren nach Anspruch 10, wobei der gewünschte Grad der Turbulenz erzeugt und gesteuert wird durch mindestens ein verstellbares mittleres Entwässerungselement (6, 7), das sich zwischen dem vorderen Entwässerungselement (5) und dem Steigrohrelement (8) befindet, das verstellbar an dem Entwässerungskasten (2) befestigt ist (42, 43, 44), so daß die bzw. jede abfallende Fläche (35, 36, 37) desselben in der zweiten Ebene liegen kann; und wobei der Grad der Turbulenz gesteuert wird durch Verstellen des verstellbaren mittleren Auflageelements in eine gewünschte Lage in der zweiten Ebene.

12. Verfahren nach Anspruch 10 oder 11, wobei die Vorrichtung ferner ein zwischen dem Steigrohrelement (8) und dem angrenzenden mittleren Element (37) angeordnetes, die Entwässerung einschränkendes Element (55) umfaßt, das eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt:

eine vordere Abstreichkante; und
eine nach oben geneigte Fläche;

wobei die Befestigung des die Entwässerung einschränkenden Elements an dem Entwässerungskasten (2) so konstruiert und ausgelegt ist, daß die nach oben geneigte Fläche (55) in einem Winkel zur zweiten Ebene liegt, so daß dazwischen in Übereinstimmung mit der geneigten Fläche des Steigrohrelements ein flacher V-förmiger Winkel bereitgestellt wird.

13. Verfahren nach Anspruch 10, 11 oder 12, wobei der gewünschte Grad der Turbulenz erzeugt und gesteuert wird durch:

- (i) mindestens ein sich zwischen dem vorderen Entwässerungselement (5) und dem Steigrohrelement (8) befindendes verstellbares mittleres Entwässerungselement (6, 7), das verstellbar an dem Entwässerungskasten (2) befestigt ist (42, 43, 44), so daß die bzw. jede abfallende Fläche (35, 36, 37) desselben in der zweiten Ebene liegen kann; und
(ii) ein zwischen dem Steigrohrelement und dem angrenzenden mittleren Element angeordnetes, die Entwässerung einschränkendes Element, das eine Gewebeauflagefläche aufweist und nacheinander folgendes umfaßt:

eine vordere Abstreichkante; und
eine verstellbare nach oben geneigte Fläche;

wobei der Grad der Turbulenz gesteuert wird durch:

- (a) Verstellen des mindestens einen verstellbaren mittleren Auflageelements in eine gewünschte Lage in der zweiten Ebene; oder
(b) Verstellen des die Entwässerung einschränkenden Elements in eine andere Lage; oder
(c) sowohl Verstellen des mindestens einen verstellbaren mittleren Auflageelements in eine gewünschte Lage in der zweiten Ebene als auch Verstellen des die Entwässerung einschränkenden Elements in eine andere Lage;

14. Verfahren nach Anspruch 10 oder 13, wobei sich das Formungsgewebe mit einer Geschwindigkeit von gleich oder kleiner als etwa 400 m/min bewegt.

Revendications

1. Appareil pour générer une turbulence dans la pâte sur une toile de formation dans une section de formation de surface ouverte d'une machine à papier, la section de formation comprenant une toile de formation se déplaçant relativement lentement ayant un côté papier et un côté machine, une couche de pâte relativement épaisse sur le côté papier de celle-ci, l'appareil comprenant un moyen de boîtier d'élimination d'eau (1) situé en dessous de la toile de formation (13) relié à un moyen d'alimentation en vide contrôlé (4) opérationnel pour créer une pression réduite à l'intérieur du boîtier d'élimination d'eau (2), et une pluralité d'éléments d'élimination d'eau de support de la toile de formation (5, 6, 7, 8) portés par le boîtier d'élimination d'eau (2) à différents niveaux,

caractérisé en ce que

les éléments (5, 6, 7, 8) de support de la toile de formation (13) se composent essentiellement de :

- (i) un élément d'élimination d'eau d'entrée (5) ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage (14) ;
une surface intermédiaire sensiblement horizontale (15) ; et
une surface arrière en pente (16) ;

- (ii) un élément d'élimination d'eau de rehausse (8) ayant une surface de support de toile com-

prenant en séquence :

un bord avant de raclage (17) ;
une surface inclinée vers le haut (18) ;
une surface de sortie (19) ; et
une partie (20) comprenant la jonction de
la surface inclinée vers le haut (18) et de
la surface de sortie (19) ; et

(iii) au moins un élément d'élimination d'eau intermédiaire (6, 7) situé entre l'élément d'élimination d'eau d'entrée (5) et l'élément de rehausse (8) et espacé de chaque autre élément d'élimination d'eau (6, 7) par un espace (10, 11, 12), le ou chaque élément intermédiaire (6, 7) ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage (21) ;
une surface en pente (22) ; et
un bord arrière (23) ;

dans lequel :

(a) la partie (20) de l'élément de rehausse (8) située à la jonction de la surface inclinée (18) et de la surface de sortie (19) est choisie parmi un sommet à la jonction de la surface inclinée (18) et de la surface de sortie (19), une surface courte sensiblement horizontale reliant la surface inclinée (18) et la surface de sortie (19), et une surface courbée reliant la surface inclinée (18) et la surface de sortie (19) ;
(b) la surface intermédiaire (15) de l'élément d'élimination d'eau d'entrée (5), et la partie (20) de l'élément de rehausse (8) comprenant la jonction de la surface inclinée (18) et de la surface de sortie (19) définissent un premier plan ;
(c) la(les) surface(s) arrière(s) en pente (22) du(des), ou de chaque, élément(s) d'élimination d'eau intermédiaire(s) (6, 7) définit(définissent) un second plan incliné d'un angle arrière vers le bas pré-sélectionné (α) par rapport au premier plan ; et
(d) le bord avant de raclage (17) de l'élément de rehausse (8) est situé au-dessus du bord arrière (23) de l'élément d'élimination d'eau intermédiaire adjacent (7), de telle sorte que le mouvement de la toile de formation à partir du bord arrière (23) de l'élément d'élimination d'eau intermédiaire adjacent (7) jusqu'au bord avant de raclage (17) de l'élément de rehausse (8) a pour résultat un mouvement vertical de la toile de formation (13), et à la fois de la bande de papier naissante et de la pâte portée sur

la toile de formation (13).

2. Appareil selon la revendication 1, dans lequel l'élément (les éléments) d'élimination d'eau intermédiaire(s) (6, 7) situé(s) entre l'élément d'élimination d'eau d'entrée (5) et l'élément de rehausse (8) et espacé(s) de chaque autre élément d'élimination d'eau par un espace (10, 11, 12), est(sont) fixé(s) de façon réglable (42, 43, 44) au boîtier d'élimination d'eau (2) permettant le positionnement de la ou de chaque surface en pente (35, 36, 37) de celui-ci dans le second plan souhaité, et permettant le mouvement jusqu'à un second plan différent souhaité.

3. Appareil selon les revendications 1 ou 2, comprenant en outre un élément de limitation de drainage, qui est interposé entre l'élément de rehausse (8) et l'élément intermédiaire adjacent (37), ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage ; et
une surface inclinée vers le haut (55) ;

dans lequel la fixation (56, 57, 58) de l'élément de limitation de drainage au boîtier d'élimination d'eau (2) est construite et agencée pour positionner la surface inclinée vers le haut d'un angle par rapport au second plan afin de fournir un angle en « V » creux entre ceux-ci se conformant à la surface inclinée (18) de l'élément de rehausse (8).

4. Appareil selon la revendication 3, dans lequel la fixation (56, 57, 58) de l'élément de limitation de drainage au boîtier d'élimination d'eau est choisie parmi le groupe se composant d'une fixation fixe, d'une fixation réglable, et d'une seconde fixation réglable incorporée dans une première fixation réglable (42, 43, 44) pour les éléments intermédiaires.

5. Appareil selon les revendications 1, 2 ou 3, dans lequel tous les éléments de support de toile intermédiaires (6, 7) sont soit de la même largeur, soit ne sont pas tous de la même largeur, dans la direction de machine.

6. Appareil selon les revendications 1, 2 ou 3, dans lequel le ou chaque élément de support de toile intermédiaire (6, 7) a une surface en pente sensiblement plate ou un profil de pale d'agitateur (35).

7. Appareil selon les revendications 1, 2 ou 3, dans lequel l'angle arrière vers le bas (α) entre le premier plan et le second plan est compris entre environ 0,25° et environ 10°.

8. Appareil selon les revendications 1, 2 ou 3 se composant essentiellement de :

(i) un élément d'élimination d'eau d'entrée (5) ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage (14) ; 5
une surface intermédiaire sensiblement horizontale (15) ; et
une surface arrière en pente (16) ;

(ii) un élément d'élimination d'eau d'entrée et de rehausse combiné (31) ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage ;
une surface inclinée vers le haut ; 15
une surface arrière en pente, et
une surface intermédiaire sensiblement horizontale joignant la surface inclinée vers le haut et la surface arrière en pente ;
et 20

(iii) au moins un premier élément d'élimination d'eau intermédiaire (29, 30) situé entre l'élément d'élimination d'eau d'entrée (5) et l'élément d'entrée et de rehausse combiné (31) et espacé de chaque autre élément d'élimination d'eau par un espace, le(s) ou chaque premier (s) élément(s) intermédiaire(s) (29, 30) ayant une surface de support de toile comprenant en séquence : 25 30

un bord avant de raclage ;
une surface en pente ; et
un bord arrière ; 35

(iv) un élément d'élimination d'eau de rehausse (8) ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage (17) ; 40
une surface inclinée vers le haut (18) ;
une surface de sortie (19) ; et
une partie (20) comprenant la jonction de la surface inclinée vers le haut (18) et de la surface de sortie (19) ; 45

(v) au moins un second élément d'élimination d'eau intermédiaire (32, 33) situé entre l'élément d'élimination d'eau d'entrée et de rehausse combiné (31) et l'élément de rehausse (8) et espacé de chaque autre élément d'élimination d'eau par un espace, le(s) ou chaque élément (s) intermédiaire(s) (32, 33) ayant une surface de support de toile comprenant en séquence : 50

un bord avant de raclage (21) ;
une surface en pente (22) ; et
un bord arrière (23) ; et 55

(vi) soit :

- un boîtier d'élimination d'eau unique (2) supportant la pluralité d'éléments de support (5, 29, 30, 31, 32, 33, 8) de toile de formation (13) et relié à un moyen d'alimentation en vide unique (4), ou
- un boîtier d'élimination d'eau (2) comprenant un premier compartiment (2B) en dessous de l'élément d'entrée (13), du (des) premier(s) élément(s) intermédiaire(s) (29, 30) et de l'élément d'entrée et de rehausse combiné (31) pourvu d'un moyen d'alimentation en vide (4B) conjointement avec
- un second compartiment (2A) en dessous de l'élément d'entrée et de rehausse combiné (31), du (des) second(s) élément(s) intermédiaire(s) (32, 33) et l'élément de rehausse (8) pourvu d'un moyen d'alimentation en vide (4A) ;

dans lequel :

(A) la surface intermédiaire de l'élément d'élimination d'eau d'entrée (5), la surface intermédiaire de l'élément d'entrée et de rehausse combiné (31) et la partie (20) de l'élément de rehausse (13) comprenant la jonction de la surface inclinée (18) et de la surface de sortie (19) définissent un premier plan ;

(B) la (les) surface(s) arrière(s) en pente (22) du (des) premier(s) élément(s) d'élimination d'eau intermédiaire(s) (29, 30) définit (définissent) un premier second plan incliné selon un angle arrière vers le bas pré-sélectionné (α_1) par rapport au premier plan ; et

(C) la(les) surface(s) arrière(s) en pente (22) du (des) second(s) élément(s) d'élimination d'eau intermédiaire(s) (32, 33) définit(définissent) un second second plan incliné selon un angle arrière vers la bas pré-sélectionné (α_2) par rapport au premier plan.

9. Appareil selon la revendication 8, dans lequel l'angle (α_1) entre le premier plan et le premier second plan est le même que, ou différent de, l'angle (α_2) entre le premier plan et le second second plan.

10. Procédé pour créer un niveau souhaité de turbulence dans une couche de pâte portée sur une toile de formation (13) dans une section de formation de surface ouverte d'une machine à papier, consistant essentiellement à déplacer la toile de formation (13) portant la pâte au-dessus d'au moins un moyen de boîtier d'élimination d'eau (1) portant une pluralité d'éléments de support de toile (5, 6, 7, 8) en dessous de, et en contact de support avec, la toile de formation (13), et à appliquer une alimentation en

vide contrôlée (4) pour créer une pression réduite contrôlée dans le boîtier d'élimination d'eau (2),

caractérisé en ce que

les éléments de support de toile d'élimination d'eau (5, 6, 7, 8) se composent essentiellement de : 5

(i) un élément d'élimination d'eau d'entrée (5) ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage (14) ;
une surface intermédiaire sensiblement horizontale (15) ; et
une surface arrière en pente (16) ; 10 15

(ii) un élément d'élimination d'eau de rehausse (8) ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage (17) ;
une surface inclinée vers le haut (18) ;
une surface de sortie (19) ; et
une partie (20) comprenant la jonction de la surface inclinée vers le haut (18) et de la surface de sortie (19) ; et 20 25

(iii) au moins un élément d'élimination d'eau intermédiaire (6, 7) situé entre l'élément d'élimination d'eau d'entrée (5) et l'élément de rehausse (8) et espacé de chaque autre élément d'élimination d'eau (6, 7) par un espace (10, 11, 12), le ou chaque élément intermédiaire (6, 7) ayant une surface de support de toile comprenant en séquence : 30 35

un bord avant de raclage (21) ;
une surface en pente (22) ; et
un bord arrière (23) ;

dans lequel : 40

(a) la partie (20) de l'élément de rehausse (8) situé à la jonction de la surface inclinée (18) et de la surface de sortie (19) est choisie parmi un sommet à la jonction de la surface inclinée et de la surface de sortie, une surface courte sensiblement horizontale reliant la surface inclinée (18) et la surface de sortie (19), et une surface courbée reliant la surface inclinée (18) et la surface de sortie (19) ; 45 50

(b) la surface intermédiaire (15) de l'élément d'élimination d'eau d'entrée, et la partie (20) de l'élément de rehausse (8) comprenant la jonction de la surface inclinée (18) et de la surface de sortie (19) définissent un premier plan ; 55

(c) la(les) surface(s) en pente (22) du(des), ou de chaque, élément(s) d'élimination d'eau intermédiaire(s) (6, 7) définit (définissent) un se-

cond plan incliné d'un angle arrière vers le bas pré-sélectionné (α) par rapport au premier plan ; et

(d) le bord avant de raclage (17) de l'élément de rehausse (18) est situé au-dessus du bord arrière (23) de l'élément d'élimination d'eau intermédiaire adjacent (7), de telle sorte que le mouvement de la toile de formation à partir du bord arrière (23) de l'élément d'élimination d'eau intermédiaire adjacent (7) jusqu'au bord avant de raclage (17) de l'élément de rehausse (8) a pour résultat un mouvement vertical de la toile de formation (13), et à la fois de la bande de papier naissante et la pâte portée sur la toile de formation (13).

11. Procédé selon la revendication 10, dans lequel le niveau souhaité de turbulence est créé et contrôlé par au moins un élément d'élimination d'eau intermédiaire réglable (6, 7) situé entre l'élément d'élimination d'eau d'entrée (5) et l'élément de rehausse (8) qui est de façon réglable fixé (42, 43, 44) au boîtier d'élimination d'eau (2) permettant le positionnement de la ou de chaque surface en pente (35, 36, 37) de celui-ci dans le second plan ; et le niveau de turbulence est contrôlé en réglant l'élément de support intermédiaire réglable selon une position de second plan souhaitée.

12. Procédé selon les revendications 10 ou 11, dans lequel l'appareil comprend en outre un élément de limitation de drainage (55), qui est interposé entre l'élément de rehausse (8) et l'élément intermédiaire adjacent (37), ayant une surface de support de toile comprenant en séquence :

un bord avant de raclage ; et
une surface inclinée vers le haut ;

dans lequel la fixation de l'élément de limitation de drainage au boîtier d'élimination d'eau (2) est construite et agencée pour positionner la surface inclinée vers le haut (55) selon un angle par rapport au second plan afin de fournir un angle en « V » creux entre ceux-ci en conformité avec la surface inclinée de l'élément de rehausse.

13. Procédé selon les revendications 10, 11 ou 12, dans lequel le niveau souhaité de turbulence est créé et contrôlé par :

(i) au moins un élément d'élimination d'eau intermédiaire réglable (6, 7) situé entre l'élément d'élimination d'eau d'entrée (5) et l'élément de rehausse (8) qui est de façon réglable fixé (42, 43, 44) au boîtier d'élimination d'eau (2) permettant le positionnement de la ou de chaque surface en pente (35, 36, 37) de celui-ci dans

le second plan ; et

(ii) un élément de limitation de drainage, qui est interposé entre l'élément de rehausse et l'élément intermédiaire adjacent, ayant une surface de support de toile comprenant en séquence :

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un bord avant de raclage ; et

une surface inclinée vers le haut réglable ;

dans lequel le niveau de turbulence est contrôlé :

10

(a) en réglant l'élément(les éléments) de support intermédiaire(s) réglable(s) selon un positionnement de second plan souhaité ; ou

15

(b) en réglant l'élément de limitation de drainage selon un positionnement différent ; ou

(c) en réglant à la fois l'élément(les éléments) de support intermédiaire(s) réglable(s) selon un positionnement de second plan souhaité, et

20

en réglant l'élément de limitation de drainage selon un positionnement différent.

14. Procédé selon les revendications 10 ou 13, dans lequel la toile de formation se déplace à une vitesse égale ou inférieure à environ 400 m/min.

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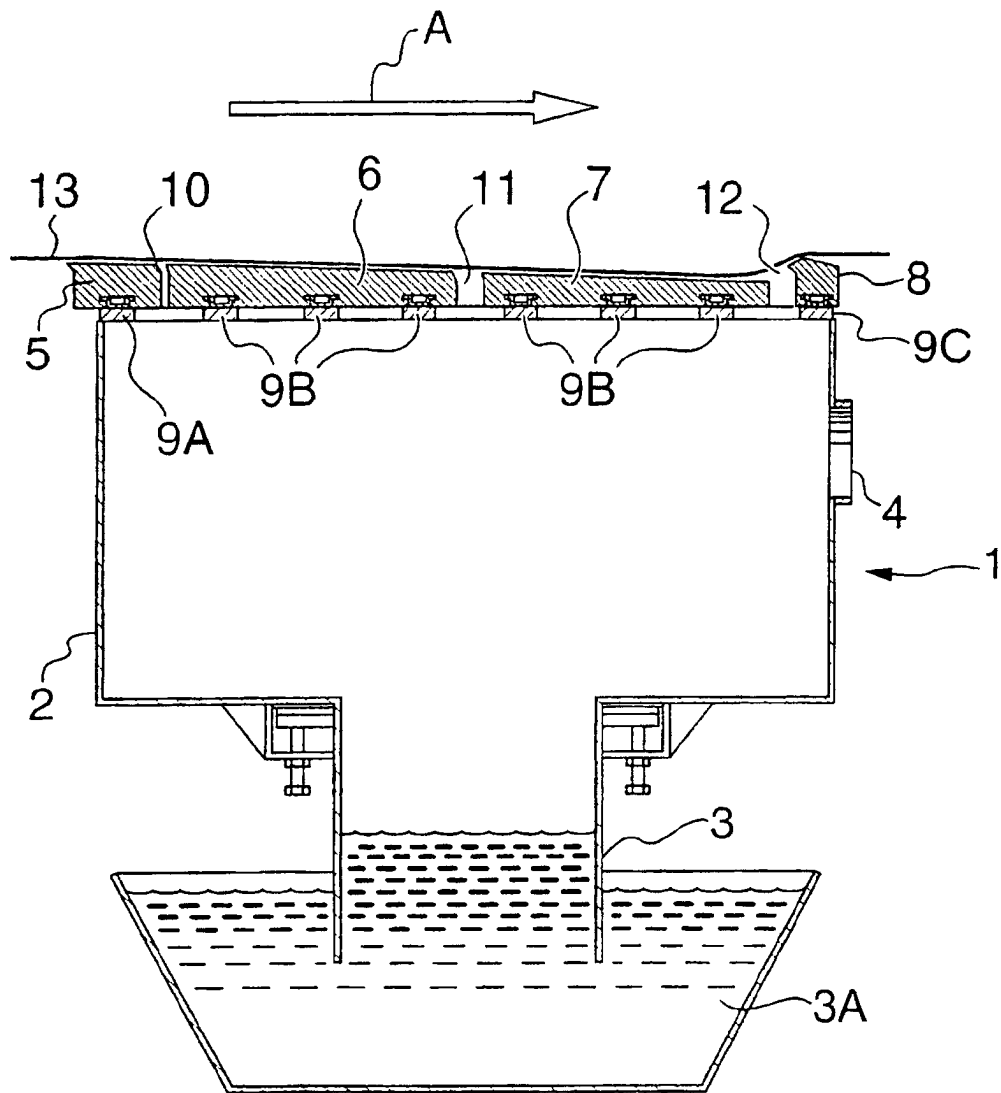
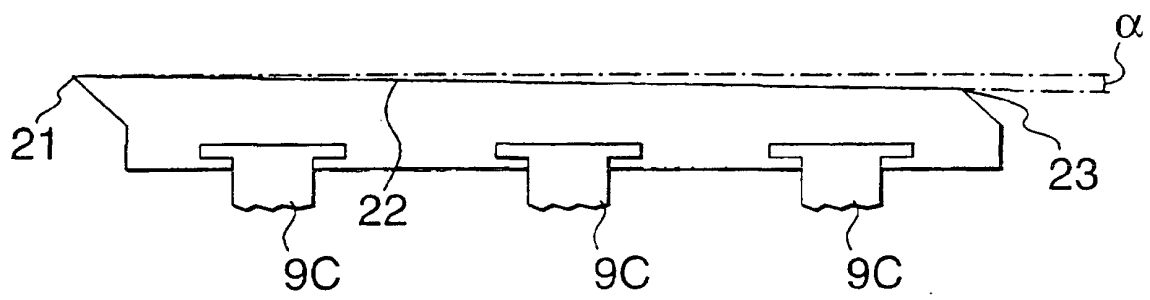
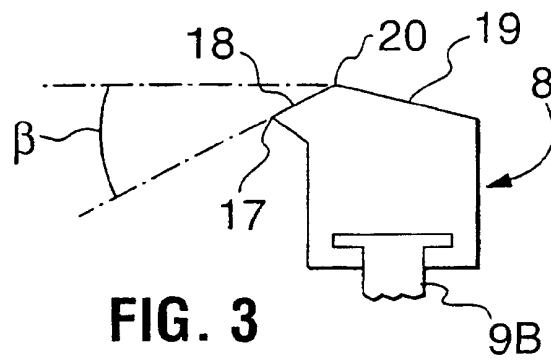
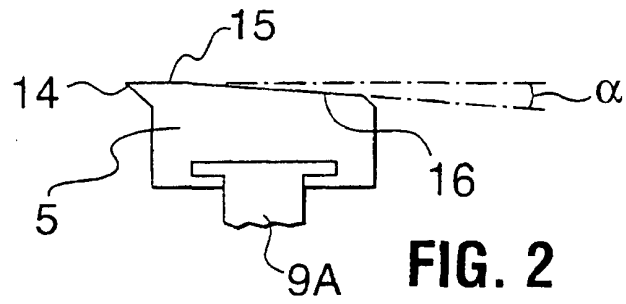


FIG. 1



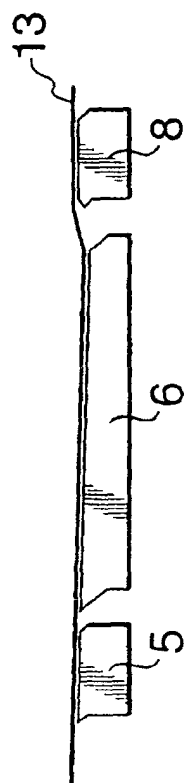


FIG. 5

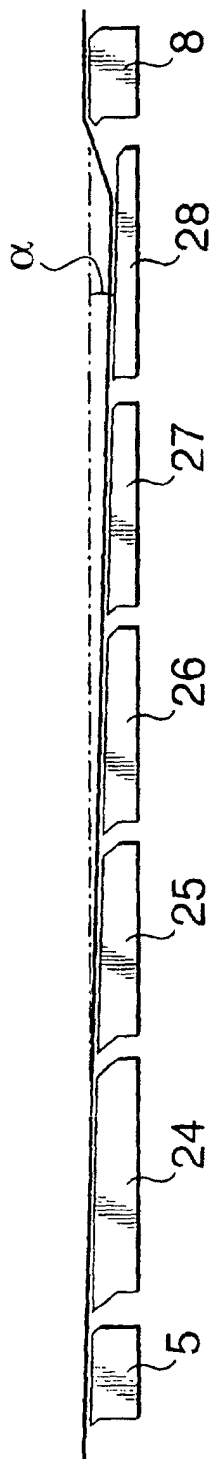


FIG. 6



FIG. 8

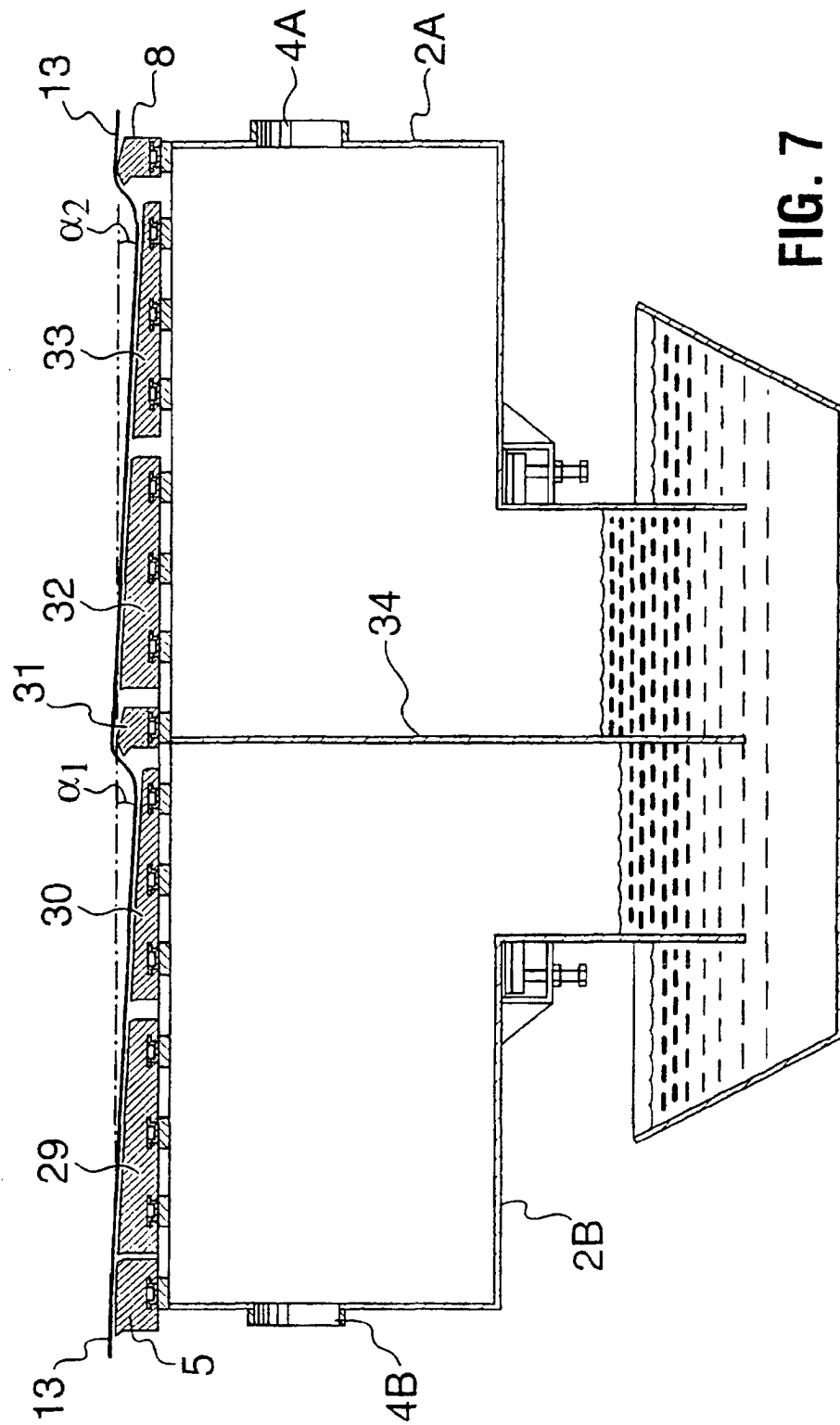


FIG. 7

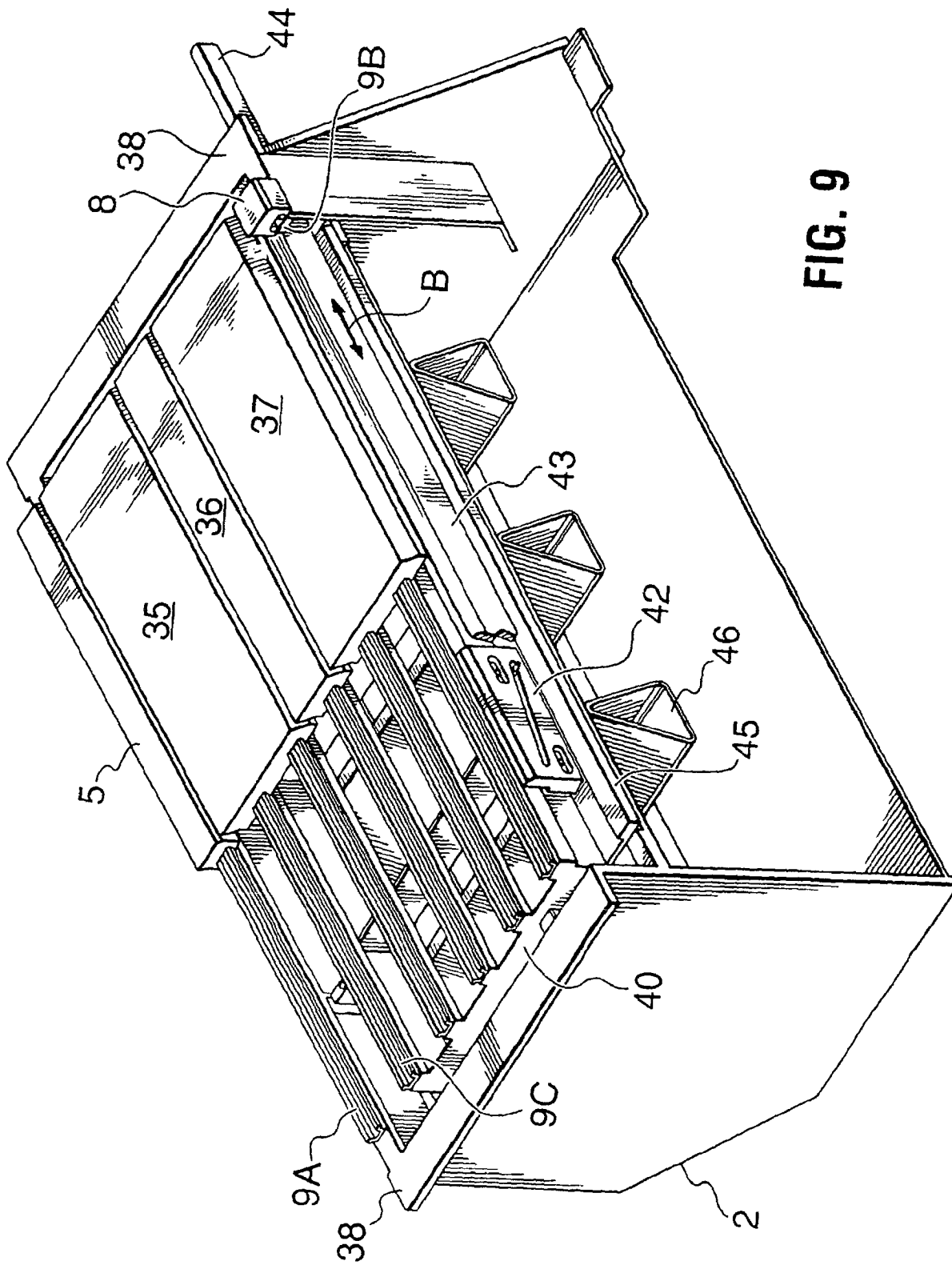
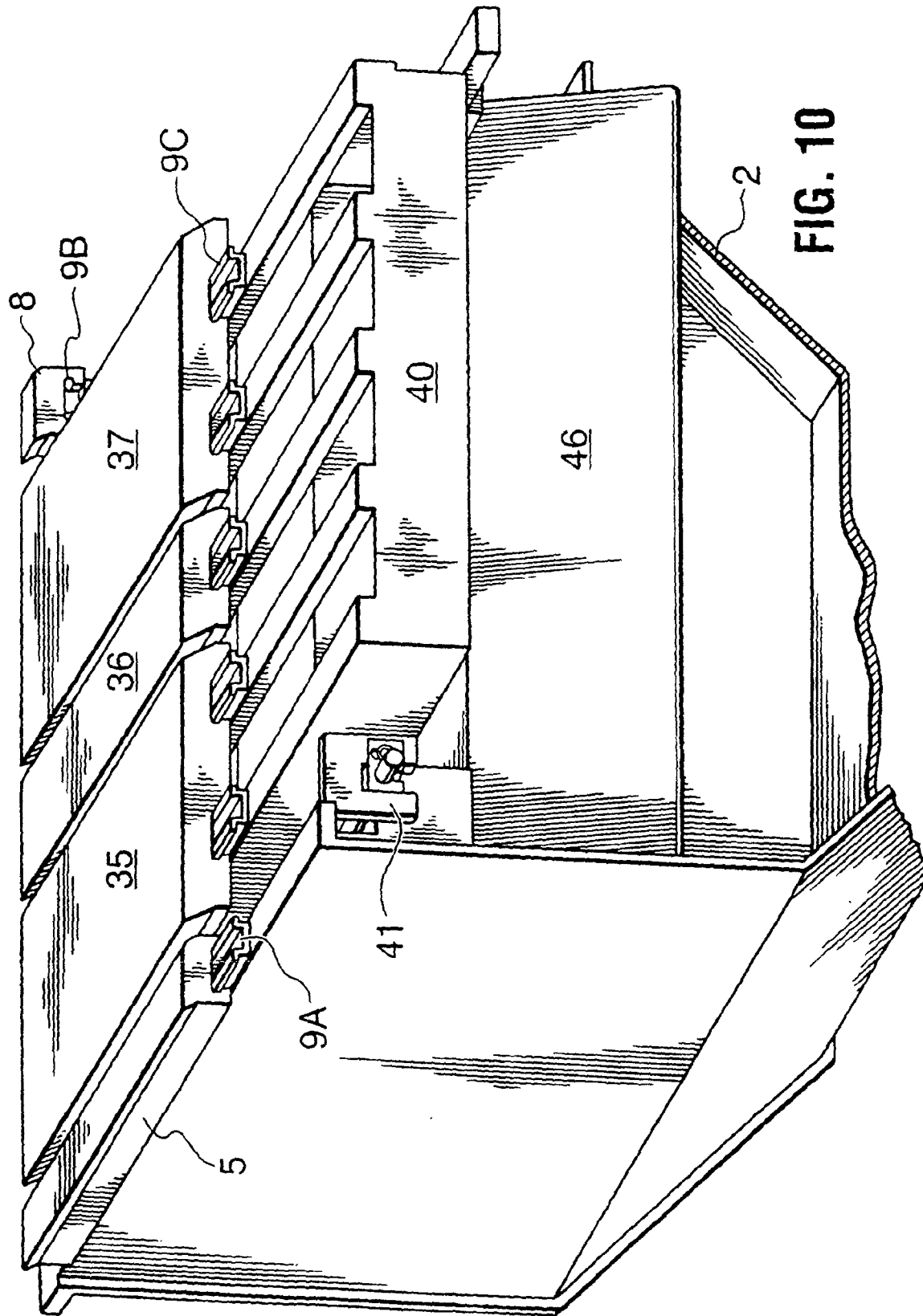


FIG. 9



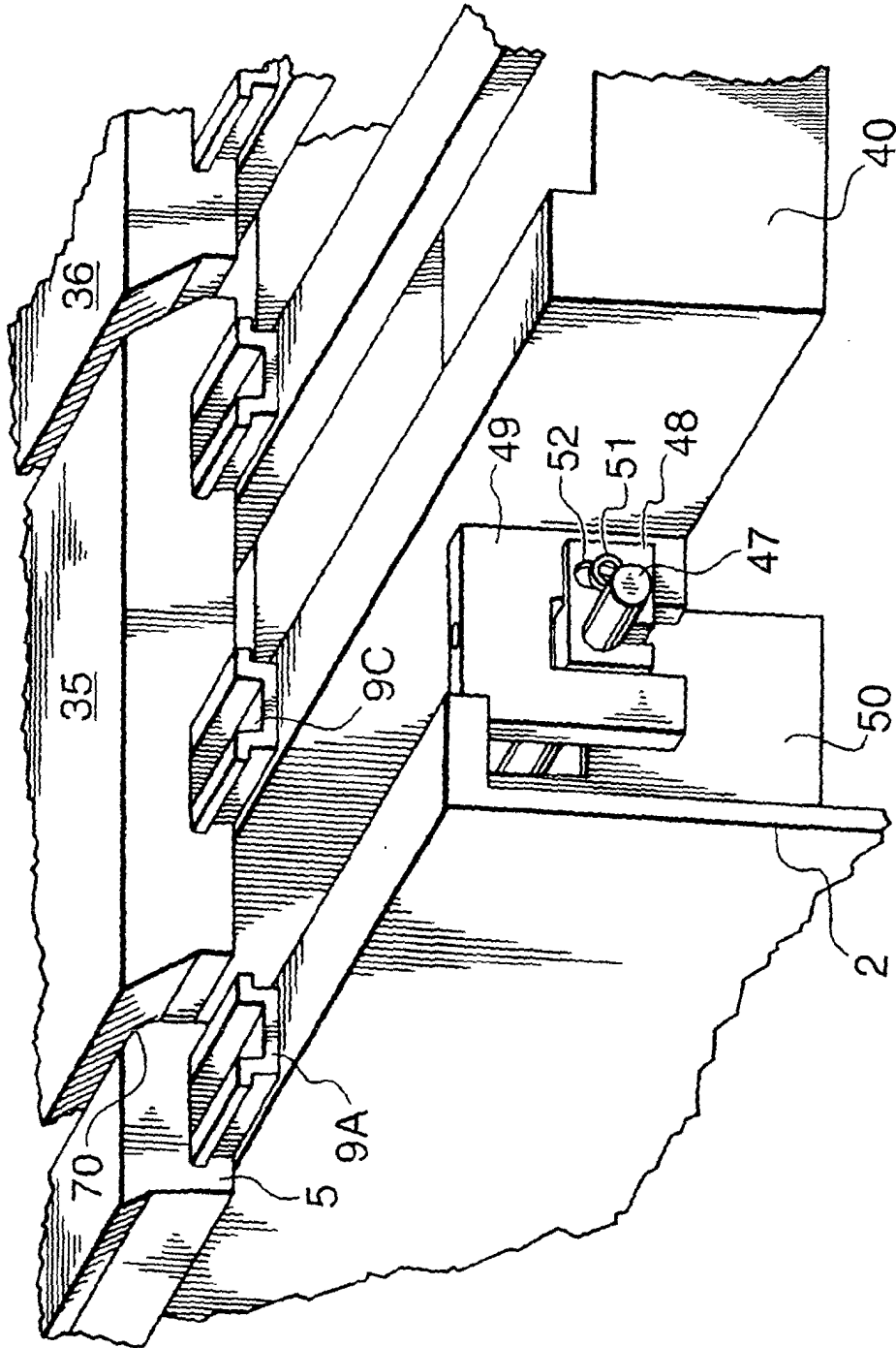


FIG. 11

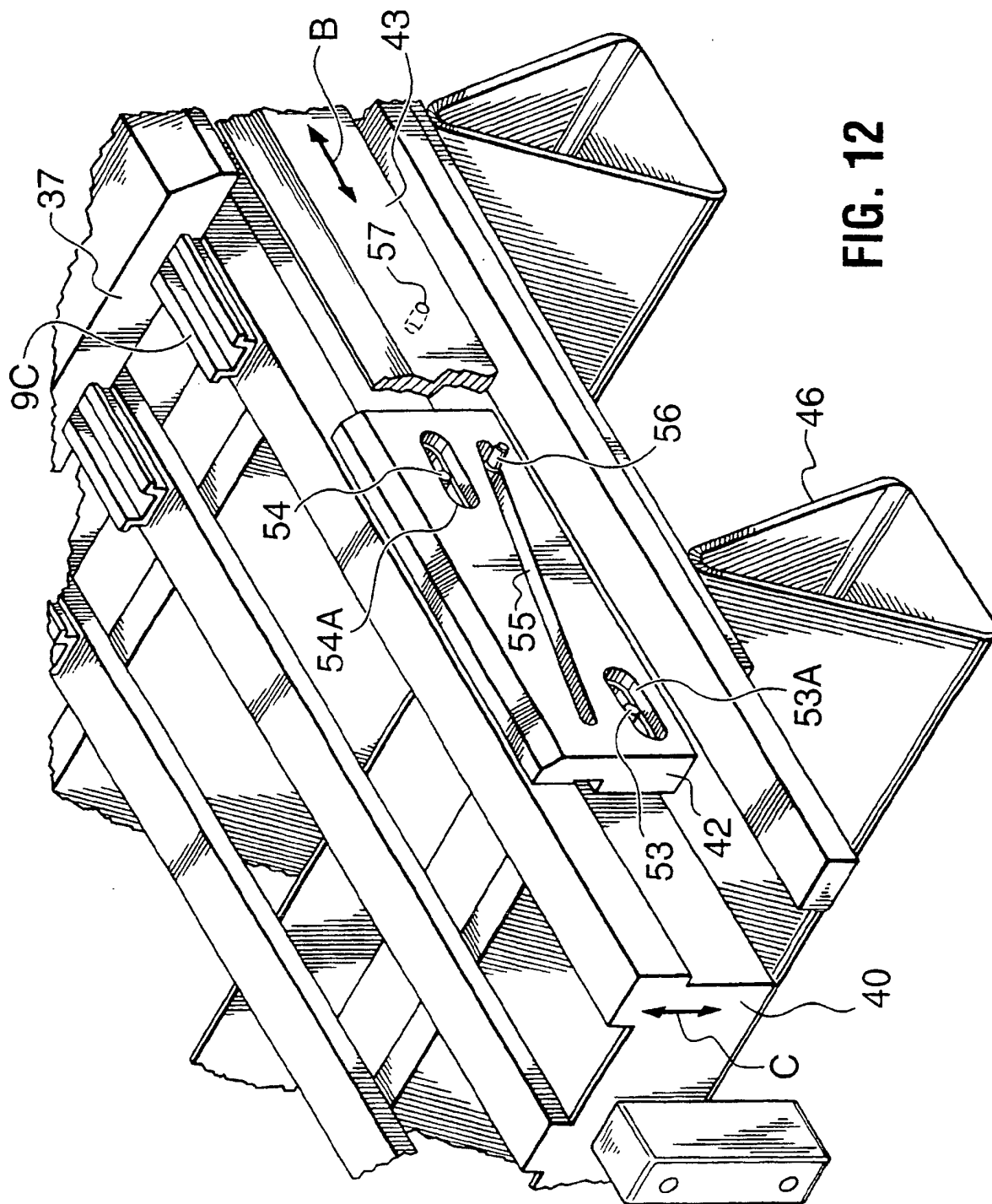


FIG. 12

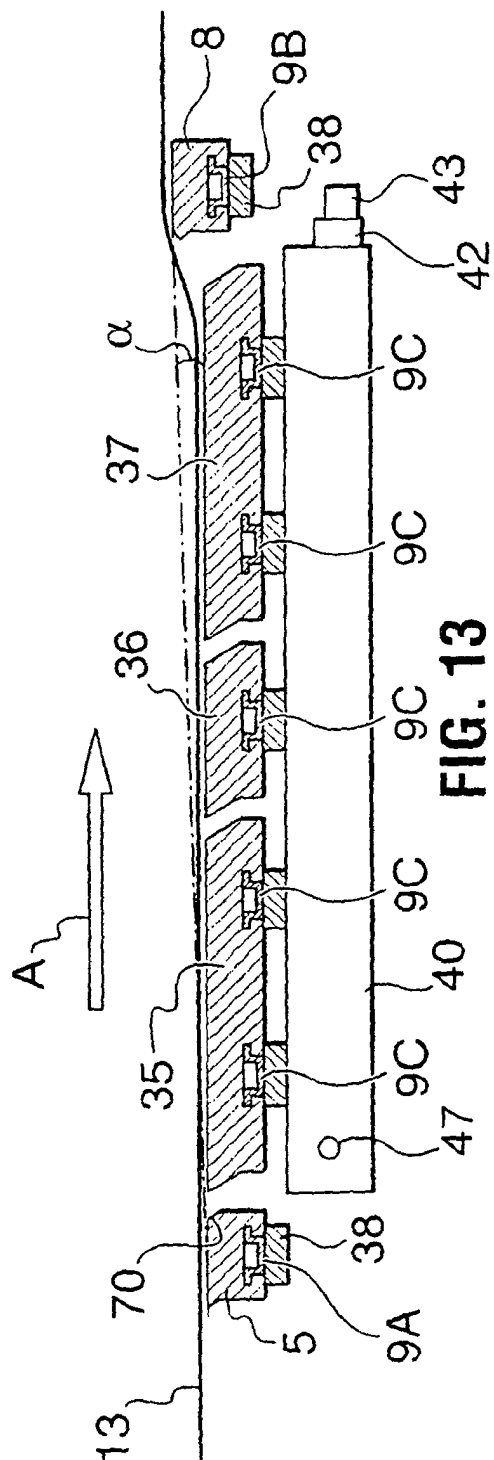


FIG. 13

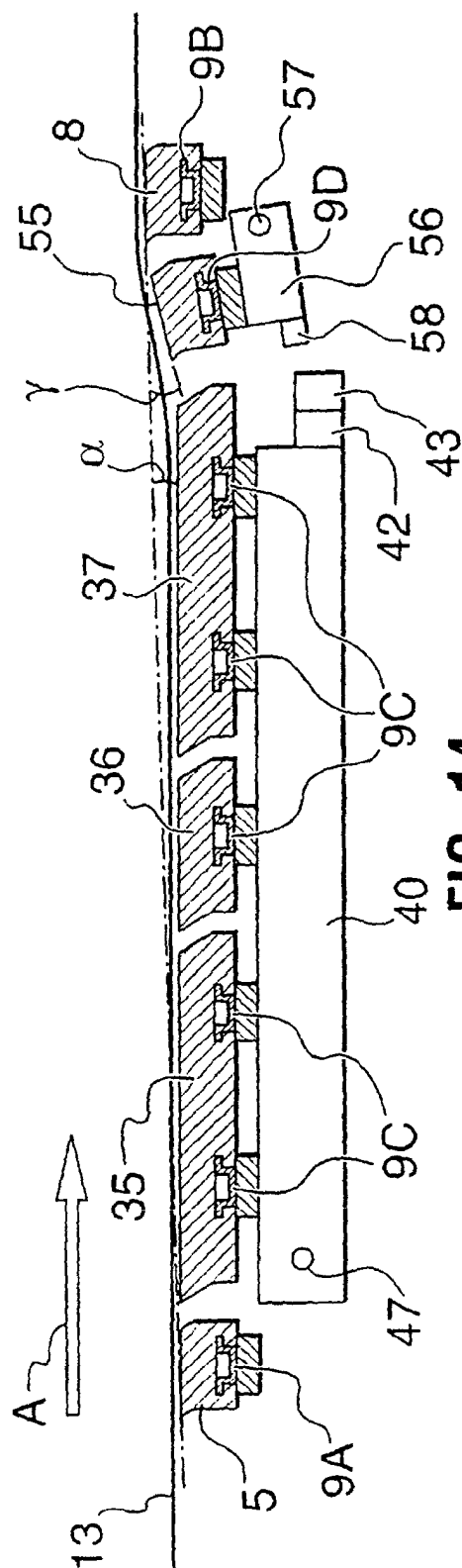


FIG. 14

