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(54) Title: ADJUSTABLE ACTIVITY DRAINAGE BOX

(57) Abstract: A process, and an apparatus, for improving sheet properties in the initial impingement zone of a paper making machine including a forming section, a forming fabric moving in the machine direction and a head box having a head box slice which delivers a stock jet onto the moving forming fabric. The scale and intensity of agitation within the stock is adjusted by moving some of the support elements beneath the forming fabric adjacent the head box slice so that they either contact, or do not contact, the machine side surface of the forming fabric. This technique is of use in a papermaking machine forming section having a single open surface forming fabric, in the initial open surface section of a so-called hybrid gap former having two superposed forming fabrics, and in the forming section of a two fabric papermaking machine.



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ADJUSTABLE ACTIVITY DRAINAGE BOX

SUMMARY OF THE INVENTION

The present invention relates to a process, and an apparatus for improving sheet properties in the wet end of a paper making machine including a forming section, a forming fabric moving in the machine direction and a head box having a head box slice which delivers a stock jet onto the moving forming fabric. It is particularly concerned with a method in which the activity within the stock is adjusted in terms of scale and intensity by moving some of the support elements beneath the forming fabric adjacent the head box slice so that they either contact, or do not contact, the machine side surface of the forming fabric. This invention is thus of use in both a conventional papermaking machine forming section having a single open surface forming fabric, in the initial open surface section of a so-called hybrid gap former having two superposed forming fabrics, and in twin fabric papermaking machines equipped with a curved forming shoe.

BACKGROUND OF THE INVENTION

In the manufacture of paper and board products, a highly aqueous stock consisting of about 98 - 99.8% water and from 0.2 - 2% papermaking fibers and other solids is ejected at high speed from a headbox slice onto a moving forming fabric. Adjacent the head box slice, the forming fabric passes in sliding contact over a plurality of fabric support elements which serve to support the forming fabric, and to define a reference surface over which the forming fabric moves. Depending on the surface profile chosen for the fabric support elements, they may also assist in draining water from the stock

on the forming fabric. The fabric support surfaces usually include a lead blade located more or less underneath the point at which the stock jet impinges the forming fabric, followed downstream by at least two additional surfaces, each of which may be flat, or profiled to act as foils (e.g. as disclosed by Wrist in US 2,928,465) or as agitators (e.g. as disclosed by Johnson, in US 3,874,998), although stock agitation is not typically initiated at this very early point in the forming section. In current practice, the individual fabric contacting elements adjacent the head box slice are not vertically adjustable. These elements are normally mounted using either a dovetail, or a T-bar, and in some cases are solidly mounted. The mountings are also arranged so that all of the elements are in contact with the forming fabric. Stock activity can only be adjusted by changing, or physically removing the fabric contact elements by sliding them out of their dovetail or T-bar mount.

Papermakers are currently seeking means to accommodate changes in the basis weight of the paper product being manufactured by the same machine. For example, a papermaking machine producing liner or board grades at a relatively low basis weight may have to shift to a far higher basis weight product. It is thus apparent that a given papermaking machine, without some means of adjustment, is best at making one grade of paper product and cannot readily be altered to make a significantly different one. It is not uncommon today for a papermaking machine to have to accommodate a doubling or tripling of the basis weight of the product being manufactured. Such changes are frequently difficult to accommodate, and therefore alternative means of achieving a required level of activity in the stock are necessary to accommodate changes in paper grade with minimal disruption to production.

Good sheet properties result from the injection of kinetic energy into the stock, which causes the papermaking fibers to become agitated and thus relatively more uniformly dispersed. This is particularly important at the early part of the forming section, where the paper making fibers are still relatively mobile.

This invention seeks to provide a method and an apparatus by means of which the papermaker can alter the number of fabric support elements in contact with the forming fabric immediately after the stock impinges onto the forming fabric in the area adjacent to the head box slice so as either to enhance, to maintain or to diminish stock activity and thereby optimize agitation in accordance with papermaking conditions.

DISCUSSION OF THE PRIOR ART

Smith et al. in US 5,080,760 disclose a sealed pressurized forming board in which the rate of drainage of fluid from the stock is slowed by applying a small positive pressure to the machine side of the forming fabric, which also allows stock activity to be initiated without increasing drainage. The level of stock activity can only be controlled by physically removing the fabric supporting elements and replacing them with others having differing support surface profiles.

Johnson in US 4,140,573 discloses a sealed cover for a low vacuum suction box in which some of the fabric contacting elements are fixed in a position that is a small amount below the others; the applied vacuum causes the forming fabric to follow the element surfaces along an undulating path, thereby inducing agitation in the stock. Johnson discloses that the relative heights of the elements can be adjusted by means of

pins and set screws, or by movement of an element having a sloping T-recess relative to sloping a T-bar. Both adjustment means are time consuming, laborious and may require shutting down the paper machine to perform. This box is not generally used adjacent the headbox slice, since vacuum assisted drainage is usually not desirable at that early point in the forming section.

Miller in US 5,421,961 discloses a forming board whose cross-machine direction orientation relative to the headbox is adjustable and controlled so as to maintain it in parallel relation to the slice. There is no effort or intention to control stock activity.

Thorp in US 4,443,298 discloses an adjustable blade support member whereby, in one embodiment, the blade-to-blade spacing in the machine direction is adjusted by means of a screw. However, the elements are only moved laterally, not vertically.

Ibrahim in US 4,684,441 and US 4,718,983 discloses a forming board in which the width of the lead-in blade is adjustable without stopping the papermaking machine. A thin strip located on the paper side surface of the blade can be moved so as to intercept the point of impingement of the stock jet.

Morley in GB 2,190,932 discloses a forming board in which the depth of a slot or groove can be changed by physically removing or inserting spacers of different thicknesses, without stopping the papermaking machine so as to induce microturbulence.

A number of inventors have disclosed vertically adjustable support element mounting devices. Typical structures are shown by: Bartelmuss et al in US 5,660,689; Bubik et al. in US 5,262,010 and US 5,061,347; and Jaakkola US 5,387,320.

SUMMARY OF THE INVENTION

This invention seeks to provide both a process, and an apparatus, whereby agitation in the stock on the forming fabric adjacent to the head box slice can be controlled. It is thus possible to initiate agitation within the stock, and to adjust both its scale and intensity, adjacent to the headbox slice. This is achieved by mounting at least some of the fabric support elements on vertically adjustable support means so that their height can be altered. Further, the apparatus envisaged by this invention allows the element vertical position to be altered without stopping the paper making machine.

Thus in a first broad embodiment this invention seeks to provide a process for improving sheet properties in a paper making machine including a forming section, at least one forming fabric, having a machine side and a paper side, moving in the machine direction and a head box having a head box slice which delivers a stock jet onto the paper side of the at least one moving forming fabric, comprising the steps of:-

(i) discharging the stock jet onto the paper side of the at least one moving forming fabric;

(ii) causing the machine side of the at least one forming fabric carrying the stock on its paper side to move over in sequence in the machine direction:

- a first fixed support element adjacent the head box slice and in contact with the forming fabric;

- at least one drainage box provided with a foraminous support surface, which support surface includes at least one vertically moveable support element, and provided with support means for the first fixed element; and

- a last fixed support element in contact with the forming fabric, which together with the first fixed support element and the machine side of the at least one forming fabric defines a reference surface; and

(iii) adjusting both the scale and intensity of agitation in the stock at at least one locus by altering the vertical position relative to the reference surface of at least one vertically adjustable element whereby the at least one element is moved vertically into a position chosen from the group consisting of in contact with the machine side of the forming fabric, and out of contact with the machine side of the forming fabric.

In a second broad embodiment this invention seeks to provide an apparatus for improving sheet properties in a paper making machine including a forming section, at least one forming fabric, having a machine side and a paper side, moving in the machine direction and a head box having a head box slice which delivers a stock jet onto the paper side of the at least one moving forming fabric, comprising in sequence in the machine direction:

- a first fixed support element adjacent the head box slice and in contact with the machine side of the at least one forming fabric;

- at least one drainage box provided with a foraminous support surface, which support surface includes at least one vertically moveable support element, and provided with support means for the first fixed element;

- a last fixed support element in contact with the machine side of the at least one forming fabric, which together with

the first fixed support element and the machine side of the at least one forming fabric defines a reference surface; and

- an independently controlled vertical adjustment means for the at least one vertically moveable support element.

Preferably, the last fixed element is supported by an adjacent drainage box in the forming section. Alternatively, the last fixed element is supported by the at least one drainage box.

Preferably, the apparatus includes one drainage box. Alternatively, the apparatus includes two drainage boxes, each of which supports part of the foraminous surface.

Preferably, the foraminous surface includes a plurality of support elements, at least one of which is vertically moveable, and the remainder of which have their fabric support surfaces located along the reference surface. More preferably, the foraminous surface includes a plurality of support elements, at least some of which are vertically moveable, and the remainder of which have their fabric support surfaces located along the reference surface. Alternatively, the foraminous surface includes a plurality of support elements, all of which are vertically moveable. Conveniently, the foraminous surface includes either a plurality of support elements in which alternate elements are vertically moveable, or a plurality of support elements in which alternate elements are vertically moveable, and in which the support elements adjacent the first and last fixed elements are moveable.

Preferably, at least that portion of the forming section adjacent the head box slice has an open surface. More preferably, the papermaking machine including the forming section is chosen from the group consisting of:

- an open surface papermaking machine having a single forming fabric;
- a hybrid gap former papermaking machine having two superposed forming fabrics in which at least that portion of the forming section adjacent the head box slice has one forming fabric having an open surface; and
- a twin fabric papermaking machine having two forming fabrics each having a paper side and a machine side, in which the jet of stock is delivered into the gap between the paper sides of the two fabrics, and at least one support element in contact with the machine side of one of the forming fabrics is moveable.

In the context of the direction of movement of the moveable forming fabric support elements used in this invention, the word "vertical" is to be taken to mean a direction essentially perpendicular to the machine side of the forming fabric adjacent to that element. In an open surface forming section this generally will be in a truly vertical direction, as the forming fabric open surface is horizontal. In the forming section of a twin fabric papermaking machine, this will often be a direction other than truly vertical, since the forming sections in such machines are often not horizontal.

DETAILED DESCRIPTION OF THE INVENTION

The invention will now be described with reference to the attached schematic drawings in which:

Figure 1 shows schematically the general arrangement of the initial impingement zone of a paper making machine having an open surface forming section;

Figure 2 shows the apparatus of Figure 1 set up for use;

Figure 3 shows a first alternative general arrangement to that shown in Figure 1;

Figure 4 shows an element adjusting means; and

Figure 5 shows a second alternative arrangement to that shown in Figures 1 and 2.

Referring first to Figure 1, the initial impingement zone 1 shown includes a forming fabric 2 which moves in the machine direction indicated at 3. The forming fabric 2 wraps around a breast roll 4, and passes underneath a head box 5, which has a head box slice 6. A jet of stock 7 is delivered from the head box slice 6 onto the paper side 2B of the moving forming fabric 2 as its machine side 2A passes over support elements 8, 9, 10, 11, 12, and 14. Support elements 8 - 12 inclusive are mounted onto a first drainage box 15, and support element 14 is mounted onto a second drainage box 16. The drainage box is not sealed, and drainage through the forming fabric is consequently not vacuum assisted. There is a gap 17 between the two drainage boxes 15 and 16.

As shown in Figure 1, the machine side surface 2A of the forming fabric 2 is in the reference surface 20. This plane is defined by the location of the fabric supporting surface 8A on the first fixed support element, and by the location of the fabric supporting surface 14A on the last fixed support element 14. The position of the reference surface can be readily determined, as its ends are defined by two fixed support surfaces. It is therefore used in this invention as a datum line for adjusting the moveable support elements relative to the forming fabric.

In between the first fixed support element 8, and the last fixed support element 14, the foraminous surface includes four support elements 9 - 12. As shown in Figure 1, all four are retracted out of the reference plane 20 (in Figure 1, and the other Figures, all vertical distances concerning the moveable

support elements are exaggerated for clarity) and thus out of contact with the forming fabric. Several arrangements for these support elements are possible.

Figure 2 shows one possibility. In this arrangement, support elements 10 and 12 are retracted out of contact with the forming fabric, and support elements 9 and 11 are in contact with the forming fabric. Depending upon the level of activity desired in the stock at this early point in the formation process, it may be desirable to reverse this sequence, and locate elements 9 and 11 out of contact, and elements 10 and 12 in contact.

In Figure 3, two changes are made in comparison with Figure 1.

First, the foraminous surface is supported by two drainage boxes. The first part of the foraminous surface, represented by the support elements 9 - 12 inclusive, is supported by the drainage box 15, and the second part, represented by the support elements 30 - 34, is supported by the drainage box 18. The three drainage boxes 15, 18 and 16 in sequence are separated by the gaps 17 and 17A. The first fixed element 8 is supported by the drainage box 15, and the last fixed element 14 is supported by the drainage box 16. As shown, the support elements 9 - 12 and 31 - 34 are retracted out of the reference plane 20, and thus out of contact with the surface 2A of the forming fabric 2. Support element 30 is shown in the reference plane and thus in contact with the machine side surface 2A of the forming fabric 2. Although support element 30 can be a moveable element, it is preferred that support element 30 is fixed, with its surface 30A set in the reference plane defined by the preceding first fixed element 8 and the following last fixed element 14.

Second, the number of support elements in the foraminous support surface between the first and last fixed support elements is higher, there being 4 in Figure 1, and 9 in Figure 3. It can thus be seen that there is considerable flexibility in choosing how many support elements are to comprise the foraminous surface. In use, the vertical position of each the support elements 9 - 12 and 30 - 34, will locate each of them either in contact, or out of contact, with the machine side surface 2A of the forming fabric 2, and will be chosen so as to adjust the scale and intensity of activity in the stock carried by the paper side 2B of the forming fabric 2.

In Figure 4 a preferred mechanism for locating the moveable elements is shown, as part of an alternative arrangement to that shown in Figures 1 and 2. As shown in Figure 3, two elements, 9 and 11 are fixed and cannot be moved, and two elements, 10 and 12, can be moved to locate their fabric support surfaces 10A and 12A each separately in or out of contact with the forming fabric. The mounting for element 10 is exemplary.

The support element 10 includes a suitably shaped slot 41 which is a sliding fit onto a standard T-bar 42. The T-bar is carried by an arm, 43 which is pivotally mounted at one end, as at 44. The framing required to support the pivot 44 is not shown; in practice, several mounting units will normally be required for each moveable element spread out across the width of the forming section framing. At the other end, the arm 43 is attached to one end of a link 45; the other end of the link 45 is attached to a lever arm 46 carried by a shaft 47. Rotation of the shaft 47, as indicated by the arrows 48 either will move the contact surface 10A of the support element 10 into contact with the surface 2A of the forming fabric 2 substantially in the reference plane 20 (anticlockwise rotation

as shown) or will move the contact surface 10A of the support element 10 out of contact with the surface 2A of the forming fabric 2 (clockwise rotation as shown). In practice, it should be noted that the range of movement required for a support element to be moved into and out of contact with the machine side surface 2A of the forming fabric 2 whilst in the region of the reference plane is quite small: the distance between being just out of contact and in full contact with the wet surface 2A of the forming fabric 2 is of the order of about 2.0mm. The mounting should be configured to move the support element so far that there is free space between the support element surface and the surface 2A of the forming fabric.

In each of Figures 1, 2 and 4 there is an even number of support elements between the first and last fixed elements. If an odd number of elements is used, further combinations become possible. As is shown in Figure 5, it is then possible to alternate the raised and lowered elements so that the sequence is symmetrical. In Figure 5 the first element 8, and the last element 14 are still fixed in place. In between them are five support elements 9 - 13. As shown, only elements 10 and 12 are in contact with the surface 2A of the forming fabric 2, and elements 9, 11 and 13 are retracted. Other arrangements are possible if all of the support elements are moveably mounted. It is also possible to use fixed mountings for one, or more, of such a set of elements.

In each of these arrangements, the amount of agitation, in terms of its scale and intensity, generated in the stock by the combination of the fixed first and last support elements with the at least one element in the foraminous support surface depends essentially on two factors. These are:

(i) which elements are chosen to be in contact with the forming fabric, and

(ii) the profile chosen for the forming fabric contacting surfaces of each of those elements.

For any given working papermaking machine, it is thus apparent that some experimentation will often be required to obtain the desired scale and intensity of agitation within the stock. Further, since there is always the possibility to alter these selections, it becomes far easier to reconfigure the initial impingement zone of the papermaking machine to accommodate a change in product being made.

In the preceding description, an open surface forming section is described. This invention is not so limited, and is applicable to other known forms of papermaking machines. Thus this invention can be applied to any one of the following group of papermaking machines:

- an open surface papermaking machine having a single forming fabric;

- a hybrid gap former papermaking machine having two superposed forming fabrics in which at least that portion of the forming section adjacent the head box slice has one forming fabric having an open surface; and

- a twin fabric papermaking machine having two forming fabrics each having a paper side and a machine side, in which the jet of stock is delivered into the gap between the paper sides of the two fabrics, and at least one support element in contact with the machine side of one of the forming fabrics is moveable.

In the first two types, the reference surface defined by the fixed first and last blades is essentially a horizontal plane. In a twin fabric machine, the forming section adjacent to the head box slice includes a forming shoe, which may be curved or flat, and which carries support elements in contact with the machine side of a first forming fabric. In the

practice of this invention, at least one of the support elements carried by the forming shoe will be moveable into and out of contact with the machine side of the first forming fabric. Further, when a curved forming shoe is used, the reference surface defined by the machine side of the first forming fabric and the positions of the fixed support elements may not be a single plane, but instead will follow the contour of the forming shoe.

WHAT IS CLAIMED IS:

1. A process for improving sheet properties in a paper making machine including a forming section, at least one forming fabric, having a machine side and a paper side, moving in the machine direction and a head box having a head box slice which delivers a stock jet onto the paper side of the at least one moving forming fabric, comprising the steps of:-

(i) discharging the stock jet onto the paper side of the at least one moving forming fabric;

(ii) causing the machine side of the at least one forming fabric carrying the stock on its paper side to move over in sequence in the machine direction:

- a first fixed support element adjacent the head box slice and in contact with the forming fabric;

- at least one drainage box provided with a foraminous support surface, which support surface includes at least one vertically moveable support element, and provided with support means for the first fixed element; and

- a last fixed support element in contact with the forming fabric, which together with the first fixed support element and the machine side of the at least one forming fabric defines a reference surface; and

(iii) adjusting both the scale and intensity of agitation in the stock at at least one locus by altering the vertical position relative to the reference surface of at least one vertically adjustable element whereby the at least one element is moved vertically into a position chosen from the group consisting of in contact with the machine side of the forming fabric, and out of contact with the machine side of the forming fabric.

2. A process according to Claim 1 wherein the foraminous surface includes a plurality of support elements, at least one of which is vertically moveable, and the remainder of which have their fabric support surface located in the reference surface.

3. A process according to Claim 1 wherein the foraminous surface includes a plurality of support elements, at least some of which are vertically moveable, and the remainder of which have their fabric support surface located in the reference surface.

4. A process according to Claim 1 wherein the foraminous surface includes a plurality of support elements, all of which are vertically moveable.

5. A process according to Claim 3 wherein the foraminous surface includes a plurality of support elements in which alternate elements are vertically moveable.

6. A process according to Claim 5 wherein the foraminous surface includes a plurality of support elements in which alternate elements are vertically moveable, and in which the support elements adjacent the first and last fixed elements are moveable.

7. A process according to Claim 3 wherein the foraminous surface is supported by two drainage boxes in sequence.

8. An apparatus for improving sheet properties in a paper making machine including a forming section, at least one forming fabric, having a machine side and a paper side, moving in the machine direction and a head box having a head box slice which delivers a stock jet onto the paper side of the at least

one moving forming fabric, comprising in sequence in the machine direction:

- a first fixed support element adjacent the head box slice and in contact with the machine side of the at least one forming fabric;

- at least one drainage box provided with a foraminous support surface, which support surface includes at least one vertically moveable support element, and provided with support means for the first fixed element;

- a last fixed support element in contact with the machine side of the at least one forming fabric, which together with the first fixed support element and the machine side of the at least one forming fabric defines a reference surface; and

- an independently controlled vertical adjustment means for the at least one vertically moveable support element.

9. An apparatus according to Claim 8 wherein the papermaking machine including the forming section is chosen from the group consisting of:

- an open surface papermaking machine having a single forming fabric;

- a hybrid gap former papermaking machine having two superposed forming fabrics in which at least that portion of the forming section adjacent the head box slice has one forming fabric having an open surface; and

- a twin fabric papermaking machine having a two opposed forming fabrics each having a paper side and a machine side, in which the jet of stock is delivered into the gap between the paper sides of the two fabrics, and at least one support element in contact with the machine side of one of the forming fabrics is moveable.

10. An apparatus according to Claim 8 wherein the last fixed element is supported by an adjacent drainage box in the forming section.

11. An apparatus according to Claim 8 wherein the foraminous surface is supported by a first and a second drainage box in sequence.

12. An apparatus according to Claim 11 wherein the first support element on the second drainage box has its fabric support surface located in the reference surface.

13. An apparatus according to Claim 8 wherein the foraminous surface includes a plurality of support elements, at least one of which is vertically moveable, and the remainder of which have their fabric support surface located in the reference surface.

14. An apparatus according to Claim 8 wherein the foraminous surface includes a plurality of support elements, at least some of which are vertically moveable, and the remainder of which have their fabric support surface located in the reference surface.

15. An apparatus according to Claim 8 wherein the foraminous surface includes a plurality of support elements, all of which are vertically moveable.

16. An apparatus according to Claim 8 wherein the foraminous surface includes a plurality of support elements in which alternate elements are vertically moveable.

17. An apparatus according to Claim 8 wherein the foraminous support surface includes a plurality of support elements in

which alternate elements are vertically moveable, and in which the support elements adjacent the first and last fixed elements are moveable.

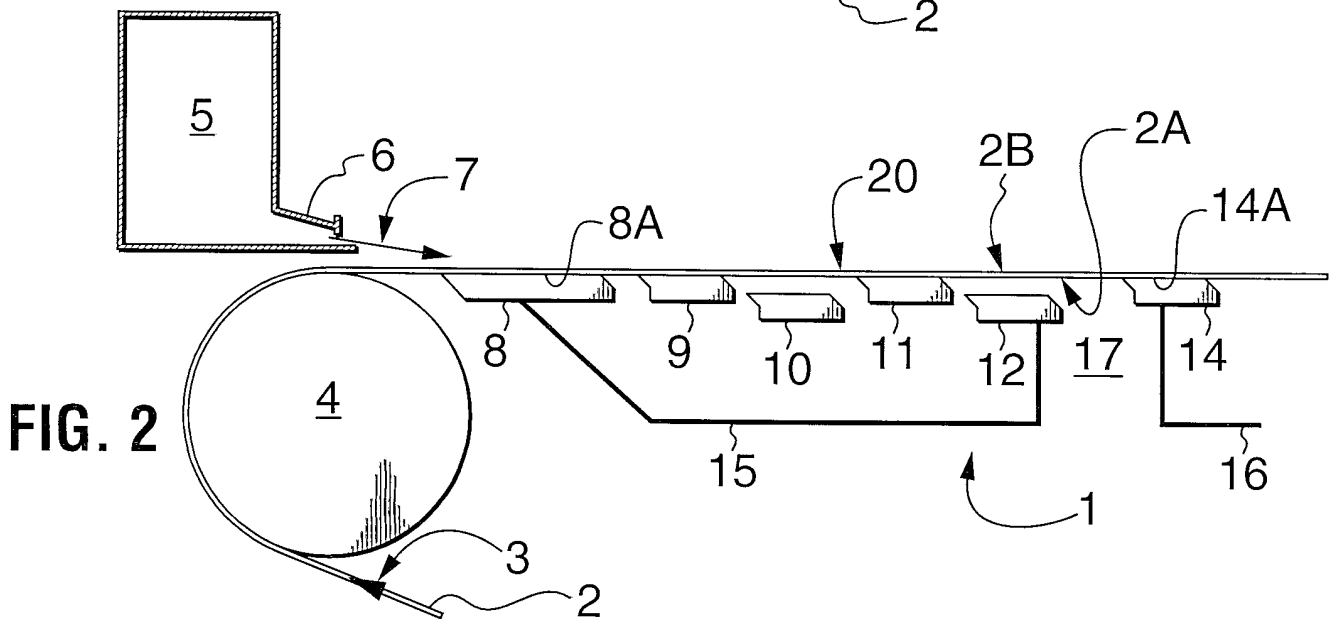
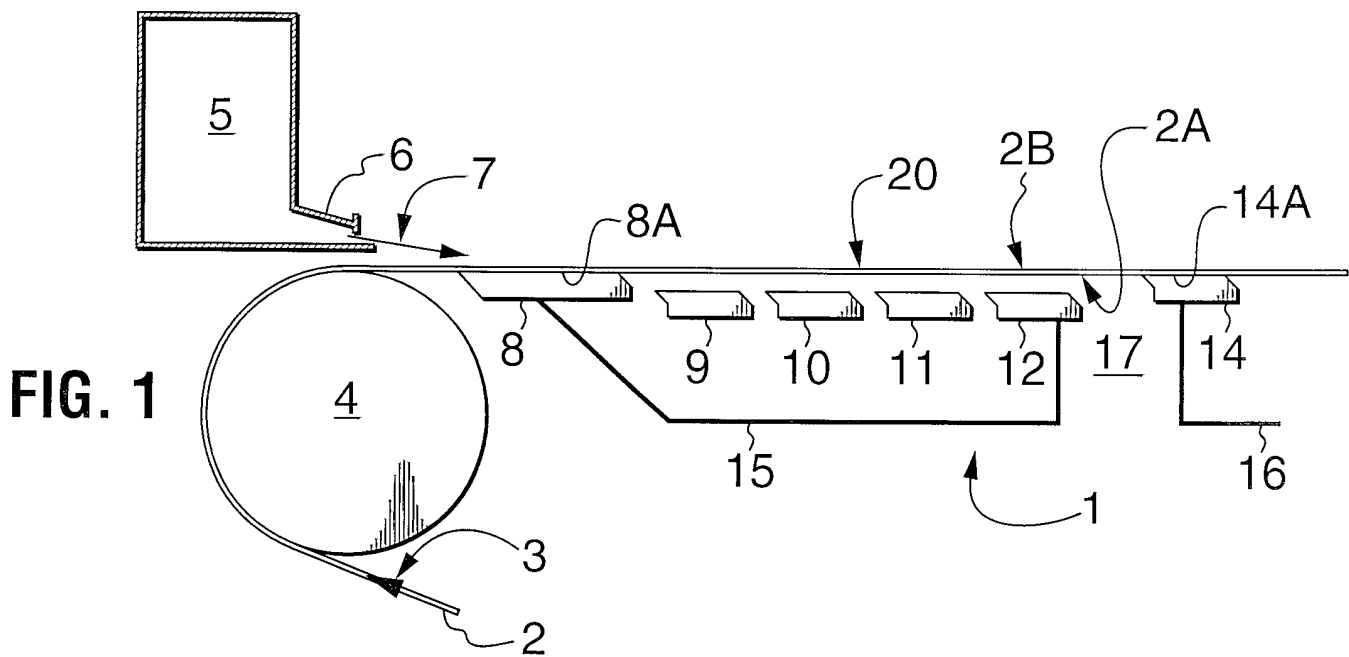
18. A process according to Claim 1 wherein the papermaking machine including the forming section is chosen from the group consisting of:

- an open surface papermaking machine having a single forming fabric;

- a hybrid gap former papermaking machine having two superposed forming fabrics in which at least that portion of the forming section adjacent the head box slice has one forming fabric having an open surface; and

- a twin fabric papermaking machine having two forming fabrics each having a paper side and a machine side, in which the jet of stock is delivered into the gap between the paper sides of the two fabrics, and at least one support element in contact with the machine side of one of the forming fabrics is moveable.

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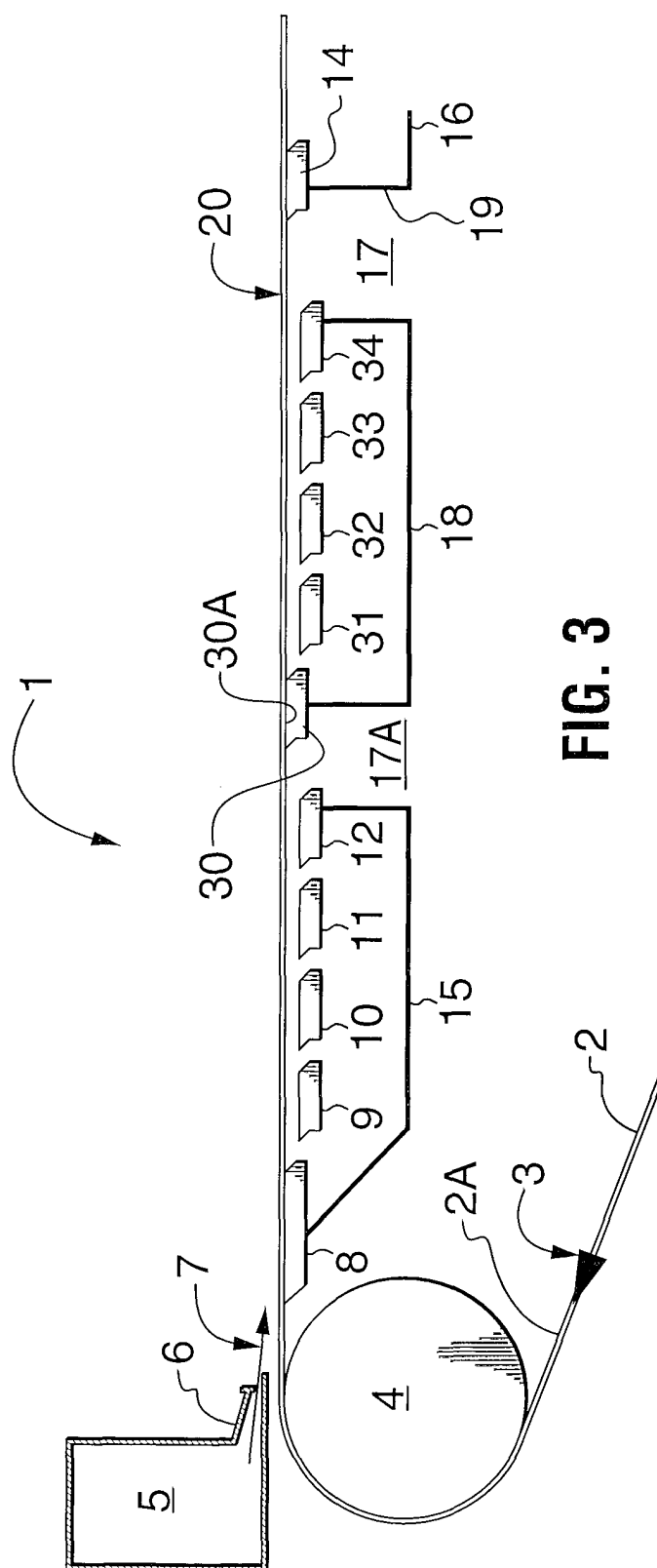


FIG. 3

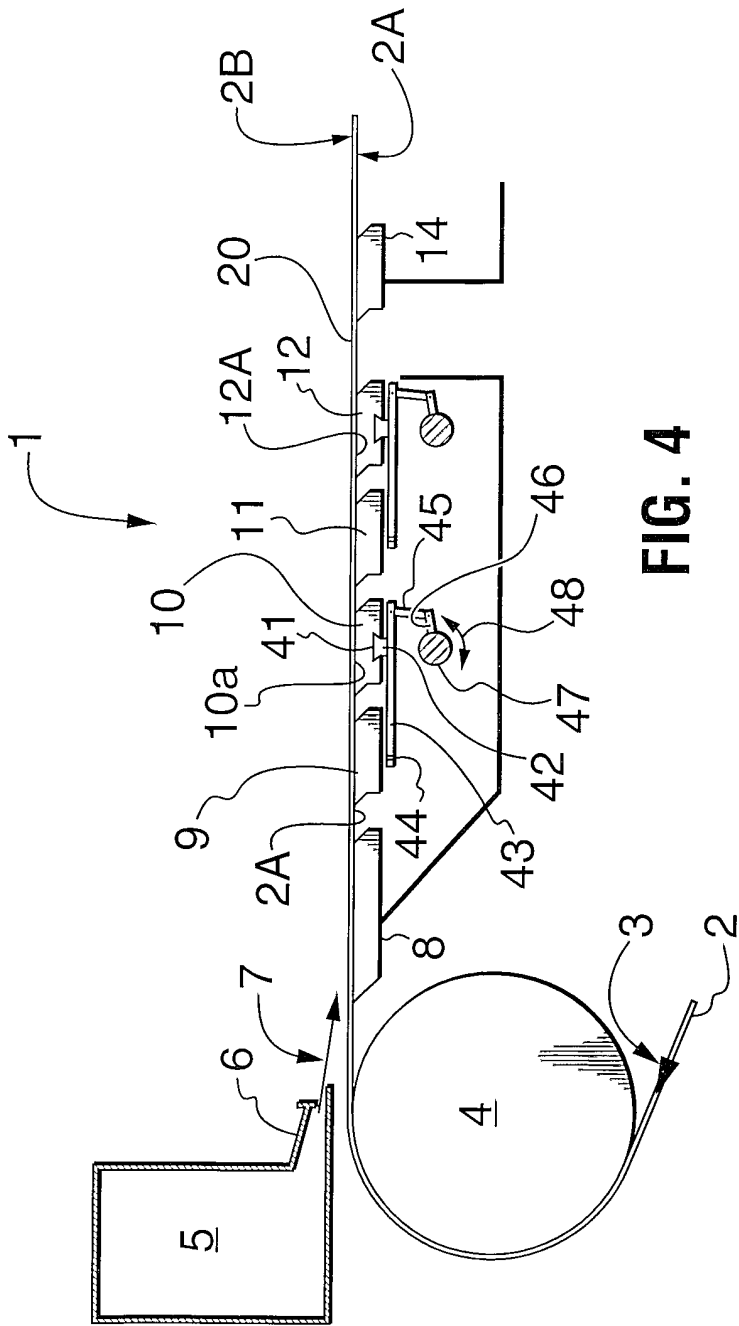


FIG. 4

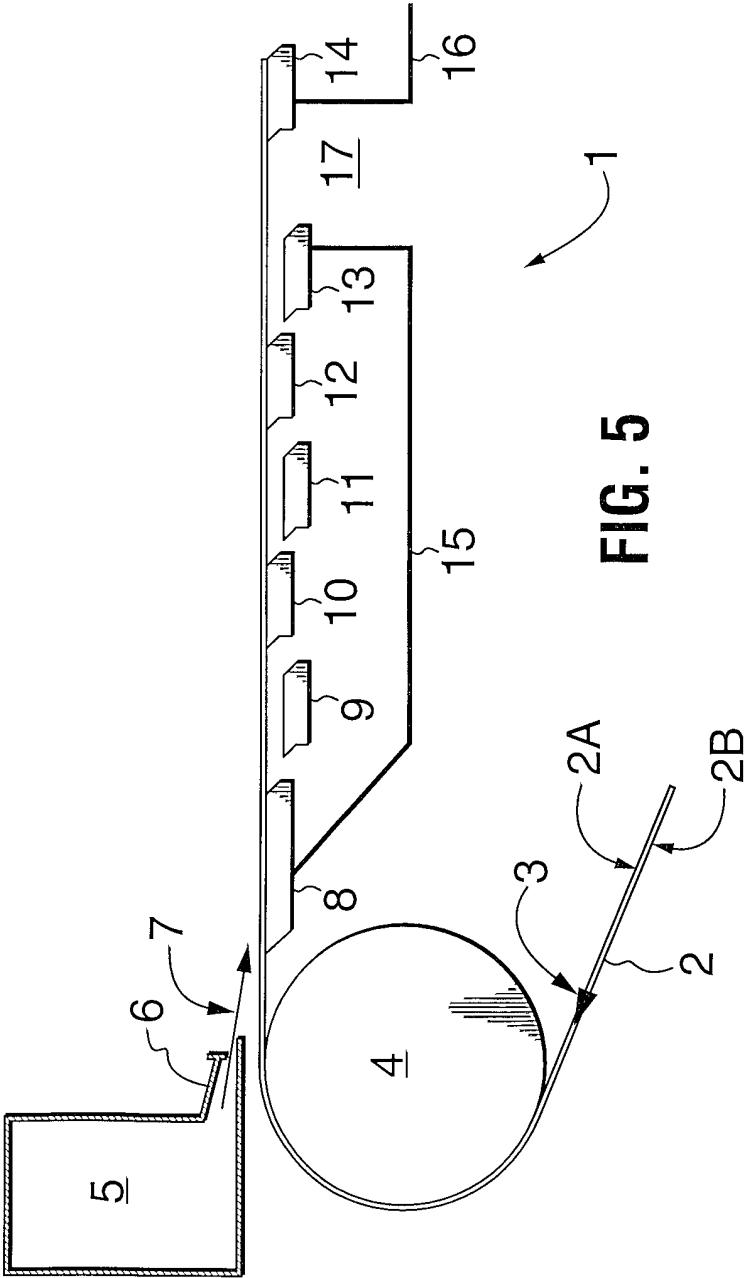


FIG. 5