April 14, 1959 R. J. THOMAS 2,881,670

APPARATUS AND METHOD FOR DE-WATERING STOCK ON A FOURDRINIER TYPE PAPER OR BOARD-MAKING MACHINE

Filed July 13, 1955 2 Sheets-Sheet 1

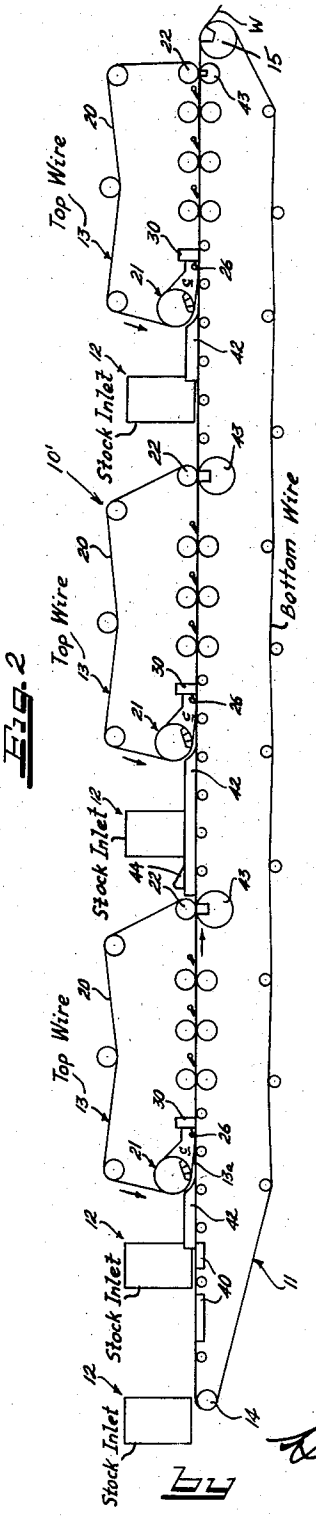


Fig. 2

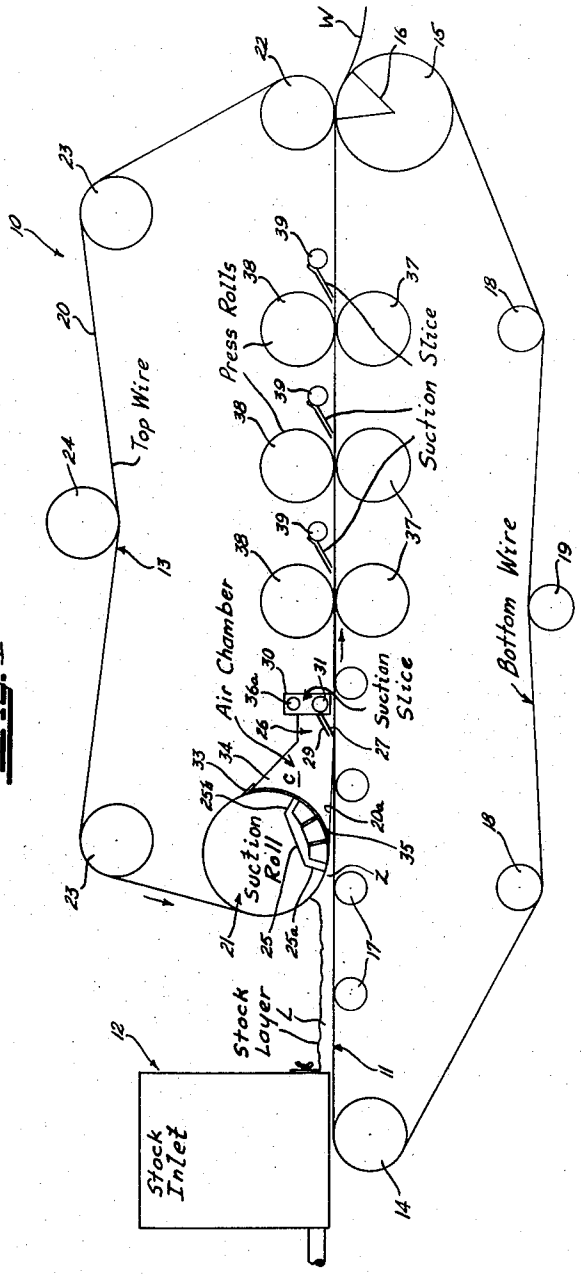


Fig. 1

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Fig. 3

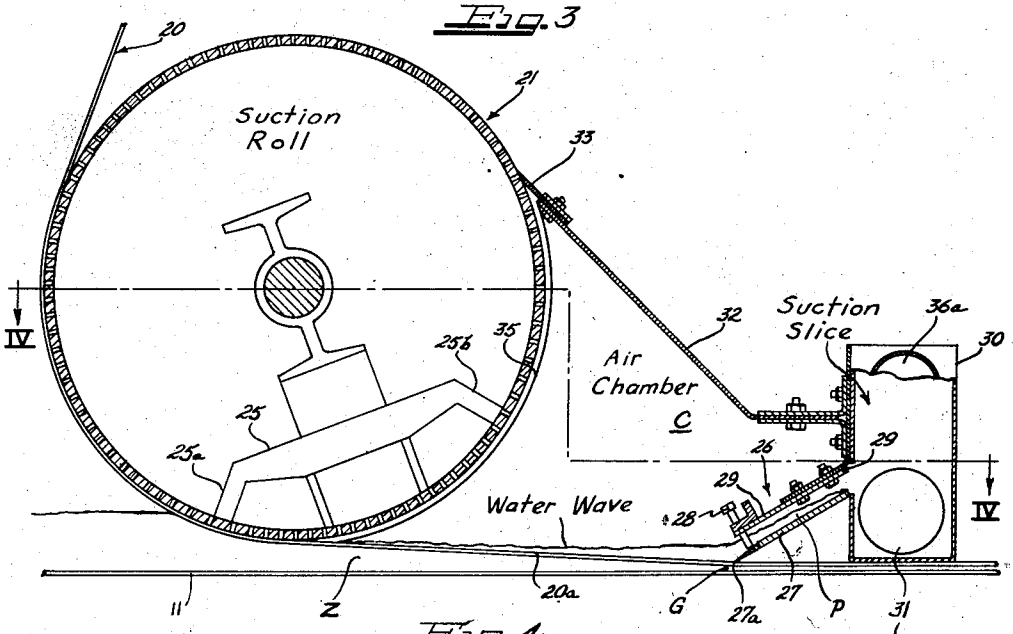
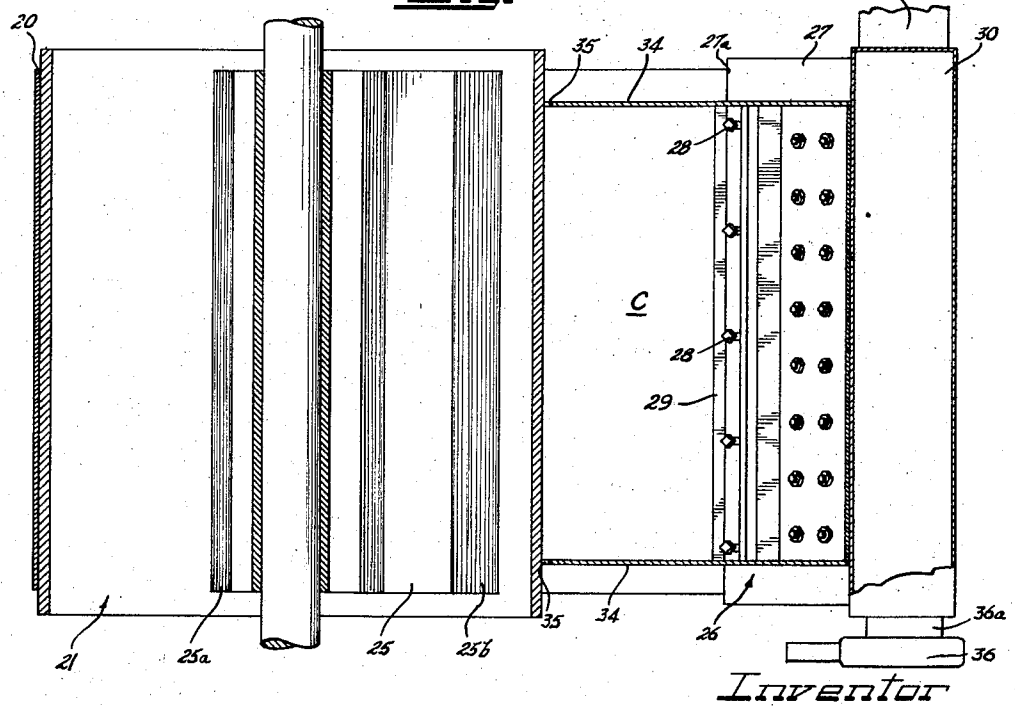


Fig. 4



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2,881,670

APPARATUS AND METHOD FOR DE-WATERING STOCK ON A FOURDRINIER TYPE PAPER OR BOARD-MAKING MACHINE

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Application July 13, 1955, Serial No. 521,816

Claims priority, application Great Britain July 23, 1954

12 Claims. (Cl. 92—39)

This invention relates to the de-watering of stock on a Fourdrinier type paper or board-making machine wherein one or more top forming wires cooperate with the main Fourdrinier wire and mechanism in the loop of the top wire or wires creates an advancing wave of water from the stock between the wires to separate the water from the stock fibers. Particularly, this invention deals with a paper-making machine and a method of making paper wherein initial de-watering of paper stock deposited on a Fourdrinier wire includes an upward discharge of water from the stock through a covering wire, which discharge is induced by a current of air sufficiently impelled to be effective in producing an advancing wave of the water which will climb a slice or chute to become separated from fibers underneath the top wire.

The method and apparatus hereinafter described are embodied in the so-called wet end of a paper-making machine which initially de-waters the dilute aqueous paper stock to form a pulp layer. As is conventional, paper stock fed to the forming wire of a Fourdrinier type paper machine is in a very dilute condition and contains a very small percentage of fibers. The wet end machines of this invention will reduce this aqueous stock from a moisture content of about 99½% to about 96% water by weight. The thus de-watered stock is sufficiently dense to form a fibrous web layer which will not flow off of a forming surface.

A feature of the present invention is the provision of a wet end for a paper-making machine which will effect initial de-watering of paper stock within a very short length of forming wire thereby appreciably decreasing the overall length of the machine or accommodating installation of additional drying capacity within the original length of the machine. Paper machines equipped with wet ends according to this invention include pressing mechanisms which will initially form the stock and then further de-water the layer so as to render it self-supporting and capable of being removed from the main forming wire after a relatively short length of travel thereon. In the case of multi-ply machines of this machine, a number of stock inlets can be provided for a single main forming wire and the overall length of this main forming wire need not be increased materially over the conventional length for a forming wire in a single ply machine.

In the co-pending application of myself and Stanley Fred Smith, Serial No. 373,382, filed August 10, 1953, now Patent 2,821,120 granted January 28, 1958, there is described and claimed a method and apparatus for making single or multiple ply paper or board between top and bottom forming wires wherein the top forming wire passes under a doctor or chute member that creates a pressure point and cooperates with upstream guide means for forming an inclined lower run on the upper wire. This inclined run coacts with the bottom wire to define a wedge-shaped forming gap into which stock is fed and maintained under hydraulic head pressure up to the pressure point at the convergent end of the gap where the pulp is sufficiently formed as to be set into a layer which will not flow out from between the wires. The forming wires advance the stock through the converging gap, and water is flung upwardly through the top wire by the inertia built up in the advancing pond of stock so that the water will ride up over the doctor or chute and be separated from the fibers. A web is thereby formed on the underface of the top wire and, of course, natural drainage through the bottom wire will also form the stock into the web. The stock is thus integrally formed into a unitary layer through both forming surfaces.

According to the present invention, separation of water from the stock through the bottom run of the top wire is enhanced by a current of low pressure high velocity gas, such as air, flowing over the bottom wire run and creating a wave of water which will cascade upwardly over a chute away from the wire. The gas current is preferably established in a confined zone which can be under less than atmospheric pressure. The apparatus of this invention preferably includes a suction drive such as a suction roll in the loop of the top wire or pressing mechanism of the machine. This device defines the entrance mouth of the gap between the wires and will remove some water through the top wire. Immediately after passing under the suction roll, the top wire passes under a substantially enclosed zone. A slice device with a transverse drain outlet chamber extends into this zone and forms the pressure point. This slice cooperates with the suction roll to hold the wire along an inclined run thereby defining the converging gap between the wires in which the stock formation takes place. A current of low pressure high velocity speed air is flowed over the top wire between the suction roll and the slice in the direction of travel of the wire. This flowing current of air will act on water in the confined zone and will create a rearwardly flowing wave of sufficient momentum to travel up the slice and be separated from the top forming wire. Of course, the inertia of the water imparted from the traveling forming wires will also be used in causing the water to climb the slice away from the stock but the air stream enhances the water separating force so that the machine can be efficiently operated even at relatively low speeds where the momentum induced in the water by the traveling wires would not be sufficient to effect separation.

It should, therefore, be appreciated that at least three features assist the upward removal of water, viz., the suction device, the air current and the inertia of the pulp induced by the traveling forming wires.

It is then an object of this invention to enhance de-watering of paper stock in the method and apparatus of the Thomas and Smith Patent 2,821,120, filed August 10, 1953, with the aid of a stream of gas such as air.

Another object of this invention is to provide a wet end for a paper-making machine adapted to de-water stock with a shorter length of Fourdrinier wire than was heretofore possible.

A still further object of this invention is to provide a wet end for a paper-making machine wherein one or more top wires coacts with a main Fourdrinier forming wire to de-water stock in an upward as well as in a downward direction and to induce the upward de-watering of stock by a stream of air.

A specific object of this invention is to provide, in a top wire paper-making machine, a de-watering device for mounting in the loop of the top wire to create a wave of water which will separate the water from the stock under the wire.

A further and additional specific object of this invention is to provide a method of de-watering stock on a top wire equipped Fourdrinier machine by inducing in a confined zone above the bottom run of the top wire, an upwardly flowing wave of water from the stock under the top wire.

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

On the drawings:

Figure 1 is a somewhat diagrammatic side elevational view of a paper-making machine wet end according to this invention for initially de-watering a single layer of stock.

Figure 2 is a view similar to Figure 1 but illustrating the machine of this invention embodied in a multi-ply forming machine.

Figure 3 is an enlarged detail transverse vertical cross-sectional view of the de-watering mechanism in which the current of air is created to enhance water removal.

Figure 4 is a longitudinal cross-sectional view taken along the line IV—IV of Figure 3 and with parts in plan.

As shown on the drawings:

In Figure 1, the wet end **10** includes a main or bottom forming wire **11**, a stock inlet **12** for feeding a layer of paper stock onto the top horizontal run of the wire **11**, and a stock-pressing mechanism generally indicated at **13**.

The wire **11** is trained around a breast roll **14** and a couch roll **15** preferably equipped with a suction box **16**. Table rolls such as **17** support the upper run of the wire and suitable guide rolls such as **18** are provided along the bottom run of the wire to cooperate with a tension roll **19** for maintaining the wire in taut open looped condition so as to have a substantially horizontal run between the breast and couch rolls.

The stock-presing mechanism **13** includes a relatively short looped top wire or second forming wire **20** having a bottom run overlying a portion of the top run of the bottom wire. A large diameter wire cloth-covered or drilled shell roller **21** receives the wire **20** thereunder to provide the oncoming end of the active bottom run of this top wire. A turn roller **22** receives the wire therearound adjacent the couch roll **15** to define the end of the bottom run of the wire **20**. Guide rolls **23** are provided above the rolls **21** and **22** and cooperate with a tension roll **24** to keep the top wire **20** in a taut open-looped condition.

The roller **21** has a multi-compartmented suction box **25** therein with an oncoming end **25***a* at the bottom of the roll and with an offgoing end **25***b* on the ascending side of the roll.

A suction slice **26** is provided downstream from the roll **21** and includes a bottom lip, chute member or doctor **27** sloping upwardly and rearwardly from the bottom run of the wire **20** and having the leading edge thereof pressing against the wire so as to cooperate with the roll **21** in defining an inclined portion **20***a* on the bottom run of the wire. This inclined portion preferably defines an angle of about 4° with the horizontal run of the underlying main wire **11** although this angle can be varied as desired by raising and lowering the roller **21** or the doctor **27**. As indicated, the doctor **27** is equipped with adjusting screws **28** which will control the degree of pressure on the wire **20** and will regulate the gap G at the converging end of the wedge-shaped zone Z between the wires and under the portion **20***a* of the top wire. The suction slice **26** includes a top lip **29** overlying the doctor **27** in spaced parallel relation and carrying the adjusting screws **28**. This top lid can be relatively rigid while the bottom doctor can be flexible so as to adjust the pressure on the wire much in the same manner as the adjustment of a slice of a stock inlet.

A discharge path P is provided between the doctor **27** and the top lip **29** and the upper end of this path discharges into a closed casing **30** at a level above the bottom of the casing. The casing extends transversely across the width of the machine in the loop of the top wire **13** and has a suction drain outlet **31** at one or both ends thereof. The casing **30** extends appreciably above

the top lip **29** and a top plate or cover **32** extends from the front wall of the casing into closely spaced relation with the ascending or rear side of the roller **21**. This cover wall is about 8″ or so above the lip **29**. A seal strip **33** is mounted on the front edge of the cover wall **32** to wipe the periphery of the rolls **21** and provide a seal.

End plates or side walls **34** are provided at the ends of the cover **32** and extend downwardly therefrom to the inclined run of the wire **20***a*. The front edges of these side plates are arcuate to conform with the periphery of the roller **21** and are relatively closely spaced with the periphery of the roller. However, a gap **35** is provided between the front end of each plate and the periphery of the roller for the admission of air into the chamber C provided just behind the roller by the casing **30**, the cover wall **32**, the side plates **34** and the doctor **27**. Air can also enter the chamber C through the holes in the roller **21**. This chamber, of course, receives the inclined run **20***a* of the wire **13** across the bottom thereof.

The current of low pressure high velocity air is developed in the chamber C by fan means **36** pulling air through the duct **36***a* from the upper portion of casing **30**. This fan means plus the suction box **25** and the drain outlet **31** tends to reduce the pressure in the chamber C whereupon outside air will be drawn into the front end of the chamber through the gaps **35** and the holes in the roller **21**. The air is pulled into the casing through the slice passageway P. The air stream acts on water raised into the chamber C through the wire by the combined forces of vacuum in the chamber and inertia induced in the advancing pool of stock in the wedge-shaped gap. A rearwardly flowing wave is thereby built up to cascade through the passage P over the doctor **27**. The air flow also has an aspirating effect to draw water through the wire.

A plurality of presses are provided downstream from the casing **30** and each press includes a bottom roll **37** within the loop of the main wire **11** and a top roll **38** within the loop of the top wire **20**. A suction slice **39** is provided immediately adjacent the downstream side of the nip of each press. The rolls cooperate to squeeze the layer of pulp between the wires and to further express water from this layer.

In operation, dilute aqueous paper stock from the inlet **12** flows onto the top run of the bottom forming wire **11** to form a layer of stock L. Deckle plates (not shown) hold this aqueous layer against flowing off the edges of the wire. The wire travels in the direction indicated by the arrow and the layer is subjected to a pressure mechanism including the wire **20** on the downcoming side of the drilled or wire cloth covered roller **21**. The suction box **25** in the roller **21** will maintain a reduced pressure in the entrance mouth of the wedge-shaped forming zone Z but the stock layer L is not sufficiently de-watered in this zone to become set. A pond of fluid stock thereby is maintained in the wedge-shaped zone Z and this pond is advanced along the wedge-shaped zone with the wires **11** and **20**. Water from the pond is expressed both upwardly and downwardly through the wires. The enclosed chamber C above the inclined wire run **20***a* is under reduced pressure from the suction box compartments at the offgoing end **25***b* of the suction box **25**, the drain outlet **31** and the fan **36**. Air then leaks through the gaps **35** and perforations in the roller **21** into the chamber and is impelled by the fan **36** to form a rearwardly flowing low pressure high velocity stream which will form a wave on the water being expressed through the wire run **20***a*. This stream will push a wave of water on the wire into the slice passage P to assist the cascading of the water over the doctor **27**. When the pulp in the zone Z reaches the gap G at the pressure point **27***a* of the doctor **27**, it is sufficiently dewatered so that it will not be flowable. Web formation therefor takes place both upwardly against the wire **20** and down-

wardly against the wire **11**. The presses and suction slices thereupon take over to effect further de-watering of the formed stock layer so that by the time the layer reaches the suction couch **15**, it can be removed from the supporting wires as a self-sustaining web W.

To facilitate de-watering of the stock through the top run of the bottom forming wire, suction boxes or suction rolls (not shown) can be mounted in the loop of the wire **11** to act on the upper run of this wire underneath the layer of stock thereon.

In the multi-ply machine **10'** of Figure 2, parts identical with parts described in connection with Figure 1 have been marked with the same reference numerals.

As shown in Figure 2, a plurality of stock inlets **12** supply stock to the upper run of the bottom forming wire **11** and a plurality of top wire assemblies or pressing mechanisms **13** are provided each equipped with a short top wire **20** and wire cloth oncoming roller **21**, suctionized slice **26** and casing arrangement for providing the chamber C above each inclined run **20***a* of each wire **20**.

The first stock inlet **12** deposits the base web-forming stock on the wire **11** and this stock is formed into a layer as it passes over suction boxes such as **40**. A second layer of stock is then deposited at the second stock inlet **12** and water from this second layer is discharged upwardly through the first of the pressing mechanisms **13** as was described above in connection with Figure 1. As shown, deckles **42** are provided at the sides to confine the pool of stock issuing from the second inlet **12**.

A suction roll **43** coacts with the return roll **22** of each pressing mechanism **13** and the couch roll **15** for the main forming wire is illustrated as being positioned downstream from the last suction roll **43** so that the web W will have an uncovered run on the bottom forming wire after the last top wire **13** is separated therefrom.

If desired, a supplementary stock inlet for applying color, size, or the like, can be mounted adjacent one of the inlets. Thus, as shown, a supplementary inlet **44** is provided ahead of the third inlet **12**. This supplementary inlet may deposit a very thin layer of filler, glue size, or the like, before the layer issuing from the second inlet.

It should be appreciated that a multiple ply web can be built up on a single bottom-forming wire without materially increasing the length of the wire beyond that which is used in forming a single ply because the top forming wires of this invention are very short and the upward de-watering of the stock through these wires is efficient even when the machine is operated at relatively slow speeds.

The term "rearwardly" as used herein means from upstream to downstream positions, or, in other words, the direction of flow of stock or air as it advances downstream.

The term "forwardly" as used herein means the reverse direction from downstream to upstream positions, or, in other words, the direction of flow of stock or air as it backs upstream.

From the above descriptions it will, therefore, be understood that this invention provides de-watering apparatus for top wire equipped Fourdrinier machines wherein a wave of water is created to separate water upwardly from the pulp through the top wire. The wave is created by a stream of air entering a partially evacuated zone.

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. The method of de-watering paper stock which comprises depositing a layer of dilute aqueous paper stock on the top run of a bottom forming wire, covering said layer with a top wire, advancing the wires and stock rearwardly, locally pressing the top wire toward the bottom wire at a point downstream from the point of initial contact of the wire with the layer of stock to incline a portion of the bottom run of the top wire and create a wedge-shaped gap between the wires narrowing in the direction of travel of the wires, enclosing a space over the wedge gap defining portion of the top wire, evacuating said space, introducing air into said evacuated space forwardly from said pressure point, flowing said air in said space with said top wire rearwardly over the top of the wedge gap defining portion of the top wire to develop a rearwardly flowing wave of water on the wire from stock in the wedge gap, and directing said wave away from said wire out of contact with the wire and the stock at the point where the top wire is locally pressed toward the bottom wire.

2. In the method of making a paper web including the steps of depositing a layer of aqueous paper stock on the top run of a bottom forming wire and covering said layer with the bottom run of a top forming wire, the improvement which comprises enclosing a localized space above the bottom run of the top forming wire, pressing a chute member against the top forming wire in said space, reducing the air pressure in said space, venting air into the reduced pressure space, forming a rearwardly flowing stream of said air in said space, inducing with said air stream a rearwardly flowing stream of water on top of the top forming wire in said space, and cascading the rearwardly flowing stream of water over said chute out of contact with the layer of pulp between the forming wires.

3. The method of forming paper on a Fourdrinier type paper-making machine equipped with top and bottom looped forming wires which comprises depositing a layer of stock on the top run of the bottom forming wire, covering said layer of stock with a bottom run of the top forming wire, advancing the stock and wires rearwardly, drawing water from said layer of stock through said bottom run of the top forming wire under the influence of vacuum as said bottom run of the top wire initially contacts the layer of stock, locally pressing the bottom of the top wire toward the top run of the bottom wire downstream from the initial contact of said bottom run with said stock layer, flowing air rearwardly over and along the top of the bottom run of the top wire within the loop of said top wire from the area of vacuum application thereon to the locally pressed area thereof, inducing with said flowing air a rearwardly flowing wave of water on top of the bottom run of the top wire from the layer of stock between the wires, and directing said wave of water off of said top wire at the locally pressed portion of the top wire to thereupon separate the water from the top wire and the stock layer between the wires.

4. A Fourdrinier type paper-making machine which comprises a main forming wire having a substantially horizontal top run, a stock inlet for depositing dilute paper stock on said top run, a relatively short looped top forming wire having a bottom run opposing a portion of the top run of the bottom wire, a suction roller in the loop of the top wire directing the wire to the top run of the bottom wire for providing a gap between the wires, a suction slice in the loop of the top wire pressed against the bottom run of the top wire, an evacuated discharge casing in the loop of the top forming wire cooperating with said suction slice for draining water received therefrom, walls extending from said casing and slice into closely spaced relation with said suction roller to provide a chamber between the roller and casing enclosing the suction slice, a suction box in said suction roller communicating with said space, means for evacuating said casing, said means and said suction box coacting to maintain reduced pressure in said chamber, said walls enclosing said chamber accommodating leakage of air into the front end of the chamber, means for flowing air in the chamber toward the slice for creating a wave of water from the top forming wire causing the water to cascade through the suction slice, and said suction slice cooperating with said suction roller to provide a sloping portion

on the bottom run of the top wire for cooperating with the top run of the bottom wire to define a gap of gradually diminishing height from the suction roller to the suction slice.

5. A Fourdrinier type paper-making machine which comprises a looped bottom forming wire having a top forming run, a looped top forming wire having a bottom forming run, a roll in the loop of the top forming wire directing said bottom run of the top forming wire into coacting relation with the top run of the bottom forming wire, an upwardly and rearwardly inclined chute in the loop of the top forming wire downstream from said roll and coacting with the roll to provide a wedge gap defining portion of the bottom run of the top wire, means for feeding a layer of stock onto the top run of the bottom forming wire under said wedge gap forming portion of the top wire, a housing in the loop of the top forming wire defining an enclosed space above said wedge gap forming portion of the top wire between said roll and said chute, and means for inducing a stream of air to flow through said housing from said roll to said chute and carry water from the stock layer through the wedge gap forming portion of the top forming wire for creating a wave of water and for cascading said wave over the chute and out of contact with the top wire.

6. A top wire equipped Fourdrinier type paper-making machine which comprises looped top and bottom forming wires having opposed active runs, a suction roll in the loop of the top wire directing the bottom run of the top wire toward the top run of the bottom wire, a suction slice in the loop of the top wire downstream from said suction roll, a box enclosing the space over the bottom run of the top wire between the suction roll and the suction slice, and means for inducing flow of a stream of air over the top wire in said space to create a wave of water for flow into the suction slice.

7. De-watering means for a top wire equipped Fourdrinier type paper-making machine which comprises a casing in the loop of the top wire extending transversely across the lower active run of said wire, a bottom lip sloping upwardly and rearwardly from said casing into pressure contact with the active bottom run of the top wire, an open bottomed box enclosing said lip and receiving the bottom run of the top wire across the open bottom thereof, and means for inducing flow of a stream of air through said box and over said lip to cascade water received in the box from the bottom run of the forming wire over said lip into said casing.

8. A paper machine wet end which comprises opposed top and bottom looped forming wires, each of said wires having opposed active forming runs defining a stock receiving gap therebetween and accommodating drainage of water upwardly and downwardly from said gap to form webs of paper on the wires, a housing in the loop of the top forming wire enclosing the gap defining run of the top forming wire, a suction slice in the loop of the top forming wire pressing said wire toward the bottom forming wire to control the height of the gap between the top and bottom wires at the narrow end of the gap, means for evacuating said suction slice, means for admitting air into said housing in spaced relation upstream from said suction slice to flow over the gap refining portion of the top wire into said suction slice and create a wave of water from stock in the gap between the wires to cascade the water through the suction slice.

9. A paper machine wet end which comprises opposed looped top and bottom forming wires having a stock receiving gap therebetween, a roll in the loop of the top forming wire directing said wire toward the bottom forming wire, a suction slice in the loop of the top forming wire downstream from said roll, said slice pressing the top wire toward the bottom wire and being inclined upwardly and rearwardly to receive water from the top wire therethrough, a housing enclosing the bottom run of the top wire between the roll and suction slice, said housing having an air inlet adjacent said roll, and means for evacuating said suction slice to induce a flowing stream of air over the bottom run of the top wire in said housing thereby creating a wave of water from stock between the wires and causing said wave to cascade through said suction slice out of contact with the top wire.

10. A method of making fibrous web material which comprises feeding a layer of pulp into a gap between top and bottom looped forming wires, pressing a slice in the loop of the top forming wire against the bottom run of said top forming wire to locally depress the top wire toward the bottom wire, means for driving the wires to move the stock between the wires toward said slice, impelling a current of air over the top surface of the bottom run of the top wire toward said slice to entrain water from said stock layer as the water passes through the top wire, and withdrawing the entrained water with the air over said slice out of contact with the top wire to thereby effect upward formation of a web on the top wire from the stock between the wires.

11. Apparatus for making fibrous web material from an open topped layer of pulp supported on a travelling carrier band, comprising a permeable pressing member adapted to be arranged above the carrier band to move therewith for squeezing the layer of pulp to separate water therefrom, means to direct a current of air across and along the surface of water passing upwardly through the permeable member to entrain said water, and a rearwardly and upwardly directed waterway member adjacent said surface, whereby the entrained water is carried towards the waterway member up which it is withdrawn to assist in effecting at least partial upward formation of the layer.

12. The method of de-watering stock in the wet end of a top wire equipped Fourdrinier type paper-making machine which comprises flowing stock into a gap between the top and bottom wires of the machine, advancing the wires and stock rearwardly, pressing the top wire toward the bottom wire to maintain a pond of stock in said gap and form a wedge-shaped gap narrowing in the direction of travel of the wires, flowing air rearwardly over and along the top of the wedge gap forming run of the top wire at a rate to sweep water therewith and create a wave of water on said run of the top wire, simultaneously forming a web on the under face of the top wire, and directing said wave of water off of the top wire out of contact with the wire and pond of stock.

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