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J. S. AMNEUS

3,536,582

ADJUSTABLE NOZZLE HEADBOX FOR A PAPER MACHINE

Filed Aug. 3, 1967

2 Sheets-Sheet 1

Fig. 1

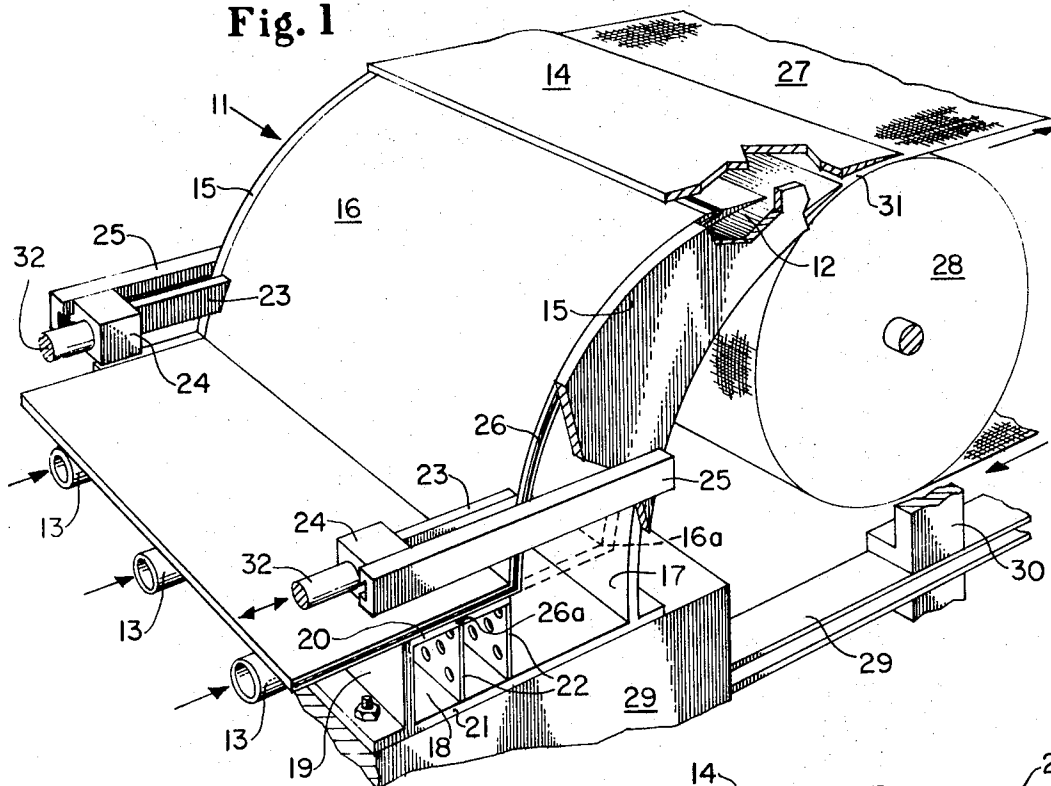
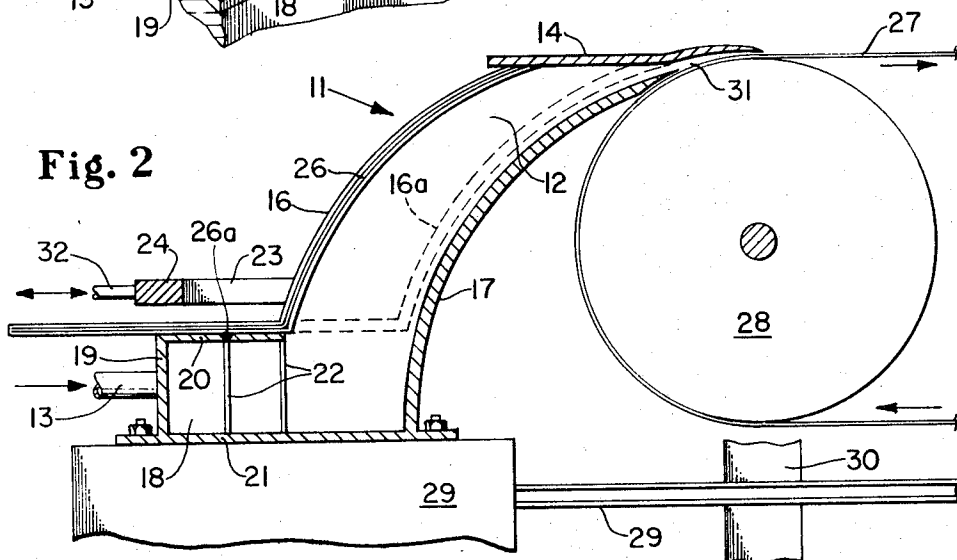


Fig. 2



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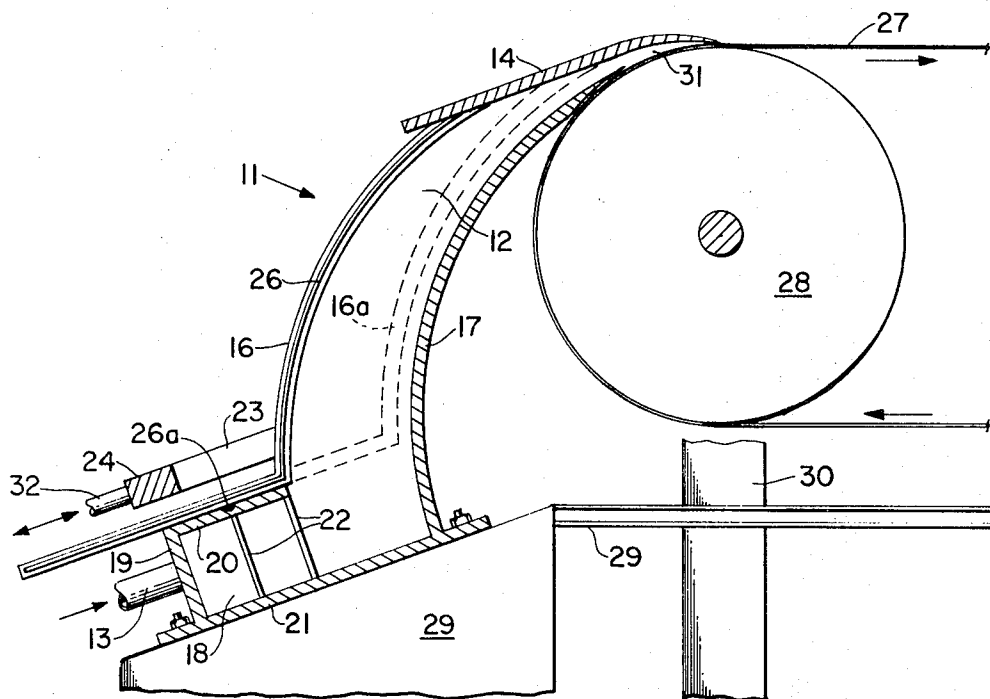
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Fig. 3



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ADJUSTABLE NOZZLE HEADBOX FOR A PAPER MACHINE

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7 Claims

ABSTRACT OF THE DISCLOSURE

An adjustable pressure nozzle headbox for use in delivering fibrous slurry to the formation zone of wet-laid non-woven web forming and papermaking machines. The adjustable pressure nozzle headbox delivering the fibrous slurry to the formation zone is provided with an adjustable upper nozzle roof or approach zone roof plate, which approach zone roof plate is adjustable in the machine direction. The adjustment affords means whereby the hydraulic characteristics of the adjustable nozzle with regard to fiber orientation can be controlled to affect fiber orientation and thereby control the machine direction tensile strength to cross-machine direction tensile strength ratio in the non-woven webs and papers produced.

BACKGROUND OF THE INVENTION

This invention relates to improvements in apparatus for delivering a fibrous slurry to a formation zone, i.e., the initial fiber deposition zone of a Fourdrinier wire or other foraminous formation medium, of a web forming machine in the manufacture of a wet-laid non-woven web, including paper. More particularly, the invention, although it will be found useful in connection with wet-laid non-woven web forming operation, finds its principal application in pressure nozzle headboxes for use in high speed, i.e., over 1,500 feet per minute, continuous papermaking operations. Specifically, the invention consists of a pressure nozzle headbox provided with an adjustable approach zone roof plate or upper nozzle roof. The adjustable approach zone roof plate is positionable in the machine direction and cooperates with its opposite member, the approach zone floor plate, to provide a practical means for precise and convenient adjustment of the convergence angle within the pressure nozzle headbox. By means of the foregoing adjustment the amount and direction of fiber orientation obtained within the adjustable pressure nozzle during continuous papermaking and other wet-laid non-woven web forming operations is affected. Fiber orientation controls to a large degree machine direction tensile strength to cross-machine direction tensile strength ratio, or simply tensile ratio in wet-laid non-woven webs and papers.

The most careful calculation of the proper convergence angle, i.e., angle included between the floor plate and roof plate of a pressure nozzle headbox in the approach zone, to be used in a pressure nozzle headbox can only satisfy one set of wet-laid non-woven web, including paper, formation conditions or the hydraulic equivalent thereof. The pressure nozzle headbox of the present invention affords means whereby the hydraulic characteristics of said pressure nozzle headbox can be controlled to affect fiber orientation in wet-laid non-woven, including paper, webs. Inasmuch as techniques for predicting the fiber orientating effects of a pressure nozzle may also leave something to be desired where the interior hydraulic action of a proposed pressure nozzle headbox is concerned, adjustable headboxes of various types have been developed. The adjustable headboxes, conventional and known

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in the present papermaking art, are provided with varying degrees of adjustability which may or may not be capable of being exercised during continuous wet-laid non-woven web, including papermaking, operations. The adjustable headbox which comprises the subject matter of U.S. 2,418,600 issued to Harry M. Ostertag and Francis A. Boylan on Apr. 8, 1947, constitutes an example of an adjustable type of headbox in which adjustment is obtained by means of multiple knuckles in the top plate, or roof, defining the headbox channel or nozzle.

Although the adjustable headboxes proposed heretofore have offered degrees of flexibility and adjustment, they have not proven entirely satisfactory, because the adjustment or adjustments provided were somewhat cumbersome. In many cases the adjustments required multiple mechanical movements of a reasonably simultaneous and coordinated nature. The nature of these mechanical movements and a certain apparent lack of understanding in their use made headbox adjustments of a radical nature uncertain if disruption of continuous wet-laid non-woven web, including papermaking, operations was to be avoided.

SUMMARY OF THE INVENTION

Inasmuch as a precise and convenient means of adjusting the convergence angle of a nozzle type headbox by means of a single simple and precise mechanical adjustment during continuous operation was desired, the apparatus of this invention which comprises an adjustable pressure nozzle headbox of the type useful in the continuous deposition of fibers from fibrous slurries was developed to form wet-laid non-woven, including paper, webs. The adjustable pressure nozzle headbox of this invention is provided with an adjustable approach zone roof plate, which adjustable approach zone roof plate is positionable in the machine direction to effect modification of the hydraulic characteristics of the adjustable pressure nozzle headbox. As will be further discussed hereinbelow, the adjustable approach zone roof plate cooperates with the approach zone floor plate of the adjustable pressure nozzle headbox to provide a means of adjusting the convergence angle and thus the fiber orienting characteristics of the adjustable pressure nozzle headbox by a single mechanical adjustment.

Accordingly, it is the principal object of this invention to overcome the aforementioned problems and disadvantages.

Another object of this invention is to provide an adjustable pressure nozzle headbox for a wet-laid non-woven web forming or papermaking machine wherein the convergence angle can be conveniently and precisely adjusted for tensile ratio control during continuous operation.

It is another object of this invention to provide an adjustable pressure nozzle headbox having a convergence angle which can be adjusted by means of adjusting an upper nozzle forming element in a substantially linear adjustment motion in the machine direction.

It is yet another object of this invention to provide an adjustable pressure nozzle headbox whereby the ratio of machine direction tensile strength to cross-machine direction tensile strength, or tensile ratio, of wet-laid non-woven, including paper, webs can be adjusted during continuous operation.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of this invention will become apparent as the description proceeds in accordance with the drawings wherein a Fourdrinier papermaking machine is used to illustrate the adjustable pressure nozzle

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headbox of this invention. In the drawings like numbers refer to like pressure nozzle headbox elements and:

FIG. 1 is a partial perspective view of an adjustable pressure nozzle headbox constructed in accordance with the precepts of this invention and mounted in operative relationship for use in a Fourdrinier papermaking machine with parts broken away in order to illustrate the adjustable feature;

FIG. 2 is a side elevation of the adjustable pressure nozzle headbox illustrated in FIG. 1 with parts removed in order to further illustrate the adjustable feature of the headbox; and

FIG. 3 is a side elevation of yet another embodiment of the present adjustable pressure nozzle headbox, wherein the nozzle elements and direction of adjusting movement are arranged for increased convergence angle adjustment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing the preferred embodiments of the invention illustrated in the drawings, specific terminology will be adhered to for the sake of clarity in describing the features of the adjustable pressure nozzle headbox of this invention. It is not intended, however, to be limited to the specific terms selected, and it is to be understood that each such specific term is presumed to include all technical equivalents which operate or can operate in a similar manner to accomplish a similar purpose.

Referring now to the specific embodiments of the invention selected for illustration in the FIGS. 1, 2 and 3, the number 11 designates generally an adjustable pressure nozzle headbox constructed according to the precepts of this invention, which adjustable pressure nozzle headbox 11 defines a nozzle channel 12. Fibrous slurry enters nozzle channel 12 through supply pipes 13 in the direction indicated by the arrows. Definition of the nozzle channel 12 in adjustable pressure nozzle headbox 11 is accomplished by means of formation zone roof plate 14, side plates 15, approach zone roof plate 16 and approach zone floor plate 17.

Adjustable pressure nozzle headbox 11 is provided with an entry box 18 into which supply pipes 13 empty through entry box back wall 19. Entry box floor 21 connects with approach zone floor plate 17, while entry box roof 20 provides one bearing surface for the sliding adjustment of approach zone roof plate 16. Approach zone roof plate 16 is also provided with a bearing surface by the underside of formation zone roof plate 14. Entry box 18 is illustrated as provided with two foraminous baffles 22, although these can be dispensed with entirely, or other means of inducing fiber dispersing currents including "holey" rolls and the turbulence generating devices used in U.S. 3,309,264, issued to Joseph D. Parker, Malcolm R. Jones and John F. Schmaeng on Mar. 14, 1967, can be installed therein.

Approach zone roof plate 16 is equipped with stabilizing bars 23 leading to slide blocks 24 which cooperate with guide bars 25 which for clarity are cut away and not shown in FIGS. 2 and 3. Approach zone roof plate 16 is also equipped with sealing means in the form of O section gaskets 26 and 26a which extend around its operative periphery to bear against side plates 15 and the underside of approach zone roof plate 16. Approach zone roof plate 16 is capable of linear, and specifically rectilinear, adjustment motion in the machine direction. In other embodiments of adjustable pressure nozzle headbox 11 the adjustment motion of approach zone roof plate can be curvilinear depending on the shape of bearing surfaces provided on entry box roof 20 and the underside of formation zone roof plate 14.

Approach zone floor plate 17 and formation zone roof plate 14 are cooperatively positioned above Fourdrinier wire 27 to form a formation zone 31 thereon. Stand 29 together with trunnion 30, which is conventional and

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cut away for clarity, provides support for adjustable pressure nozzle headbox 11 and breast roll 28.

In FIG. 3 there is illustrated an embodiment of the present invention wherein the linear adjustment motion of approach zone roof plate 16 takes place in a plane substantially parallel to the plane of approach zone floor plate 17 as it approaches the Fourdrinier wire 27 covered breast roll 28. This configuration affords a slightly greater change in the nozzle convergence angle within given travel or adjustment limits than does the adjustable pressure nozzle headbox 11 illustrated in FIG. 2.

In operation, fibrous slurry or papermaking furnish is supplied to entry box 18 under pressure through supply pipes 13. The fibrous slurry flows through foraminous vertical baffles 22 and upward through nozzle channel 12 to formation zone 31. As will be appreciated by those skilled in the art, the ratio of machine direction tensile strength to cross-machine direction tensile strength or tensile ratio of the paper formed in formation zone 31 and carried forward to the press and drying sections, not shown, of the papermaking machine on Fourdrinier wire 27 is controlled in large measure by the shape of nozzle channel 12 through which the fibrous slurry passes on its way to formation zone 31. In the formation of wet-laid non-woven webs, similar tensile ratio control can be applied. In the adjustable pressure nozzle headbox 11 of the present invention, the nozzle channel 12 can be adjusted from a parallel position illustrated by dotted lines and defined in part by a down-machine positioning of approach zone roof plate 16a to a more convergent position wherein it is partially defined by approach zone roof plate 16 in the machine direction retracted position.

With the approach zone roof plate 16 in the retracted position, the adjustable pressure nozzle headbox 11 engenders an increased tensile ratio, i.e., an increase in the number generated by dividing the machine direction tensile strength of the paper product by its cross-machine tensile strength. With the approach zone roof plate in the 16a position, the adjustable pressure nozzle headbox 11 results in paper formation which has the characteristics of paper with a low tensile ratio, or a paper which approaches the same tensile strength in the cross-machine direction that it exhibits in the machine direction. Similar effects will be produced if adjustable pressure nozzle headbox 11 is used to produce wet-laid non-woven webs.

Adjustment of the machine direction position of approach zone roof plate 16 is accomplished by the application of a suitable force in the machine direction on control rods 32, which control rods 32 serve to position approach zone roof plate 16 in any desired position between that represented in FIG. 2 and FIG. 1 by approach zone roof plate 16 and approach zone roof plate 16a, as portrayed in the latter instance by dotted lines. Approach zone roof plate 16a represents the down-machine limit of linear adjustment motion of approach zone roof plate 16. The precise and desired positioning can be accomplished during continuous papermaking operations and has as one advantage the ability to engender desirable cross-machine tensile improvement in the resultant paper. Similar control and cross-machine tensile improvement can be achieved by the use of adjustable pressure nozzle headbox 11 in wet-laid non-woven web forming operations.

The advantages of such an adjustable pressure nozzle headbox 11 in the formation of wet-laid non-woven webs and papers are numerous, and it is especially adapted for use in high speed papermaking machines used for the preparation of facial and bathroom tissues. Adjustable pressure nozzle headbox 11 can also find use in the formation of heavier basis weight papers such as those used in kitchen toweling and other wiping papers. A specific advantage of the type of adjustability afforded by the apparatus of the present invention as exemplified in FIGS. 1, 2 and 3 by approach zone roof plate 16 is that adjustment is continuous and precise. The tensile

ratio adjustments can be made during continuous operation so that the results of adjustment and re-adjustment can effect the desired ratio of machine direction tensile strength to cross-machine direction tensile strength in the resultant wet-laid non-woven web and paper products. Another advantage of the present type of adjustable pressure nozzle headbox 11 is that it is imminently adapted for use in machines wherein product characteristics are under the control of computers. In this use, the position of adjustable approach zone roof plate 16 can be controlled by the read-out of a computer through a suitable positioning device connected to control rods 32.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred embodiment. Various changes may be made in the shape, size and arrangement of parts without departure from the invention. For example, equivalent elements may be substituted for those illustrated and described herein, parts may be reversed and certain features of the invention may be utilized independently of the use of other features, all without departing from the spirit or the scope of the invention as defined in the attached claims. For example, machines constructed in accordance with this invention may have other equivalent mechanical positioning and guiding systems substituted for guide bars 25, stabilizing bars 23 and control rods 32. Also, the top surface of entry box roof 20, which provides a bearing surface for the sliding adjustment of approach zone roof plate 16, together with the bottom surface of formation zone roof plate 14 can be cooperatively curved to provide a slightly rocking, or curvilinear, adjustment motion for approach zone roof plate 16. Accordingly, it is to be understood that such equivalents are within the scope of the invention as defined in the claims below.

Having thus defined and described the invention, what is claimed is:

1. In a pressure nozzle headbox, comprised of an approach zone floor plate, an approach zone roof plate and a formation zone roof plate, for use in delivering fibrous slurry to a formation zone of a web forming machine in the manufacture of a wet-laid non-woven web, the improvement which comprises providing an adjustable approach zone roof plate for said pressure nozzle headbox, which adjustable approach zone roof plate is capable of linear adjustment motion on sliding bearing surfaces in the machine direction of said web forming machine, whereby the hydraulic characteristics of said pressure nozzle headbox can be controlled to affect fiber orientation in said wet-laid non-woven web.

2. A pressure nozzle headbox for use in delivering fibrous slurry to a formation zone of a web forming machine in the manufacture of a wet-laid non-woven web as claimed in claim 1, wherein the wet-laid non-woven web is paper and the linear adjustment motion of the adjustable approach zone roof plate is substantially rectilinear.

3. In a pressure nozzle headbox, comprised of an approach zone floor plate, an approach zone roof plate and a formation zone roof plate, for use in delivering fibrous slurry to a formation zone of a papermaking machine in the manufacture of a paper product, the improvement which comprises providing an adjustable approach zone roof plate for said pressure nozzle headbox, which adjustable approach zone roof plate is capable of substantially rectilinear adjustment motion on sliding bearing surfaces in the machine direction of said papermaking machine, whereby the hydraulic characteristics of said pressure nozzle headbox can be controlled to affect fiber orientation in the paper product.

4. A pressure nozzle headbox for use in delivering fibrous slurry to a formation zone of a papermaking machine in the manufacture of a paper product as claimed in claim 3, wherein the papermaking machine is a Fourdrinier papermaking machine.

5. In a pressure nozzle headbox, comprised of an approach zone floor plate, an approach zone roof plate and a formation zone roof plate, for use in delivering fibrous slurry to a formation zone of a Fourdrinier papermaking machine in the manufacture of a paper product, the improvement which comprises providing an adjustable approach zone roof plate for said pressure nozzle headbox, which adjustable approach zone roof plate is capable of linear adjustment motion on sliding bearing surfaces substantially parallel to the plane of the approach zone floor plate of said pressure nozzle headbox as it approaches the Fourdrinier wire covered breast roll of said Fourdrinier papermaking machine.

6. A pressure nozzle headbox for use in delivering fibrous slurry to a formation zone of a Fourdrinier papermaking machine in the manufacture of a paper product as claimed in claim 5, wherein the nozzle forming surfaces of the adjustable approach zone roof plate and the approach zone floor plate are substantially parallel when said adjustable approach zone roof plate approaches the down-machine limits of said linear adjustment motion.

7. A pressure nozzle headbox for use in delivering fibrous slurry to a formation zone of a Fourdrinier papermaking machine as claimed in claim 5 wherein the linear adjustment motion is curvilinear.

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