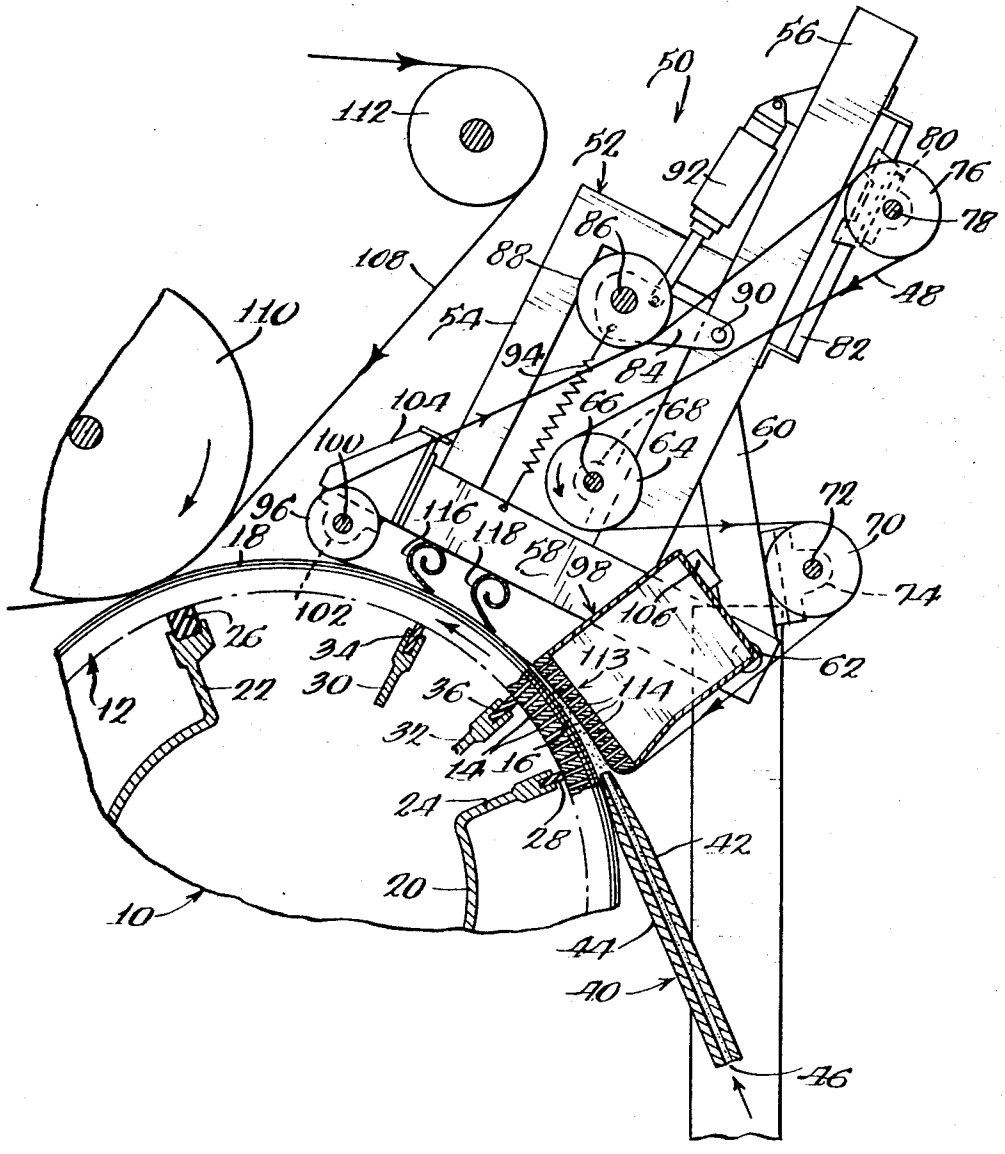
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SUCTION CYLINDER MOLD PARTIALLY WRAPPED BY AN ENDLESS, POROUS CONTROL MEMBER

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SUCTION CYLINDER MOLD PARTIALLY WRAPPED BY AND ENDLESS, POROUS CONTROL MEMBER

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ABSTRACT OF THE DISCLOSURE

An improved paper forming device including a rotatable suction forming roll and a flexible stock control member such as a porous wire which is trained over a portion of the forming roll in wrapped engagement with a segment of the latter so as to define a nip therebetween, there being provided nozzle means for directing stock at the nip and also dewatering means disposed above the stock control member thus producing simultaneous dewatering from both sides of the stock.

The present invention relates to paper forming apparatus, and particularly to apparatus which utilizes a cellular suction forming cylinder or roll to form a continuous paper web from liquid stock suspension or furnish delivered to the periphery of the roll from a nozzle.

It is known to provide a cellular suction forming roll in place of the extremely long Fourdrinier section conventionally used in paper making machines. Such a suction forming roll comprises a rotatable cylindrical shell having a plurality of radial openings therein. A nozzle is employed to supply the stock suspension to a predetermined forming area on the surface of the rotating suction roll, and the major part of the water in the stock suspension is removed by suction means disposed inside of the forming roll, such water being largely discharged outwardly from the forming roll by centrifugal force after the portion of the roll containing the water has passed beyond the forming area and beyond the effect of the vacuum section within the roll. In this manner, a continuous web of paper is formed on a Fourdrinier wire on the surface of the suction forming roll and is subsequently removed by a suction pick-up or couch roll over which a pick-up felt is trained.

A cylinder sheet forming apparatus of the type described above is shown in Ostertag et al. Patent 2,418,600 wherein a traveling Fourdrinier wire is trained over a suction forming roll or breast roll, and the stock suspension is delivered to the Fourdrinier wire at an area where the latter is directly supported by the forming roll. Other types of cylinder sheet forming apparatus are disclosed in the copending applications of Sherwood G. Holt, Ser. No. 315,033, filed Oct. 9, 1963, now Patent No. 3,321,360, and Ser. No. 543,268, filed Apr. 18, 1966, now Patent No. 3,352,454, both of which are assigned to the assignee of the present invention. In the latter two applications there is described a suction forming roll including a Fourdrinier wire on the form of a sleeve which is intimately engaged over the periphery of the roll.

In the above-mentioned copending application of Sherwood G. Holt, Ser. No. 315,033, now Patent No. 3,321,360, there is described a cylinder-type paper forming device wherein the nozzle which delivers the stock suspension to a forming area on the suction forming roll has an upper lip which extends for a considerable distance over the forming area on the periphery of the forming roll so that substantially all of the formation of the paper web occurs under the extended upper lip of the nozzle.

Thus, control of the stock during formation of the web is effected substantially entirely by the upper nozzle lip in combination with the forming roll. In the apparatus described in the other copending application of Sherwood G. Holt, Ser. No. 543,268, now Patent No. 3,352,454, a substantial portion of the extended upper nozzle lip is eliminated and replaced by an endless flexible stock control member which is movable at the peripheral speed of the forming roll and is trained over guide means which maintain an operative portion of the length of the stock control member in engagement or wrapping relation with a segment of the periphery of the rotatable forming roll in an area between the end of the nozzle upper lip and the pick-up roll. Accordingly, in the latter embodiment, partial formation of the web occurs in an initial forming zone under the nozzle upper lip, and further formation occurs in a second forming zone under the moving stock control member and immediately adjacent the first forming zone.

It is a primary object of the present invention to provide a cylinder-type paper forming device which provides increased control of the stock in an initial forming area where the stock first contacts the forming roll surface.

In furtherance of the foregoing object, we provide paper forming apparatus including a rotatable suction forming roll, and in combination therewith we provide an endless flexible stock control member of the general type mentioned above, the stock control member being driven over guide means which hold a portion of its length in engagement with a segment of the periphery of the forming roll. Moreover, in order to provide increased control over the stock suspension as soon as the same contacts the forming roll surface, we provide a nozzle wherein the upper lip portion is approximately coextensive with the lower lip portion, and such nozzle is positioned with the end thereof in close proximity to the moving stock control member. In other words, the nozzle has no projecting or overhanging upper lip, and it simply delivers the stock suspension to a nip formed between the suction forming roll and the endless stock control member in an area proximate where the latter initially contacts the forming roll. Consequently, the formation of the stock after it first contacts the forming roll occurs substantially entirely under the moving stock control member, in contrast with the prior structures described hereinabove where formation occurs entirely or partially under an extended upper lip of the nozzle.

We further provide suction means immediately above the moving stock control member proximate the end of the nozzle. In this manner, as the stock suspension is initially delivered to the forming drum it is conducted between the periphery of the drum and the moving stock control member, and the stock is simultaneously subjected to dewatering means inside of the forming roll and oppositely disposed dewatering means above the stock control member. Such an arrangement effects maximum control of the stock during formation of the paper web, and such control begins substantially immediately upon contact of the stock with the forming roll.

The foregoing and other objects and advantages of the invention will be apparent from the following description thereof.

Now in order to acquaint those skilled in the art with the manner of practicing and utilizing our invention, we shall describe, in conjunction with the accompanying drawing, a preferred embodiment of the invention.

The drawing is a side elevational view, partly broken away, illustrating a cylindrical paper forming device constructed in accordance with the present invention.

Referring now to the drawing, there is shown a rotatably mounted cylindrical suction forming roll indicated generally at **10** comprising a cylindrical shell **12** having a

plurality of closely spaced radial holes or cells **14** formed therein. A plurality of circumferentially spaced longitudinal spacer strips **16** extend along the outside of the cylindrical shell **12** and support a foraminous surfacing material or the like (not shown in detail) over which a wire sleeve **18** is mounted. If desired, a traveling Fourdrinier wire could be trained over the forming roll **10** as shown in the abovementioned Ostertag et al. patent, but it is preferred that the wire comprise a sleeve which thus constitutes the peripheral surface of the forming roll.

Within the rotatable cylindrical shell **12** there is positioned a stationary tubular member **20** which together with a pair of radial partition walls **22** and **24** defines a suction box assembly or vacuum chamber to assist in the dewatering of the stock suspension which is supplied to the wire surface **18** of the suction forming roll. The radial partitions **22** and **24** extend the full length of the forming roll **10** and are provided at their radially outer ends with sealing strips **26** and **28**. Additional partition walls **30** and **32** having sealing strips **34** and **36** may also be provided, the latter partitions being circumferentially adjustable and serving to divide the vacuum chamber into several compartments which may be subjected to varying degrees of vacuum.

Normally, the first compartment between the partitions **24** and **32** will be subjected to a somewhat lower vacuum than the other compartments within the forming roll **10**, due in part to the fact that the stock suspension is under pressure as it leaves the nozzle **40**, and the latter pressure will itself tend to force the water into the openings **14** in the periphery of the roll **10**. Moreover, in some instances it may even be found desirable to provide a low positive pressure within the first compartment between the partitions **24** and **32** to partially offset the pressure provided by the nozzle **40**. Accordingly, while the chambers or compartments within the roll **10** between the two outermost partitions **22** and **24** are referred to herein as "vacuum chambers," and while most of the compartments will be in fact be subjected to a vacuum, it should be understood that in certain applications a small positive pressure may be created in one or more of the compartments, particularly in the area of the nozzle outlet. For a more detailed description of the cellular suction forming roll **10**, reference is made to the above-mentioned copending application of Sherwood G. Holt, Ser. No. 315,033, now Patent No. 3,321,360.

A nozzle **40** comprises an upper nozzle lip **42** and a lower nozzle lip **44**, and it will be seen that the upper and lower nozzle lips are coextensive in the sense that they terminate together, such an arrangement being in contrast with various prior art devices where the upper lip extends well beyond the lower lip so as to exert control over the stock after it engages the forming roll. In the embodiment being described, the nozzle **40** is substantially straight and is approximately tangential to the forming roll **10**. However, it should be understood that if desired only the outlet end of the nozzle need be approximately tangential to the forming roll, and the inlet end of the nozzle may join with the outlet end thereof through a curved nozzle section. Moreover, while no means for adjustment of the upper lip **42** relative to the lower lip **44** is provided in the embodiment illustrated, the end of the upper lip may comprise a movable section which is capable of adjustment relative to the lower lip. The overall nozzle assembly **40** may also be pivotally mounted or otherwise adjustable, as shown for example in the abovementioned copending application of Sherwood G. Holt, Ser. No. 315,033, now Patent No. 3,321,360. The stock nozzle **40** is supplied at its inlet **46** with stock suspension through the usual supply pipes and through transition pieces which spread out the flow into a wide thin pattern of uniform dimensions and density across substantially the entire axial length of the roll **10**, the stock suspension being delivered by the nozzle to the wire surface **18** on the forming roll.

A stock control member in the form of a movable porous top wire or fabric **48** is provided in order to control the stock during formation of the paper web. The stock control member may be made from conventional Fourdrinier wire, or if desired it may be made from various types of porous fabric, for example a synthetic fiber fabric. There is shown a stock control assembly **50** including a supporting frame **52** comprised of interconnected frame elements **54**, **56**, **58** and **60**, the frame **52** being pivotal about a pair of trunnion shafts such as shown at **62**. The pivotal position of the frame **52** on the trunnions **62** may be determined by one or more adjustable jacks or the like (not shown) which extend from the frame **52** to a fixed supporting member. A plurality of rolls or pulleys are rotatably mounted on the supporting frame **52** in order to support and drive the endless stock control member **48** which is trained over a portion of the periphery of the forming drum **10** adjacent the end of the nozzle **40** and thereby controls the stock during formation of the continuous paper web. Thus, a drive roll **64** is rotatably mounted on a shift **66** supported by lugs **68** extending from the lower end of the frame element **56**. The drive roll **64** engages the outside of the endless stock control member **48**, and the roll **64** is driven by a variable speed drive (not shown) so as to move the stock control member at a desired speed, preferably the same as the peripheral speed of the forming roll **10**. A guide roll or pulley **70** is rotatably mounted on a shaft **72** supported by lugs **74** which project from the frame element **60**, and the roll **70** engages against the inside of the stock control member **48** to guide the same. Above the guide roll **70** there is mounted a stretch roll **76** which is rotatable on a shaft **78**, the latter being supported on a carriage **80** which is slidably adjustable along one or more guide rods **82**. The stretch roll **76** is engaged against the inside of the endless stock control member **48**, and the carriage or slide **80** may be adjustably positioned on the guide rods **82** in order to apply a predetermined desired tension to the stock control member.

A pivotally mounted arm **84** serves to support one end of a shaft **86** on which an adjustable wire control roll or guide roll **88** is rotatably mounted. The other end of the shaft **86** is mounted in a universal spherical bearing or the like (not shown), and the pivot arm **84** has one end pivotally mounted to the frame element **56** by means of a pin **90**. Accordingly, movement of the arm or lever **84** about its pivot pin **90** will cause the roller shaft **86** to pivot about the one end thereof which is universally mounted. An air cylinder **92** has one end connected to the arm **84** and its other end connected to the upper end of the frame element **56**, and a tension spring **94** extends between the arm **84** and the frame element **58**. Thus, by controlling the supply of air to the air cylinder **92**, and thereby varying the length of such air cylinder, it is possible to vary the position of the arm **84** and in this manner control the orientation of the shaft **86** and wire control roller **88**.

The roll **88** engages against the outside of the endless stock control member or wire **48**, and the position of the roll **88** is continuously adjusted as required by means of the air cylinder **92** in order to control or guide the movement of the stock control member **48**. More specifically, a movable feeler or sensing member (not shown) engages the moving stock control member **48** and senses lateral or transverse movements of the latter. The feeler or sensing member is associated with valve means (not shown) so as to control the air supply to the air cylinder **92** in accordance with lateral position of the stock control member relative to the roll **88**. Thus, whenever the stock control member **48** tends to move from a centered position on the roll **88**, the orientation of the roll is varied in order to maintain the member **48** in a centered position on the roll. In this manner, the moving endless stock control member or wire **48** is continuously maintained in a proper centered position on

the roll **88** and on the various other guide and tension rolls over which it travels.

The lower portion of the stock control member **48** is trained over a guide roll **96** and a suction box **98** which together cause the stock control member to partially wrap or engage on a segmental portion of the periphery of the forming roll **10**. The guide roll **96** is rotatably mounted on a shaft **100** supported on a pair of lugs **102** which project downwardly from a mounting bracket **104**. The suction box **98** is supported in any suitable manner such as from a frame element **106**, and it is positioned in close proximity to the periphery of the forming roll **10** and immediately adjacent the end of the nozzle **40**. It should be understood that the drive roll **64**, the several guide rolls **70**, **76**, **88** and **96**, the suction box **98**, and the endless stock control member **48**, all extend for substantially the full length of the suction forming roll **10**, and the portion of the endless stock control member **48** between the guide roll **96** and the suction box **98** is held in partially wrapped relation on a segment of the periphery of the roll **10** so as to control the paper web being formed thereon from the stock suspension supplied by the nozzle **40**. After the paper web is formed on the wire surface **18** of the forming roll **10**, the web is couched off of the forming roll by a pick-up felt **108** which is trained over a pick-up roll **110** and a guide roll **112**.

As stated earlier herein, and as described more fully in the copending application of Sherwood G. Holt, Ser. No. 315,033, now Patent No. 3,321,360, the forming roll **10** effects dewatering of the stock suspension and resulting paper web due to either or both the suction applied at the wire side or bottom side of the web and the pressure created by the nozzle **40** which causes the water to enter the radial openings **14** in the roll. However, in accordance with the present invention it is possible to effect additional dewatering by means of the suction box **98**, such dewatering occurring during initial formation of the web as soon as the stock suspension contacts the periphery of the forming roll **10**. It will be seen that the bottom of the suction box **98** adjacent the periphery of the forming roll **10** and immediately inside of the stock control member **48** comprises a perforate member **113** having a plurality of openings **114** so as to permit water passing up through the porous stock control member **48** to be drawn into the suction box and thereby removed. In addition, in the preferred embodiment being described, a pair of foils or scoops **116** and **118** are positioned in close proximity to the periphery of the roll **10** immediately above the endless stock control member **48** between the suction box **98** and the guide roll **96**. Such foils also serve to remove water which moves up through the porous stock control member **48**.

The stock suspension delivered by the nozzle **40** may for example constitute 1% solids, whereas the stock must be dewatered to approximately 15% solids by the time the web reaches the pick-up roll **110**. Accordingly, if it be assumed that the apparatus is running at approximately 1900 feet per minute, then in the embodiment being described the sheet must be dewatered from 1% solids to 15% solids in less than 0.13 second, which is roughly equivalent to removing 43 gallons per minute per square foot of forming surface. One of the important advantages of the present invention is that it permits simultaneous dewatering of the stock suspension and resulting paper web from both the bottom or wire side of the web and the top or felt side thereof, and it permits such simultaneous dewatering from both above and below to be initiated approximately at the time the stock suspension first contacts the periphery of the forming roll **10**. Such an arrangement thus differs from those devices where formation occurs substantially entirely under an extended upper lip of the nozzle, or where formation occurs first in an initial forming zone under an upper nozzle lip and thereafter in an adjacent secondary forming zone defined by a segment of the periphery of the roll **10** and a stock control member which is partially wrapped thereon.

In accordance with the present invention, the upper lip **42** of the nozzle is substantially coextensive with the lower lip **44** thereof, and approximately at the time the stock suspension first engages the periphery of the roll **10** its formation is controlled by the roll **10** and the stock control member **48**. Moreover, as previously stated, the operative portion of the stock control member **48** and the suction box **98** are both closely adjacent the outlet end of the nozzle **40** thereby permitting dewatering from above and below during the initial formation of the web substantially immediately after the stock suspension contacts the periphery of the forming roll. By thus providing for a controlled rate of water removal in two opposite directions substantially as soon as the stock suspension contacts the roll **10**, the apparatus described herein permits the maximum possible control of the stock during the initial formation of the web. In addition, the elimination of any extension on the upper nozzle lip beyond the area where the stock suspension first contacts the forming roll **10** has the further advantage that there is no possibility of foreign particles in the stock suspension being caught in a restricted area between the forming roll and the tip of the top lip.

We claim:

1. A device for forming a paper web comprising, in combination, a rotatable suction forming roll, a flexible stock control member having an operative portion of its length held in wrapped engagement with a segment of the periphery of said forming roll so as to define a nip at the area where said stock control member first engages said forming roll periphery, said stock control member being continuously moved in the same direction as the periphery of said forming roll, stock supply means for delivering stock suspension to the periphery of said forming roll, said supply means being directed substantially at said nip so that said stock suspension will first engage said forming roll periphery approximately at said nip and will immediately pass into a forming zone wherein it is controlled by said stock control member, and dewatering means disposed immediately above said operative portion of said stock control member in proximity to said nip whereby when said stock suspension first contacts said forming roll and enters said nip between said forming roll periphery and said stock control member, simultaneous dewatering of said stock will occur during initial formation of said web both by said forming roll which acts on one side of the web and by said dewatering means which acts above the stock control member at the opposite side of the web.

2. The device of claim **1** wherein said dewatering means comprises suction means.

3. The device of claim **1** where said stock supply means comprises a stock supply nozzle having substantially coterminous upper and lower lip portions which both terminate in proximity to said nip, and where said dewatering means comprises suction means.

4. The device of claim **3** wherein said suction means comprises a suction box.

5. The device of claim **4** wherein additional water removal means comprising scooping means is mounted immediately over said operative portion of said stock control member in spaced relation to said suction box.

6. In a device for forming a paper web including a rotatable suction forming roll and a flexible stock control member having an operative portion of its length held in wrapped engagement with a segment of the periphery of the forming roll so as to define a nip at the area where the stock control member first engages the forming roll periphery, said stock control member being continuously moved in the same direction as the periphery of the forming roll, the improvement compris-

ing, in combination, a stock supply nozzle having substantially coterminous upper and lower lip portions which both terminate in proximity to said nip for delivering stock suspension to the periphery of the forming roll, said stock supply nozzle being directed substantially at said nip so that said stock suspension will firse engage the forming roll periphery approximately at said nip and will immediately pass into a forming zone where it is controlled by said stock control member, and dewatering means disposed immediately above the operative portion of the stock control member in proximity to said nip, whereby when said stock suspension first contacts the forming roll and enters said nip, said dewatering means will effect dewatering of the stock from immediately over the area where initial forming of the web occurs.

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