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WATER EXTRACTING DEVICE FOR PAPER MACHINES

Filed May 24, 1963

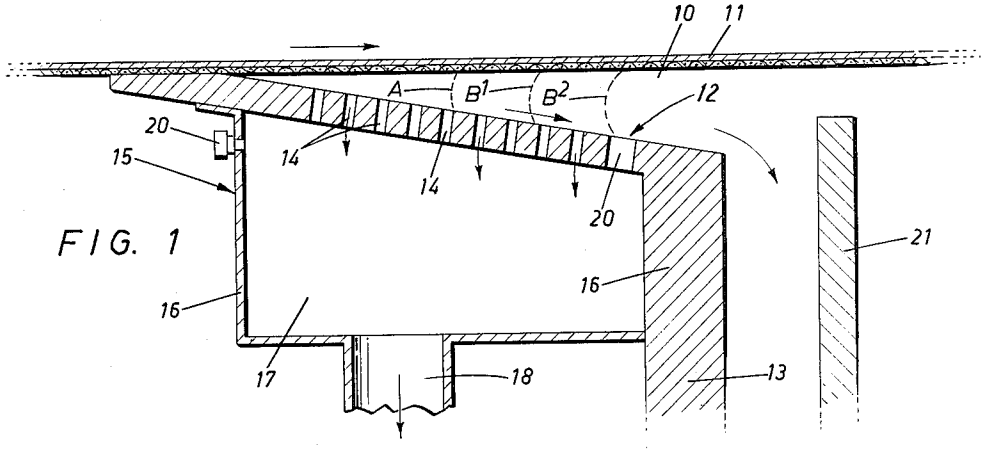


FIG. 1

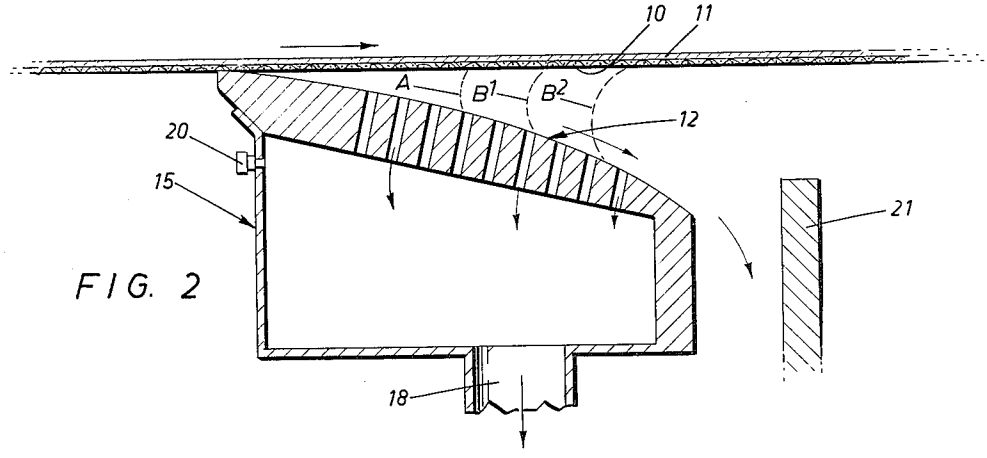


FIG. 2

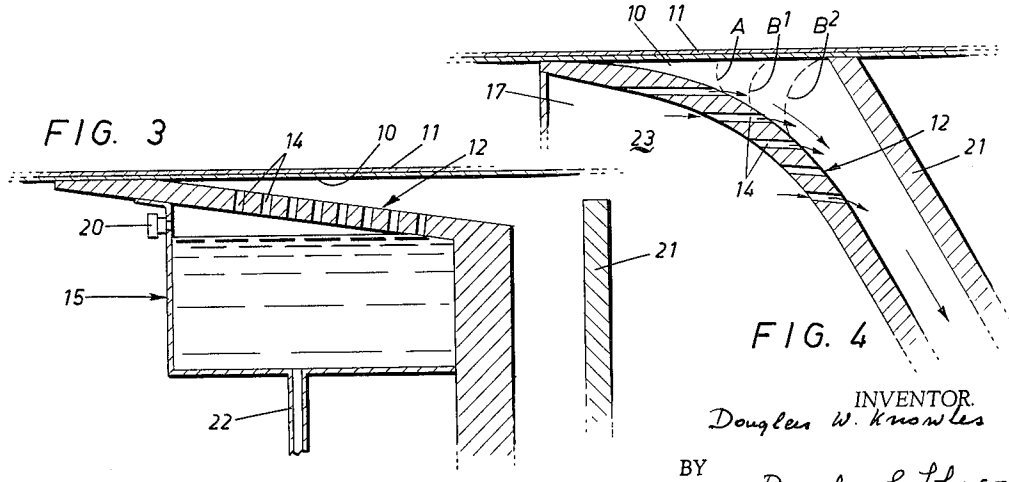


FIG. 3

FIG. 4

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WATER EXTRACTING DEVICE FOR PAPER MACHINES

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This invention relates to Fourdrinier paper making machines and more particularly to improved liquid drainage apparatus.

The forming of a pulp web in a Fourdrinier machine is made in such a way that a mixture of water and fibre flows out of a head box on to a moving endless wire screen, the water being then drained from the mixture as it travels on the wire to a point where it is finally compacted by the application of high vacuum and the web is strong enough to be removed from the wire.

In this process it is essential that the stock be drained adequately prior to its final compaction, otherwise the best results in paper strength and quality are not obtained because the fibres of the stock tend to lump together in a non-uniform paper formation. However, it has been found that with adequate drainage a dilute stock is desirable because it gives a more uniform formation of the paper fibres with resultant increase in strength and quality of the paper, but the use of such stock accentuates the problem of such drainage and proposals have been made to increase the hydrostatic head on the wire during the early part of its travel.

To this end, high vacuum boxes have been employed but these have the disadvantage that the drag imposed on the wire results in added wear and furthermore, sagging of the stock on the wire takes place with resultant non-uniformity of the thickness of the paper unless table rolls are supplied underneath the wire to give the requisite support. Unfortunately, such table rolls themselves create a problem of throw-back of the liquid carried around the rolls causing disruption of the partially orientated fibres thus impairing the drainage and hence the quality of the finished paper. Furthermore, such high vacuum suction arrangements are costly of construction because complicated and expensive sealing mechanisms are required.

Alternatively, attempts have been made to employ low suction vacuum boxes operating directly under the wire, but this again suffers in the main from difficulty of providing a constant seal between the boxes and the wire.

The result of the difficulties experienced with high and low vacuum boxes has been a general reliance on free gravity drainage in commercial machines in the early stage of travel of the stock on the wire, but it will be appreciated that if such gravity drainage is just adequate with a particular dilution of stock the only method of achieving the same adequacy if a more dilute stock is used with the intention of producing a higher quality of paper is to reduce the rate of movement of the wire. This curtailment of the speed of the wire means that the rate of production is adversely affected. In the interests of flexibility and maximum efficiency it would be desirable to introduce simple and inexpensive means which would augment the gravity drainage when necessary.

To this end a member or deflector is positioned under the wire inclined in a direction corresponding to the travel of the stock, the upper end of the deflector being substantially in a plane with the under side of the wire whereby hydrodynamic suction takes place in the zone subtended by the wire and the member resulting in withdrawal of liquid from the stock in a downward flow over the upper surface of the deflector. The natural extent of the hydrodynamic suction zone is determined by the extent to which turbulence can be delayed or "laminar" flow preserved in the liquid flowing on this upper surface, the term "laminar" flow designating regular and smooth steady motions which do not show the irregular fluctuations characteristic of turbulence flows, the existence of which will depend on differences in the rate of travel from the outside to the inside within the liquid flow.

The improvement of the invention consists in providing apertures connecting the lower and upper surfaces of the deflector and applying a pressure differential between such surfaces through the apertures whereby the static or boundary layer of the liquid adjacent to the upper surface of the deflector is given motion thus delaying separation of the faster moving liquid further removed from the upper surface of the deflector. By this means the distance of laminar flow on the upper surface of the deflector is extended and the zone of hydrodynamic suction of the stock on the wire is increased thereby augmenting the drainage.

It is then an object of this invention to provide apparatus whereby the length of stock subjected to hydrodynamic drainage may be reduced while giving the required result of high strength and quality of the drained web, the apparatus being simple and inexpensive.

This and other objects, features and advantages of this invention will become apparent to one skilled in the art from the following description of the embodiment illustrated in the accompanying drawings.

FIGURE 1 is an elevational diagrammatic view of a forming wire and a deflector in an arrangement embodying the instant invention;

FIGURE 2 is an elevational diagrammatic view of an embodiment of the invention which differs from FIGURE 1 in that the upper surface of the deflector is curved;

FIGURE 3 is an elevational diagrammatic view of an embodiment of the invention which differs from FIGURE 1 in that drainage of the water through the apertures provides a vacuum;

FIGURE 4 is an elevational diagrammatic view of another embodiment of the invention which differs from the previous arrangements in that the pressure differential is provided by positive injection of water through the apertures of the deflector.

As shown in the drawings:

In the embodiment shown in FIGURE 1 a travelling forming wire **10** carries stock **11** thereon. A deflector **12** having its upper part inclined in a direction corresponding to the travel of the stock **11** supports the wire **10**; the lower part of the deflector **12** being supported on a base **13**. The upper end of the deflector **12** is substantially in a plane with the underside of the wire **10** and the liquid extracted by hydrodynamic suction flows over the upper surface of the deflector **12**. Apertures **14** connecting its upper and lower surfaces are provided in the deflector **12** and a pressure differential operating through these apertures **14** is created by means of a vacuum applying to the lower surface of the deflector **12**. To provide this vacuum a sealed box **15** having end walls **16** and side walls **17** is

attached to the underside of the deflector **12** and the box **15** is supported by the base **13**, though if the deflector **12** is strong enough, it may itself support the box **15**. The vacuum in the box **15** may be created by means of a vacuum pump not shown, or by means of a drop leg **18** attached to the lower side of the box **15** in which case a larger aperture **19** will be provided in the deflector **12** through which sufficient liquid will pass to create a syphon pump action by means of the drop leg **18**. An air bleed **20** shown is provided to the sealed box **15** for use in relieving excessive vacuum in the box **15** should that be desired. A member **21** is positioned forward of the deflector **12** to turn the liquid downwards though it will be clear that if a series of boxes **15** are employed the end walls **16** will serve this purpose; however, the member **21** is positioned in relation to the end of the deflector **12** so that the liquid impinging on to the member **21** will not splash back and interrupt the flow of liquid on the deflector **12**.

The vacuum in the box **15** constitutes a control means for extending the natural hydrodynamic suction zone created between the wire **10** and the deflector **12**, the extent of this natural zone in cross section being indicated by the curved line A. The operation of the vacuum on the deflector **12** can be best appreciated by considering the theory of fluid film, this being introduced for the purpose of understanding and not by way of limitation. It is generally recognized that a fluid flowing along a surface does not move at an uniform rate at all points in a cross section normal to the surface of the film. On the contrary, the film adjacent to the surface, known as the "boundary layer," is practically static; the film next to this boundary film moves slightly more rapidly and so on until a point is quickly reached in the flow where the fluid moves with practically no friction. This difference in speed between the frictionless flow of the fluid and the boundary layer increases the further the fluid travels along an inclined surface of the deflector **12** and there comes a point where the difference in speed is sufficient to create turbulence and eventual separation of the film. At this point the pull of the fluid travelling along the inclined surface of the deflector **12** on the gravity suction zone will be disrupted and this is the reason for the limitation in the amount of dewatering of the stock **11** which takes place by hydrodynamic suction.

The purpose of the vacuum applied to the under surface of the deflector **12** is to exert a downward force on the boundary layer of the liquid flowing along the upper surface of the deflector **12** and thereby transmit a downward component of force operating parallel to the upper surface of the deflector **12**, to energise the boundary film. This will delay the point at which turbulence takes place or in other words, promote the persistence of laminar flow of the liquids along the upper surface of the deflector **12**; this, in turn, will delay separation of the films thereby extending the zone of hydrodynamic suction to B^1, B^2, etc., and a greater length of the web on the wire **10** will be subjected to hydrodynamic suction thereby augmenting the dewatering of the stock **11**.

It will be observed that no vacuum is applied directly to the web and that the pressure above the upper surface of the deflector **12** is atmospheric; it follows that no problem arises in creating and preserving a seal with the underside of the web.

In the embodiment shown in FIGURE 2 the deflector **12** has an arcuate upper surface, whereby the fluid as it travels thereon is turned downward; this enables the member **21** to be positioned closer to the deflector **12** without affecting the flow of liquid on the latter by splashing.

FIGURE 3 shows an alternative arrangement wherein the vacuum provided in the box **15** is created by a part of the water flowing along the upper surface of the deflector **12** travelling through the apertures **14** and maintaining a body of water below the under surface of the deflector **12**, but with a level somewhat higher than the lower end of the deflector **12**. A conduit **22** is connected to the lower part of said box **15** and a controlled amount of water is allowed to escape from the box **15** to maintain the level of the water higher than the end of the deflector **12**. The vacuum thus created is sufficient to provide the requisite component force on the static boundary layer of the fluid flowing along the upper surface of the deflector **12** to extend the zone of gravity suction.

In the embodiment shown in FIGURE 4 the deflector **12** has apertures **14** connecting the upper and lower surfaces which are inclined in a direction corresponding to the direction of the flow of liquid on the upper surface of the deflector **12**. A water supply **23** under pressure is directed against the under surface of the deflector **12** and this flow of water through the apertures **14** to the upper surface of the deflector **12** provides a pressure differential which energises the static boundary layer and thereby achieves the same result, as the vacuum differential illustrated in the previous arrangements.

In the arrangement shown in FIGURE 4 there is no requirement for the box **15** to be sealed though the end walls **16** of an adjacent box provided a suitable baffle for downward movement of the flow of water on a previous deflector. However, side walls **17** are conveniently attached to the deflector **12** not only to provide support thereof but also to contain the excess water flowing down the under surface of the deflector **12**.

What I claim is:

1. Dewatering apparatus for use with a machine of the Fourdrinier type having a screen arranged to be driven in a predetermined direction, comprising; deflector means for mounting beneath the screen, to extend transversely in relation to said predetermined direction and having an upper surface and a lower surface, the upper edge of said upper surface of the deflector means contacting the under surface of the screen for at least a portion of its length, said upper surface diverging downwardly from the screen in said predetermined direction to position the lower edge thereof from said screen, apertures extending through said deflector means and connecting said upper surface with said lower surface, and means to establish a fluid pressure gradient between the two said surfaces to cause flow of liquid through said apertures, whereby the boundary layer of liquid flowing over said upper surface is energized and hydrodynamic suction between said deflector means and said screen is improved.

2. Dewatering apparatus as claimed in claim **1** wherein said means to establish a pressure gradient between said two surfaces includes a sealed box adapted to receive fluid flowing downwardly from said upper deflector surface, and means to induce a partial vacuum in said box.

3. Dewatering apparatus as claimed in claim **2** wherein said vacuum inducing means comprises a flow way in the form of a drop leg extending downwardly from said box, and means for introducing sealing liquid within said box.

4. Dewatering apparatus as claimed in claim **2** including upstanding wall means positioned from said deflector means in said predetermined direction to deflect liquid impinging thereon in a downward direction.

5. Dewatering apparatus as claimed in claim **1** wherein said means to establish a pressure gradient between said two surfaces includes water supply means connected with said apertures at the lower surface of the deflector to supply pressurized water thereto, said apertures extending from said lower surface to said upper surface in a direction corresponding substantially with said predetermined screen direction, whereby said pressurized water flowing through said apertures serves to energize the boundary layer of liquid on said upper surface.

6. Dewatering apparatus as claimed in claim **5** including upstanding wall means positioned from said deflector means in said predetermined direction and extending transversely to said screen in substantially parallel relation with a portion of said deflector means.

7. Dewatering apparatus as claimed in claim 5 wherein said downwardly diverging upper surface is in the form of a convexly curved flow surface.

8. Dewatering apparatus as claimed in claim 7 including upstanding wall means positioned from said deflector means in said predetermined direction and extending closely adjacent said screen under surface, to direct the flow of water downwardly therefrom.

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