April 14, 1959 R. J. THOMAS 2,881,675

METHOD AND APPARATUS FOR DE-WATERING AQUEOUS PULP OR STOCK IN THE MANUFACTURE OF PAPER OR BOARD

Filed March 10, 1955 3 Sheets-Sheet 1

Fig. 1

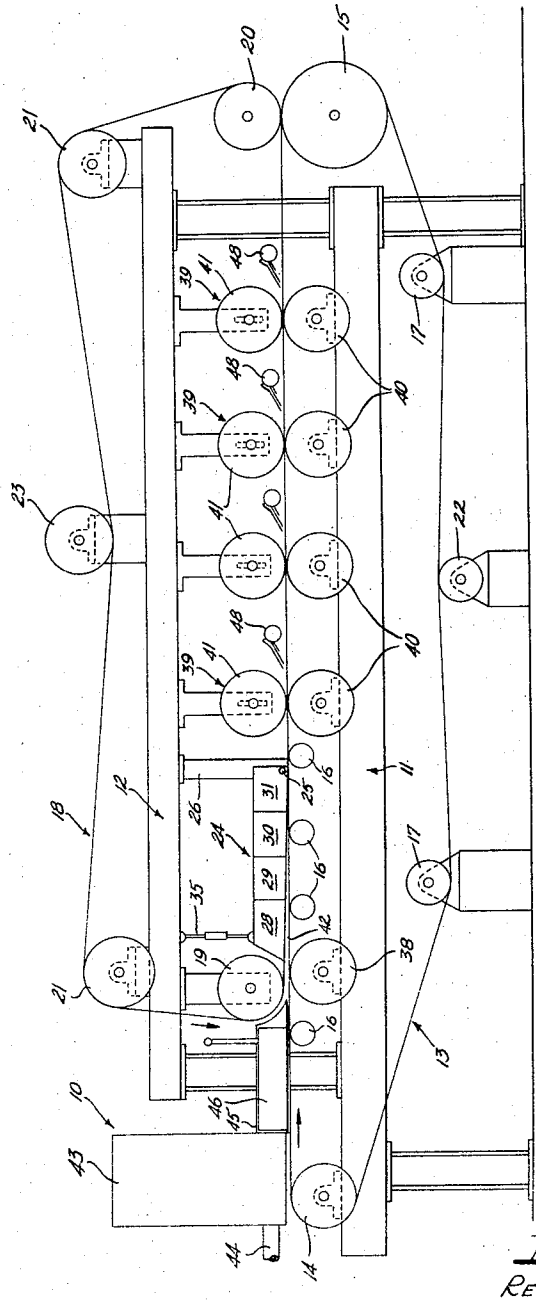

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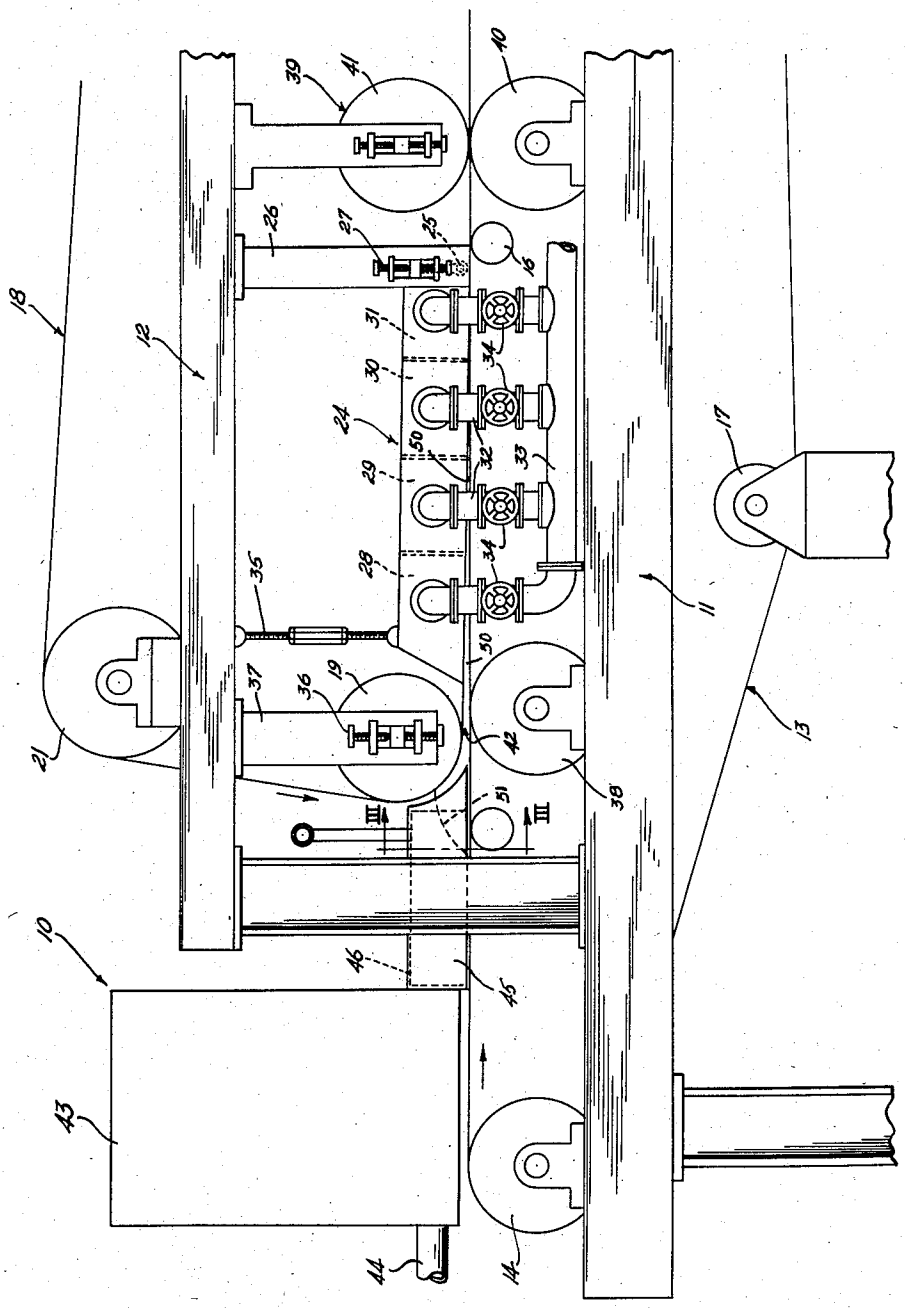
Fig. 2



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Filed March 10, 1955 3 Sheets-Sheet 3

Fig. 4

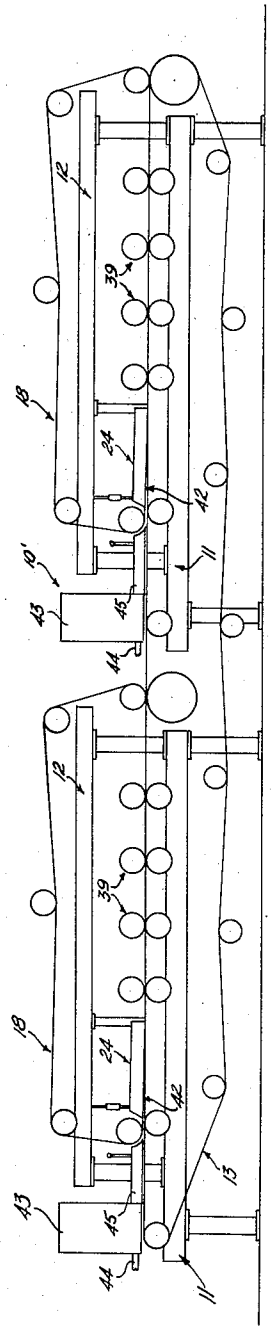
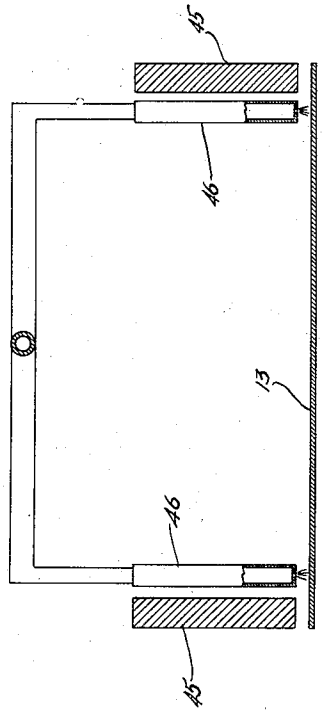


Fig. 3



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METHOD AND APPARATUS FOR DE-WATERING AQUEOUS PULP OR STOCK IN THE MANUFACTURE OF PAPER OR BOARD

Reginald James Thomas, Weston-Super-Mare, England, assignor to St. Anne's Board Mill Company Limited, Bristol, England, a British corporation

Application March 10, 1955, Serial No. 493,376

Claims priority, application Great Britain April 6, 1954

6 Claims. (Cl. 92—44)

This invention relates to method and apparatus for de-watering pulp or stock fed as an open topped layer to the traveling carrier band of a paper or board-making machine. More specifically, this invention deals with a top wire-equipped Fourdrinier type paper or board-making machine which de-waters stock upwardly and wherein such upward de-watering is facilitated by suction to accommodate slow-speed operation.

In the Reginald James Thomas and Stanley Fred Smith application Serial No. 373,382, filed August 10, 1953, now Patent No. 2,821,120 granted January 28, 1958, there is described and claimed method and apparatus for de-watering pulp wherein stock is introduced between spaced-opposed overlying and underlying forming surfaces comprising an overlying wire and an underlying carrier band, and water from this stock is discharged upwardly through the overlying wire under the influence of kinetic energy imparted to the stock and water by advancing said surfaces. The traveling surfaces build up a sufficient momentum in the water that, as they are squeezed together in passing under a doctor, the water will be flung through the top wire and flow over the doctor to a drain outlet.

The present invention now provides method and apparatus which will de-water stock through a top forming wire to form a web thereon even when the water is not advanced at a sufficiently fast rate to build up a momentum capable of creating its own separating force.

Thus, in accordance with the present invention, the top forming wire passes under suction means which will pull the water through the wire to de-water the stock. The suction means is located along a sloping run of the top wire which converges to a pressure gap.

This invention is applicable to either single or multiple ply machines and the expression de-watering as used herein means the initial de-watering which, in Fourdrinier type machines, is usually carried out by natural drainage and by suction boxes arranged beneath the traveling carrier band that reduces the water content of the pulp to, for example, about 96% to form the stock into a substantially continuous web.

Uniform pulp or stock as delivered to the traveling forming band of a paper or board-making machine usually consists of from ½% to 1½% of cellulose vegetable fiber, with or without other materials, and about 99½% to 98½% water. In this condition, the stock is fluid so that it flows freely onto and across the forming band. In the process of manufacture into paper or board, the stock is initially de-watered to a solid content of, for example, about 4%. At about this concentration, the fibers interlock and assume a structural relationship that thereafter remains substantially unaltered. The pulp is then said to be formed. Further water is removed from the stock, for example by suction boxes, couch rolls, and wet presses,

and it is finally dried by drying cylinders. Of course, it is highly desirable to remove as much water as possible by mechanical means which do not require excessive power. Therefore, the provision of the overlying or top forming wire and the de-watering of the stock upwardly from the layer of pulp on the bottom forming band when this layer is in its fluid state, regardless of the speed of operation of the machine, represents an important adjunct to the invention of the aforesaid application Serial No. 373,382. The present invention adapts the principles of the aforesaid application to slow-running machines.

It is then a subject of this invention to provide for the upward de-watering of stock through an overlying forming wire of a paper or board-making machine regardless of the speed of operation of the machine.

A further object of this invention is to provide a paper or board-making machine having a top forming wire and suction means acting through said wire to de-water stock in an upward direction.

Another object of this invention is to adapt the principles of application Serial No. 373,382 to a slow-running machine.

Another object of the invention is to provide a suction box assembly on a paper or board-making machine which can be tiltably adjusted to guide a top forming wire.

A still further object of this invention is to provide a Fourdrinier type paper or board-making machine having a top forming wire with side deckles which will cooperate to maintain a pond of stock in front of and in a wedge-shaped forming area between the main traveling band and the top forming wire.

Other and further objects of this invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of preferred examples, illustrate several embodiments of the invention.

On the drawings:

Figure 1 is a somewhat diagrammatic side elevational view of a paper or board-making machine wet end according to this invention.

Figure 2 is a view similar to Figure 1 illustrating a portion of the wet end of the machine to show the manner in which the lower run of the top wire is adjustable to vary the slope thereof.

Figure 3 is a transverse cross-sectional view taken along the line III—III of Figure 2.

Figure 4 is a somewhat diagrammatic side elevational view of a paper or board-making machine wet end equipped with a plurality of top wires according to this invention.

As shown on the drawings:

The wet end **10** of the top wire-equipped Fourdrinier type paper or board-making machine shown in Figure 1 includes a base frame **11** and an overhead frame **12.**

A main forming wire **13** is looped around a breast roll **14**, a couch roll **15**, over a plurality of table rolls **16**, and under guide rolls such as **17** so as to have an elongated substantially horizontal upper run between the couch and breast rolls.

A top forming wire **18** is trained around an adjustable oncoming roll **19**, an offgoing roll **20**, and guide rolls such as **21**, supported from the frame **12.**

Tension rolls **22** and **23** respectively, cooperate with the guide rolls **17** and **21** for holding the wires **13** and **18** in taut open loops.

The rolls **19** and **20** hold the top wire **18** to provide a bottom run over the top run of the wire **13.** A suction

box assembly 24 is mounted over this bottom run of the top wire 18 immediately downstream from the adjustable oncoming roll 19. This assembly 24 has its rear downstream end hinged or pivoted at 25 to a pair of depending columns such as 26 carried by the overhead frame 12. The pivot 25 can be raised or lowered by means of an adjusting screw 27.

A plurality of suction boxes such as 28, 29, 30 and 31, are provided in the assembly 24 and each box has a perforated or slotted bottom receiving the under-run of the top forming wire thereover. Drain conduits 32 are provided for each suction box. These conduits discharge into a header conduit 33 which is connected to a suction pump for evacuating the suction boxes. A valve 34 in each drain conduit 32 controls the degree of vacuum in each suction box and the valves can be regulated to provide, for example, a progressively increasing degree of vacuum in successive boxes. The front end of the assembly 24 is suspended from the top frame 12 by adjustable supports such as 35. For purposes of illustration, a turnbuckle support 35 is indicated to raise and lower the front end of the assembly 24 thereby swinging the assembly about its hinge or pivot 25.

Screw rod adjustments 36 are provided on the supporting columns 37 for the oncoming roll 19 so that this roll can be raised and lowered with and in front of the box assembly 24.

A relatively large diameter support roll 38 is mounted in the loop of the wire 13 under the upper run thereof to have contact with this upper run at the oncoming end of the suction box assembly 24.

A plurality of press roll assemblies 39 are provided downstream from the suction box assembly 24 and each assembly 39 includes a bottom roll 40 in the loop of the wire 13 and a top roll 41 in the loop of the wire 18. The rolls 40 and 41 cooperate to form a horizontal pressure nip squeezing the wires toward each other. If desired, the presses 39 can be suction presses with suction boxes in either the roll 40 or 41 or in both of the rolls as desired.

The oncoming roll 19 and the suction box assembly 24 are adjusted so that the bottom run of the wire 18 will cooperate with the top run of the wire 13 for forming a wedge gap 42 which diminishes in height to the pivot 25. Thus, the gap has an entrance mouth determined by the roll 38 and a convergent run from the oncoming roll 19 to the pivot 25 determined by the box assembly 24. The rear end of the suction box assembly serves as a pressure line at the terminal end of the converging wedge gap 42.

A stock inlet or head box 43 is mounted adjacent the breast roll 14 to supply stock to the open-topped upper run of the main forming wire 13. Stock is supplied to the head box through a conduit 44 and is fed from the head box under any suitable slice arrangement onto the wire between deckle boards 45 arranged above the edges of the wire.

The deckle boards 45 do not extend right down to the edges of the wire as this would cause too much wear. Accordingly air deckles 46 are secured inside the boards 45. These air deckles are perforated or slit along their bottom edges so that they act, when connected to an air supply, to direct a curtain of air along the edges of the wire to confine the stock on the surface of said wire. Since the free flow of stock is restricted under the oncoming roller 19, it forms into a pond 50 extending from in front of the oncoming roll 19, where it builds up as a wave 51, into the gap 42 as far as the pivot 25.

If desired air may be directed as a curtain to provide air deckles at the sides of the gap 42 right up to the pivot 25, but these are not indicated in the drawings.

As the wires are advanced in the direction indicated by the arrows, the stock advances into the diminishing gap 42 and water drains through the bottom wire and is drawn upwardly through the top wire into the suction

boxes. If desired, the roller 38 can be equipped with a suction box so as to increase drainage downwardly through the wire 13. The table rollers 16 and the bottom faces of the suction boxes 28 to 31 hold the respective runs of the wires rigidly so that the forming gap will withstand the load of the stock therein. Since drainage occurs both upwardly and downwardly, the stock forms simultaneously on both wires and improved fiber formation is thereby obtained. After the stock passes under the hinge or pivot 25, the presses 39 squeeze the pulp that is formed on the wires to remove further amounts of water therefrom. The squeezed out water on the top of the wire 18 adjacent each press 39 can be removed with suction slices 48 which may be provided on the downstream side of each press 39.

The gap 42 can be changed in accordance with pulp conditions. This is accomplished by merely raising or lowering the oncoming roll 19 and by similarly adjusting the turnbuckle 35 to raise or lower the forward end of the suction box assembly 24.

As illustrated in Figure 4, the multi-ply machine 10' has most of the parts identical with parts described in connection with Figures 1 and 2, and the same reference numerals have been used to identify these identical parts. In the machine 10', however, the bottom wire 13 is equipped with two top wires 18 each having a tiltable suction box assembly 24, and with a feed box or inlet 43 in front of each top wire to supply stock into each wedge gap 42. The first inlet deposits the stock as an open topped layer onto the bare upper run of the wire 13 while the second inlet deposits stock onto the previously formed web on the wire 13. Each top wire 18 dewaters the stock under the influence of suction from the suction box assembly 24 mounted in the loop thereof.

From the above descriptions it will, therefore, be understood that this invention provides a paper or board-making machine and process wherein the layer of pulp from a stock inlet is flowed onto a main forming wire and is carried thereby under a converging top wire having a wedge-shaped forming gap relationship with the main wire that decreases in height so as to provide a restriction which will maintain a pond of stock between the wires. Suction mechanism is provided to act through the top wire for de-watering the stock from the pond in an upward direction and while kinetic energy is imparted to the water in the stock pond by the advancing forming wires will assist the de-watering, the machine can be run sufficiently slow so that this kinetic energy is practically negligible because the suction mechanism will draw the water through the top wire. After the stock passes beyond the convergent end of the gap between the sloping portion of the top wire and the bottom wire, i.e. the pivot 25, it is sufficiently formed so that it will not flow off the wires and it can be pressed between the wires for further water removal. The machines of this invention may be used in tandem or several top wire assemblies can be provided on a single bottom wire machine whereupon a web of any desired number of plies or layers can be produced. It should be understood, however, that the resulting web will have the fibers so interlaced that the plies are inseparable. Further, since de-watering takes place through the top wire or wires, the stock for any ply or layer may be so dense as to permit no drainage to take place through it, thus it will be appreciated that pulp combinations of any desired types can be used. Thus, it is possible with the machines and methods of this invention to deposit a very dense impervious stock on the main wire and to then build up a superimposed layer or layers of any desired nature on this dense layer. The stock is pressed sufficiently between the forming wires so as to form a self-sustaining web before the support of the main wire is removed.

The suction acting through the top wire or wires can be regulated as desired so as, for example, to have a

progressively increasing suction pull on the stock pond between the wires as this pond becomes more and more de-watered in approaching the converging end of the forming gap.

It will be understood that variations and modifications may be effected without departing from the scope of the novel concepts of this invention.

I claim as my invention:

1. A method of making a fibrous web which comprises advancing opposed top and bottom foraminous forming wires along converging paths providing a tapering gap with an enlarged entrance mouth, introducing into said mouth between the opposed forming wires thin watery fibrous web forming stock of sufficient fluidity to flow freely onto and across the wires, maintaining a turbulent pond of said stock between said wires with the fibers in the pond freely dispersed, building up a wave of turbulent stock at said entrance mouth for feeding into said gap, sucking water from said pond through the top wire to interlock fibers and form a web on the underside of the top wire, simultaneously draining water from said pond through the bottom wire to interlock fibers and form a web on the top face of the bottom wire, building up the webs on the wires to interlock the free fibers between the webs on the top and bottom wires as the wires advance toward each other to integrally unite the webs through interlocked fibers, and squeezing the partly de-watered stock and webs between said wires to remove further water therefrom and form a unitary interlocked fiber web from said webs.

2. A method of making a fibrous web which comprises depositing aqueous stock having freely dispersed fibers on an open topped portion of the upper run of a Fourdrinier forming wire, covering the stock before it is formed into a web with the bottom run of a top forming wire so as to leave a gap between the wires with an enlarged converging entrance mouth, progressively diminishing the gap to provide a wedge-shaped forming area between the wires, maintaining a pond of fluid stock with freely dispersed fibers under hydraulic head pressure in said wedge-shaped forming area, advancing the wires in the same direction to advance the stock in said pond through the diminishing gap, restricting the entrance mouth of the gap to build up a wave of stock at said mouth, evacuating the bottom run of the top wire to de-water stock upwardly through the top wire and form one surface of a web on the under face of said top wire, simultaneously draining water downwardly through the upper run of the Fourdrinier wire to form the other surface of the web on the top face of said upper run, building up the web formations on both wires as the wires advance toward the convergent end of said gap, and pressing the wires together at said convergent end of the gap to interlock adjoining fibers of each of the webs into a unitary interlocked continuous fiber sheet having top and bottom wire sides.

3. A web making machine which comprises a main looped forming wire having a substantially horizontal upper run, a top looped forming wire having a bottom run overlying a portion only of the upper run of said main wire, a directing roll within the loop of the top wire guiding the bottom run of the top wire toward the upper run of the main forming wire downstream from the start of said upper run, a suction box assembly in the loop of the top wire downstream from said directing roll, said assembly having a bottom face guiding the bottom run of the top wire and shaping the top of a gap between the top and main forming wires to diminish in height downstream from the directing roll, means for adjusting the suction box assembly and thereby vary the height of said gap, means for adjusting said directing roll and thereby vary the height of the entrance mouth to said gap, deckle means in advance of said directing roll cooperating with the upper run of the main forming wire and confining the stock thereon, and a stock inlet having means for depositing a layer of fluid aqueous stock on said upper run of the bottom wire between said deckle means forming a pond in said gap of a depth creating a wave against the descending quadrant of the directing roll whereby drainage through the top and bottom wires forms webs on both the wires which are united as the wires approach the convergent end of the gap.

4. A web making machine which comprises a main forming wire having a substantially horizontal upper run, a looped top forming wire having a bottom run overlying a portion of said horizontal upper run and defining the top of a gap between said runs, a directing roll in the loop of the top wire having a lower quadrant guiding the top wire to the entrance mouth of said gap, means for raising and lowering said directing roll and thereby varying the height of said entrance mouth, an elongated suction box assembly in the loop of the top wire having a bottom face overlying said bottom run of the top wire and extending from directly adjacent the directing roll a considerable distance downstream therefrom, a first means for adjusting the height of the upstream end of said suction box assembly to thereby control the height of the gap between the wires immediately downstream from the entrance mouth to the gap controlled by said directing roll, second means for adjusting the height of the downstream end of said suction box assembly to thereby control the height of the discharge end of said gap, said first and second adjusting means being relatively adjustable to thereby control the inclination of the suction box assembly for varying the shape of the gap between the entrance mouth and the outlet, and a stock inlet having means depositing aqueous stock on the top run of the main forming wire upstream from said directing roll and for forming a stock pond in said gap with a raised wave against the lower quadrant of the directing roll.

5. The method of making a fibrous web which comprises advancing opposed top and bottom foraminous forming wires along converging paths, controlling the path of the top wire to coact with the bottom wire in forming a tapering gap between the wires with an enlarged arcuately converging entrance mouth, introducing a dilute fibrous web forming stock between the opposed forming wires, maintaining a turbulent pond of stock with freely dispersed fibers in said gap; between said wires, building up a wave of turbulent stock in said entrance mouth removing water from said pond through both of said wires, creating a pressure differential across at least one of said wires to assist in removal of water from the pond, forming webs on both wires as the wires advance along said converging paths with the adjacent opposed faces of the webs merging through freely dispersed fibers in the pond, and squeezing the webs between the wires to further remove water therefrom and interlock the webs with said fibers at the opposed inner faces of the webs.

6. A web making machine which comprises a looped main forming wire having a substantially horizontal upper run, a looped top covering wire having a bottom run cooperating with the upper run of the main forming wire, an impervious directing roll in the loop of the top wire having a lower quadrant shaping the top wire and forming a converging entrance mouth to a gap between the bottom run of the top wire and the upper run of the main wire, an elongated suction box in the loop of the top wire extending from a point immediately adjacent the directing wire to a point downstream from said directing roll, said suction box having a bottom face receiving the bottom run of the top wire thereagainst and controlling the run of said top wire as it is received from the directing roll, means for varying the position of said suction box and thereby vary the position of said bottom run of the top wire, means for varying the position of said directing roll and thereby vary the entrance mouth

to the gap between the wires, and a stock inlet, said stock inlet having means for depositing a layer of watery stock on the upper run of the main wire, said stock inlet, said means for varying the position of the suction box and said means for varying the position of the directing roll being relatively adjustable for maintaining a pond of stock in the gap between the wires with a wave deeper than the pond in said entrance mouth thrusting against the lower quadrant of the directing roll.

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