

[54] **HIGH SPEED PAPER WEB FORMING AND COMBINING SYSTEM WITH A STATIONARY WATER GUIDE**

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[58] Field of Search..... 162/304, 303, 133, 162/211, 363, 374, 351, 352, 203, 301

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[57] **ABSTRACT**

A high-speed web forming and combining apparatus having several web-forming units wherein each of the units dewater fluid stock in three stages: first, dewatering the material and forming it into a textured fiber mat on a horizontal section of an inner wire, second, dewatering the fiber mat on a cylinder mold and compressing it into a web between the inner wire and an outer belt lying over it, and third, dewatering the web by a stationary water guide means. This produces a completely formed web which is combined with webs from preceding web-forming units.

3 Claims, 6 Drawing Figures

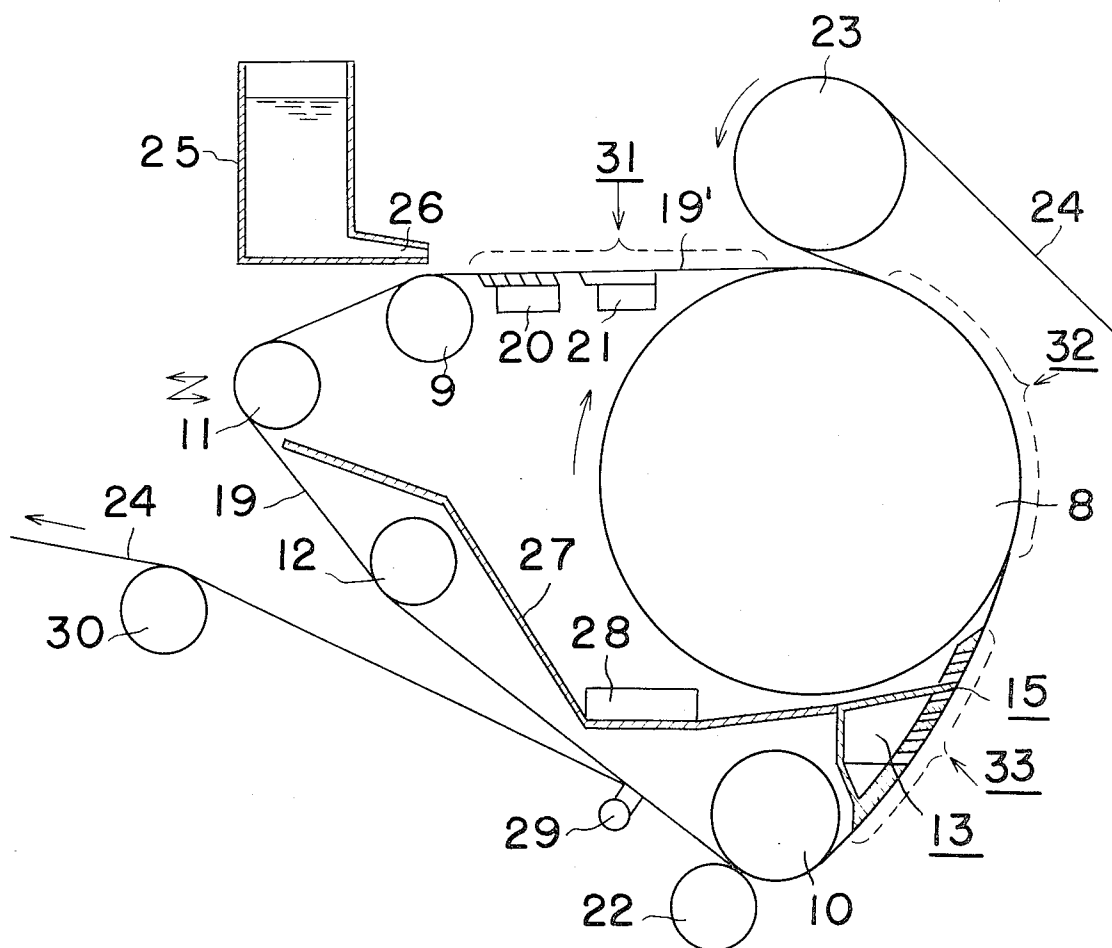


FIG. 1

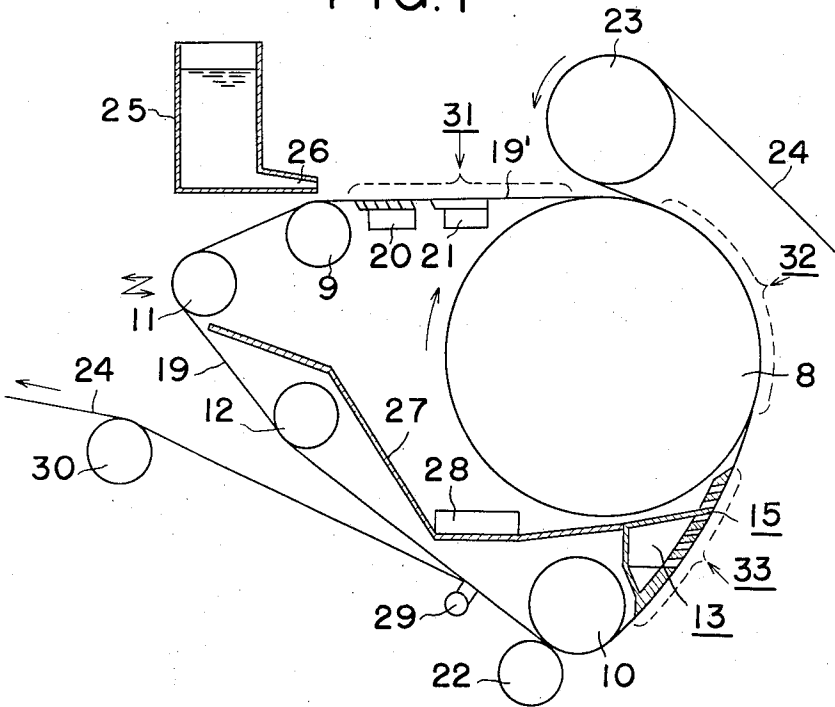
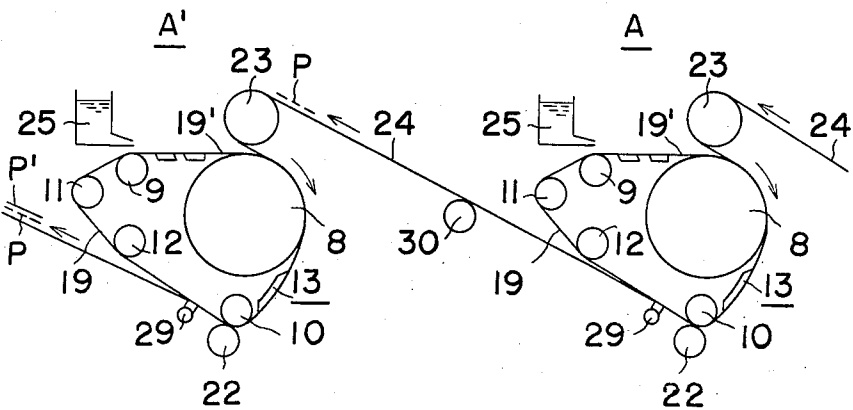


FIG. 2



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FIG.3

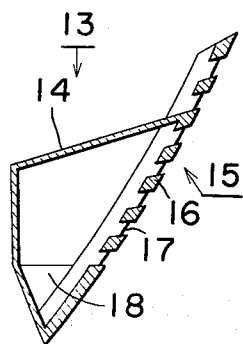


FIG.4

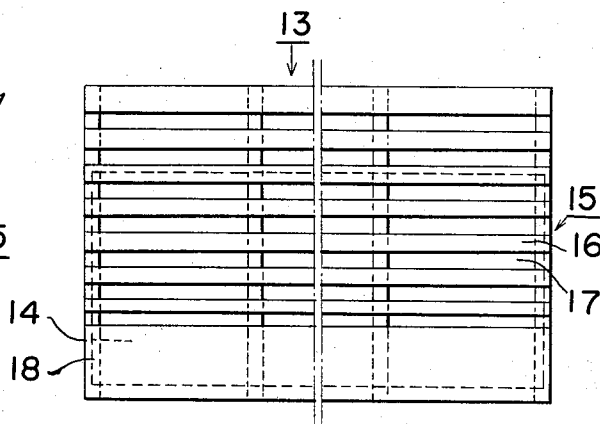
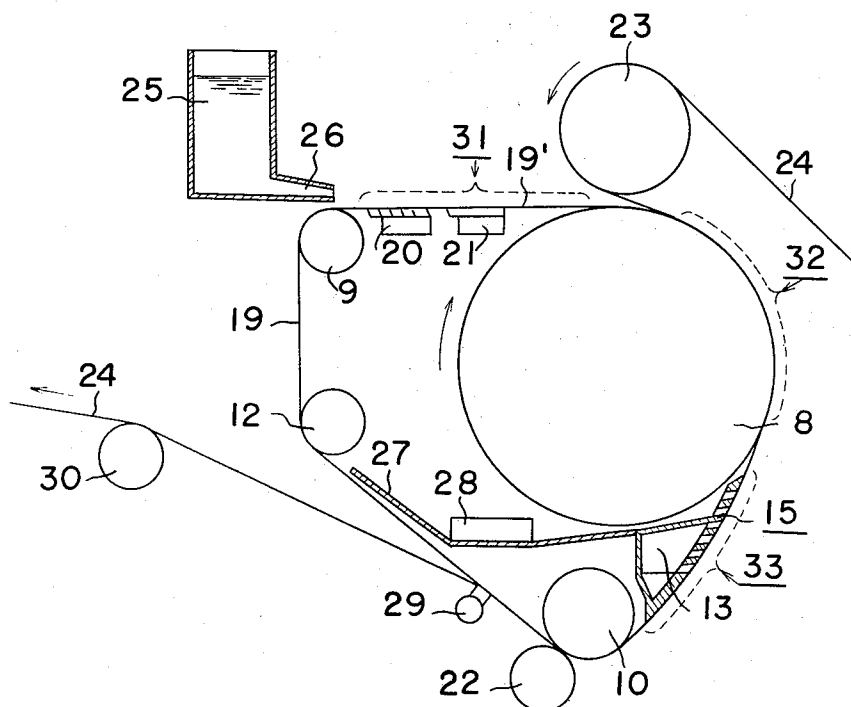


FIG.5



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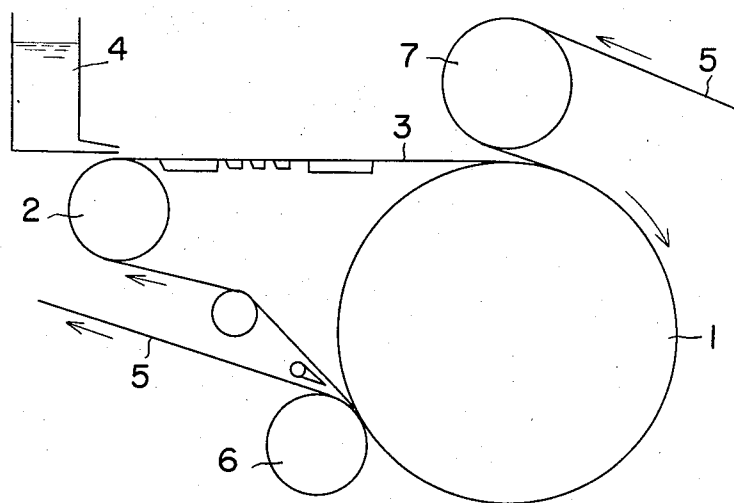
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FIG. 6 PRIOR ART



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HIGH SPEED PAPER WEB FORMING AND COMBINING SYSTEM WITH A STATIONARY WATER GUIDE

BACKGROUND OF THE INVENTION

The present invention relates to a paper-making apparatus which forms and combines paper webs at a high speed, and more particularly to an improvement over the conventional multi-layer paper-making apparatus in which stock fed from a flow box in each web-forming unit initially undergoes texture forming on a horizontal section of an endless screen, and then is formed into a web and combined with other webs from other units on a forming cylinder.

BRIEF REVIEW OF THE PRIOR ART

Known multi-layer paper-making apparatus are designed to operate at production speeds higher than 300 meters of web per minute. However, if the production speed increases to, say, 600 meters or more per minute, primary dewatering on a horizontal section of an endless screen and secondary dewatering on a forming cylinder are no longer adequate to ensure successful web forming and combination. It is important to note, especially, that the faster the forming cylinder turns, the more centrifugal force it develops. The result is that water squeezed out of the unfinished web on the forming cylinder tends to be pushed outward while being sucked inward. As less water is thus removed by suction through the forming cylinder, effective web forming becomes more difficult. Moreover, because the web still contains much water as it reaches the couch roll, water tends to collect in the neighborhood of the couch roll and disturb the texture of the web.

On such known web forming and combining apparatus, the production speed is naturally limited, and as it exceeds the level of about 600 meters per minute, it becomes practically impossible to produce a well formed and combined web due to inadequate dewatering.

OBJECTS OF THE INVENTION

It is the main object of the present invention to improve the above-described conventional type of web-forming and combining apparatus and make it possible to operate such apparatus at hitherto unachievable super-speeds in excess of, say, 600 meters per minute.

Another object of the present invention is to provide such improved web forming and combining apparatus in which means for tertiary dewatering, in addition to primary and secondary dewatering, are used to prevent water from collecting in the neighborhood of the couch roll, so that the texture of the web will not be disturbed by such water.

Still another object of the present invention is to provide such improved web forming and combining apparatus in which a rotary device without means of vacuum suction is used for intermediate dewatering of the web so that its texture will not be disturbed while the web is still unfinished.

Still another object of the present invention is to provide such improved web forming and combining apparatus in which a non-rotary stationary means for guiding water is used to quickly discharge water removed from the web while it is shifting from unfinished to finished condition, thus making high-speed web forming and combination possible.

Still another object of the present invention is to provide such improved web forming and combining apparatus in which the pressure of the web on the water guide means in the final dewatering stage is kept uniform throughout so that the texture of the finally formed web will remain undisturbed.

In summary, an apparatus according to the present invention is capable of forming and combining paper webs at a high speed by dewatering each web in three successive stages, namely, initial dewatering on a horizontal section of an endless wire, intermediate dewatering on a cylinder mold, and final dewatering by a water guide means located between the cylinder mold and a couch roll.

The initial dewatering, during which web texture forming is to take place, should be slow enough to ensure that the fluid stock not be subject to jumping and that the free surface of the stock remains stable; the intermediate dewatering should be rather slow as it is achieved by a rotary device without means of vacuum suction so that the web texture will not be disturbed by a pumping effect; and the final dewatering should be rather quick, with a non-rotary stationary guide means scraping water from the web.

Other objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a web-forming unit of an apparatus representing a preferred embodiment of the present invention;

FIG. 2 is a side view of the web-combining arrangement of said apparatus;

FIG. 3 is a vertical section of a water guide means used in said apparatus;

FIG. 4 is a front view of said water guide means;

FIG. 5 is a side view of a web-forming unit of an apparatus representing another preferred embodiment of the invention; and

FIG. 6 is a side view of a typical conventional web-forming unit without the improvement provided by the present invention.

DETAILED DESCRIPTION

Before describing this invention in further detail, it will be necessary to outline the above-mentioned known apparatus for paper web forming and combination. In FIG. 6, it is seen that between a forming cylinder 1 and a breast roll 2, a horizontal section of an endless screen 3 is provided as a means of primary dewatering. Fluid stock fed on it from a flow box 4 becomes a fiber mat before it goes in between the part of the screen 3 running around the cylinder 1 and a felt 5 which comes over the fiber mat to cover it. Water from the fiber mat thus squeezed is sucked into the forming cylinder 1. The web formed through this final dewatering then emerges from a couch roll 6. As for the function of web combination, a web conveyed by a roll 7 from a previous web-forming unit comes to the present unit on the felt 5, and lies over the fiber mat formed through primary dewatering; and the fiber mat, while becoming a web through final dewatering on the forming cylinder 1, is bonded by pressure to said pre-formed web.

As outlined above, the prior art apparatus for web forming and combination relies on initial dewatering of the material on a screen and final dewatering on a forming cylinder to successfully form a web and combine it with other webs.

A preferred embodiment of the present invention will now be described in conjunction with the accompanying drawings. A cylinder mold 8 is perforated in a given pattern to admit water, and covered by a wire of proper mesh (not shown). This cylinder mold has no internal means of vacuum suction.

A breast roll 9 is set with its top lying roughly in the same horizontal plane as that of the cylinder mold 8, and spaced from the cylinder mold 8 by a relatively short distance, namely, a distance comparable with the diameter of the cylinder mold 8.

A turning roll 10 is located nearly right below the cylinder mold 8, and may be a plain solid roll.

A tension roll 11 is mounted farther left than the breast roll 9 from the cylinder mold as seen in FIG. 1, and can be shifted to the right or left.

A guide roll 12 is located between the tension roll 11 and the turning roll 10.

The numeral 13 refers generally to a water guide means. As seen in FIG. 3, its rear is formed into a box 14 with a drain 18 provided at the bottom thereof. The front of the water guide means 13 is formed into a water guide assembly 15 with a curved face, which in vertical section constitutes an arc circumscribed around and between the cylinder mold 8 and the turning roll 10. This guide assembly is made up of a number of drain boards 16 with acutely or squarely cut ends alternating with water guide channels 17. The water guide means 13 is installed between the cylinder mold 8 and the turning roll 10 with the box 14 located inside the arc and with the face of the water guide assembly 15 lying along the arc.

An inner wire 19 is endless, and runs around the cylinder mold 8, guide assembly 15 of the water guide means 13, guide roll 12, tension roll 11, and the breast roll 9. The inner wire 19 has a horizontal section 19' between the cylinder mold 8 and the breast roll 9.

The underside of the horizontal section 19' of the inner wire 19 is in contact with a hydrofoil 20, which has a slow draining effect suited for high-speed wire operation, and with a vacuum suction box 21, or a vacuum foil box or the like, for adjusting the water content of the material.

A couch roll 22 is set against the turning roll 10 so that a web carried on the inner wire 19 will enter the nip between these two rolls.

A guide roll 23 is mounted roughly above the top of the cylinder mold 8, and guides an outer belt 24 consisting of a wire or a felt into engagement with the inner wire 19. The outer belt 24 thus runs outside the inner wire 19 around the cylinder mold 8, water guide assembly 15 and the turning roll 10; it then passes between the turning roll 10 and the couch roll 22, and proceeds to the guide roll 23 of the next web-forming unit. The outer belt 24 thus turns endlessly.

A flow box 25 has a slice 26 located roughly at the top of the breast roll 9 and opening on the horizontal section 19' of the inner wire 19 toward the cylinder mold 8.

A water receiver 27 is installed below the cylinder mold 8, tension roll 11, breast roll 9, hydrofoil 20, and

the vacuum suction box 21 or the like. A drain 28 is provided at the bottom of the water receiver 27.

There is then a section pickup roll 29; a guide roll 30 for the outer belt 24; a primary dewatering means 31; a secondary dewatering means 32; and a tertiary dewatering means 33.

OPERATION OF THE INVENTION

The apparatus described above operates in the following manner: Fluid stock fed from the slice 26 of the flow box 25 on the horizontal section 19' of the inner wire 19 is dewatered slowly by the hydrofoil 20, and the water content of the material is further adjusted by the vacuum suction box 21. The stock flow thus undergoes primary dewatering and texture forming in a stable condition free of jumping before it is fed between the cylinder mold 8 and the outer belt 24 running around the cylinder mold 8. At this point the material is still in the shape of a semi-fluid fiber mat and lacks solidity. On the cylinder mold 8, the material is now pressed between the inner wire 19 and the outer belt 24, thus undergoing secondary dewatering. Water removed here flows into the cylinder mold 8 through its encircling wire and perforations (not shown). In this secondary dewatering process, the faster the cylinder mold 8 turns, the more centrifugal force it develops, and the more the removed water tends to be flung outward. This means that increasing the operating speed of the cylinder mold results in reducing its draining efficiency. When its speed is high, therefore, secondary dewatering is not enough to complete the web. However, since this dewatering is slow and not artificial, that is, not involving the use of a pump, it does not disturb the texture of the web. Now, the still unfinished web comes over the guide assembly 15 of the stationary water guide means 13. Water squeezed out of the web between the inner wire 19 and the outer belt 24 is removed through the inner wire 19 by the scraping action of the drain boards 16, and flows through the guide channels 17 into the box 14. Thus undergoing tertiary dewatering, the material becomes a finished web before entering the nip between the turning roll 10 and the couch roll 22. After emerging from the nip between the two rolls, the web is stripped off from the inner wire 19 by the pickup roll 29 installed near the outgoing side of said nip. The web is then carried on the outer belt 24 to the next web-forming unit, in which the outer belt 24 again starts from the guide roll 23.

As may be seen from the above example of the cylinder mold 8, dewatering by a rotary device becomes less effective as its turning speed increases due to the centrifugal force it develops. The above-described water guide means 13, on the other hand, can quickly remove much water almost irrespective of the running speed of the web.

The guide assembly 15 of the water guide means 13, responsible for tertiary dewatering, has a curved face which in vertical section constitutes an arc circumscribed around and between the cylinder mold 8 and the turning roll 10. Running along this curved face, the inner wire 19 and the outer belt 24, move smoothly from the cylinder mold 8, over the water guide assembly 15 to the turning roll 10, while exerting uniform pressure on the water guide assembly. Therefore, the web pressed between the inner wire 19 and the outer belt 24 is not subject to breathing action but dewatered

uniformly while running over the guide assembly 15, so that the texture of the web remains unaffected.

Since the inner wire 19 constantly slides over the face of the water guide assembly 15, the latter should preferably be made of a relatively frictionless and wear-resistant material, such as a nylon plastic, so that the inner wire 19 will be subject to less friction and wear.

In the above process of web forming, water discharged from the cylinder mold 8, or falling from the horizontal section 19' of the inner wire 19, or coming down the breast roll 9 and the tension roll 11, or descending from above the water guide assembly 15, is all caught by the water receiver 27, and let out through the drain 28, while water taken into the box 14 through the guide channels 17 of the water guide assembly 15 is discharged through the drain 18.

The present invention also contemplates a web combining apparatus consisting of a vertical and/or transverse arrangement of web-forming units of the type described above. A typical example of this design is illustrated in FIG. 2, which shows a transverse arrangement of such units, A, A', and so on, with outer belt running through them via their guide rolls 23. Web P formed in unit A is carried on the outer wire 24 and brought onto the cylinder mold 8 of unit A' via its guide roll 23. Meanwhile, the fiber mat formed on the horizontal section 19' of the inner wire 19 in unit A' joins said web P, and is compressed with the latter between the inner wire 19 and the outer belt 24, thus undergoing secondary dewatering and becoming web P'. At the same time, webs P and P' are firmly pressed together, and subsequently well combined with each other through tertiary dewatering by the water guide means 13. Via the turning roll 10 and the couch roll 6, the combined web then moves out of web-forming unit A'.

The web-forming unit shown in FIG. 5 represents another embodiment of the present invention. Here the tension roll 11 in the other embodiment is lacking, and the wire 19 runs direct from the guide roll 12 to the breast roll 9. Moreover, one end of the water receiver 27 extends below the guide roll 12. Otherwise this unit is essentially the same in construction as the one described above. The present unit is structurally simpler, and can be made smaller in size.

It is to be observed therefore that the present invention provides a web forming and combining apparatus in which dewatering of the material takes place in three stages: first, slow dewatering on the horizontal section 19' of the inner wire 19 between the cylinder mold 8 and the breast roll 9; secondly, dewatering on the cylinder mold 8, which becomes less effective as its turning speed increases; and thirdly, relatively fast and fairly unrestricted dewatering by the water guide means 13. Even at a super-speed, therefore, the web in each unit can be well formed and drained of all but the minimum necessary water before reaching the couch roll. Moreover, the inner wire and the outer belt are pressed against the guide assembly of the water guide means with uniform pressure throughout the face of said assembly, and here the web is dewatered through a guide means without the use of suction, which would have a pumping effect on the web. Consequently, the web can be formed and combined with other webs successfully at a high speed.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that the invention is not to be limited to these

and that modifications and variations may be resorted to without departing from the spirit and scope of the invention.

I claim:

1. In a paper-making process wherein fluid stock from which a web is formed is fed from a slice of a flow box onto a horizontal section of a wire belt where it is subjected to a first dewatering treatment by the action of first dewatering means disposed under said horizontal section, said stock and wire belt then passing between a vertically rotating perforated cylinder mold and an outer belt and pressed therebetween along an arcuate path extending from the upper to the lower part of said cylinder thereby receiving a second dewatering treatment partially forming a web, the improvement in said process which comprises: passing said partially formed web over means for tertiary dewatering comprising stationary water guide means disposed under said lower part of said cylinder mold, said water guide means having a curved face which in vertical section constitutes an arc circumscribed around and extending between a point closely adjacent the surface said cylinder mold for secondary dewatering and a point closely adjacent to a point on the surface of a turning roll installed below said cylinder mold, and thereby guiding the partially formed web along an arcuate downward travel path, said water guide means including a series of drain boards disposed normal to said travel path so that said web travels over said drain boards, there being water guide channels between said drain boards and removing water from said water guide channels by water removal means thereby providing a third dewatering treatment and permitting said web to be formed at higher speeds than in the absence of said third dewatering means.

2. In a paper-making apparatus wherein fluid stock from which a web is formed is fed from a slice of a flow box onto a horizontal section of an inner wire belt where it is subjected to a first dewatering treatment by the action of first dewatering means under said horizontal section, said stock and said inner wire belt then passing between a vertically rotating, perforated cylinder mold and an outer belt and pressed therebetween along an arcuate path extending from the upper to the lower part of said cylinder mold thereby receiving a second dewatering treatment and partially forming a web, the improvement in said apparatus which comprises tertiary dewatering means including:

a stationary water guide means disposed under said lower part of said cylinder mold, said water guide means having a curved face which in vertical section constitutes an arc circumscribed around and between the outer surface of said cylinder mold and a point closely adjacent to the outer surface of a turning roll installed below said cylinder mold, thereby constituting a guide assembly for guiding the partially formed web along an arcuate downward travel path between the cylinder mold and the turning roll, said water guide means including a series of drain boards disposed normal to said arcuate downward travel path, said drain boards defining water guide channels therebetween, said web traveling over said drain boards and said water guide channels between said drain boards, and said water guide channels being disposed so as to feed any drained water to a water removal means.

3. A web forming and combining apparatus consisting of an arrangement of web-forming units wherein each of said units dewater initially fluid stock in three stages comprising:

- a first means for dewatering the material and forming it into a textured fiber mat on a horizontal section of an inner wire belt;
- a second means for dewatering said fiber mat on a cylinder mold and compressing said fiber mat into a web between said inner wire belt and an outer belt lying over it;
- a third means for dewatering said web including a stationary water guide means disposed under said cylinder mold, said water guide means having a curved face which in vertical section constitutes an arc circumscribed around and between the outer surface of the cylinder mold and a point closely ad-

jacent to the outer surface of a turning roll installed below said cylinder mold, thereby constituting a guide assembly for guiding the partially formed web along an arcuate downward travel path between the cylinder mold and the turning roll, said water guide means including a series of drain boards disposed normal to said arcuate downward travel path, said drain boards defining water guide channels therebetween, said web traveling over the drain boards and said water guide channels between the drain boards, said water guide channels being disposed so as to feed any drained water to a water removal means; and means for combining said web with a web or webs from a preceding web forming unit or units.

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