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Filed April 29, 1963

2 Sheets-Sheet 1

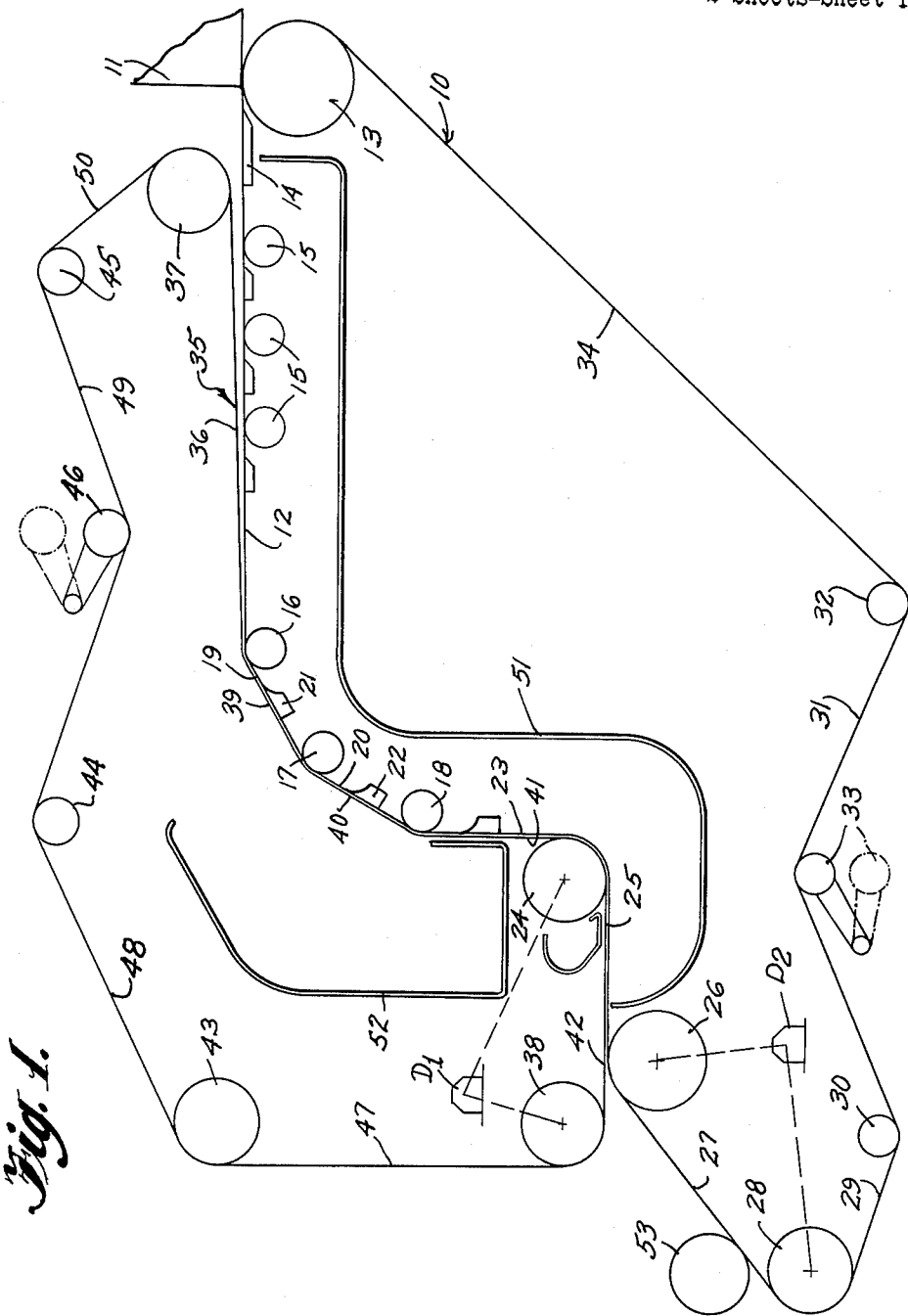


Fig. 1.

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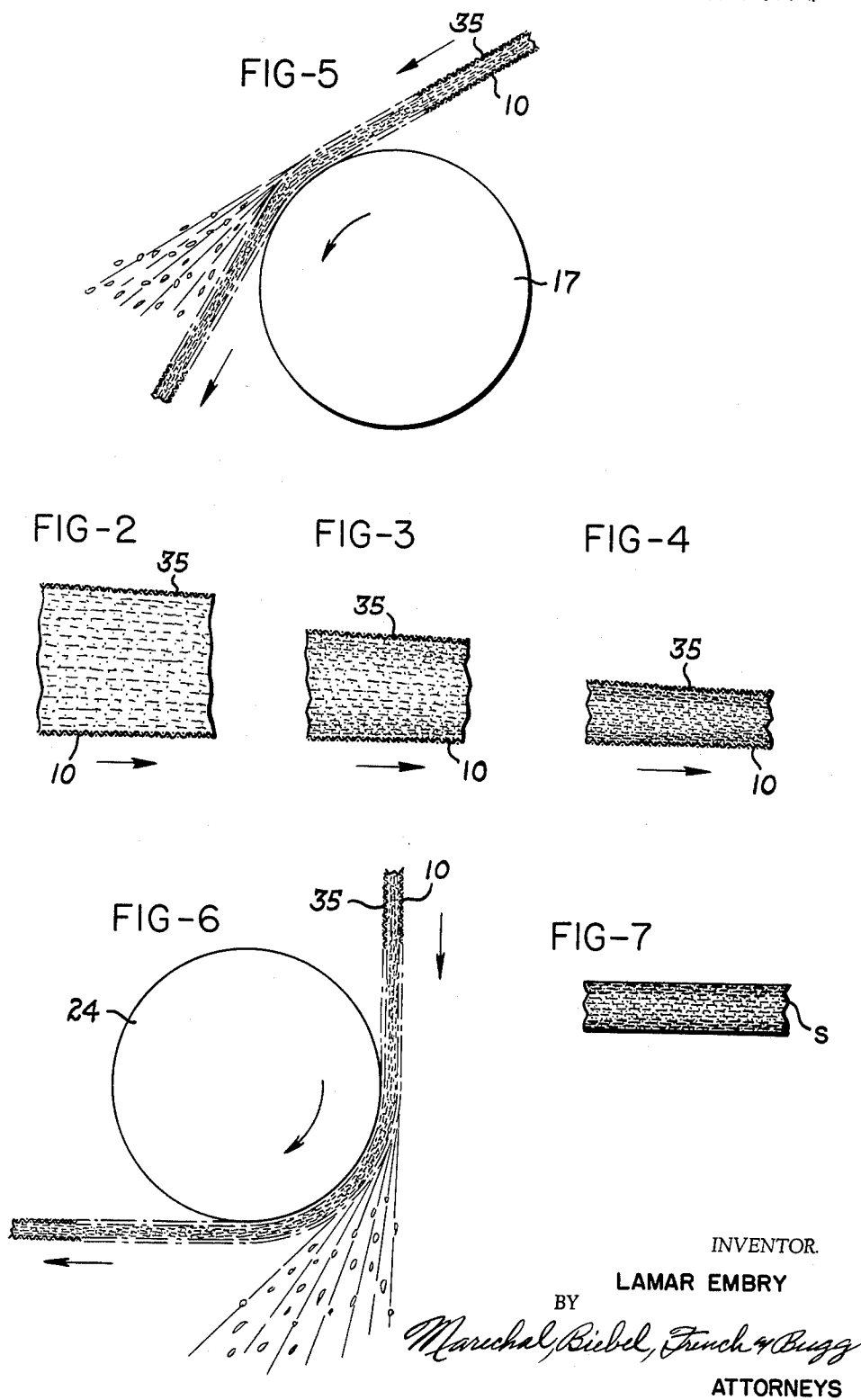
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4 Claims. (Cl. 162—301)

This application is a continuation-in-part of my co-pending United States application Serial No. 855,392, filed November 25, 1959, and now abandoned.

The present invention relates in general to paper making equipment, and particularly to high-speed paper making machines having improved means for removing fluids from watery pulp stock or the like.

As is well known in the paper making art, a large portion of the water in the pulp stock deposited on the endless Fourdrinier wire or fabric web must be removed before the wire reaches the couch roll at the end of the forming zone. Heretofore, the conventional types of Fourdrinier paper machines for manufacturing paper, tissue, box-board and the like have been arranged so that the pulp stock of fiber, water, additives and the like flow from a headbox onto a traveling endless Fourdrinier wire supported by a series of table rolls extending transversely of the axis of travel of the wire and spaced from each other, so that the liquid in the stock can immediately drain therefrom through the forming wire, between the table rolls and into a drip pan positioned below the table rolls. Additional liquids remaining in the stock are subsequently removed by suction boxes over which the wire travels, and a suction couch roll is usually provided for removing still more of the liquid from the stock.

However, in a typical high-speed Fourdrinier machine wherein the machine is operated at high speeds, that is, up to and exceeding 2500 feet per minute, the vacuum created by the table rolls has a tendency to remove water at an undesirably high rate, thus adversely affecting the formation of the sheet on the wire and making it difficult to obtain the desired character of paper formation. The heavy drag produced by the vacuum boxes over which the wire is drawn at high speed imparts a high load on the forming wire and produces substantial abrasive friction between the wire and the vacuum boxes, requiring a large input of power for driving the wire and greatly shortening its life. Additionally, such an arrangement produces a "two sided" paper sheet wherein the opposite sides are of different quality, since downward removal of water causes the fine fibers to be washed from the lowermost side of the sheet as it passes through the forming zone.

Accordingly, an important object of the present invention is to provide a method and apparatus for producing paper or the like at high speed and which are relatively simple and effectively obviate the aforementioned disadvantages.

Another object of the present invention is the provision of a high speed Fourdrinier type of paper machine wherein effective drainage of water from the pulp stock deposited on the Fourdrinier wire is achieved without the use of suction boxes, and particularly to provide such a paper machine wherein the liquids are removed from both sides of the pulp stock so that both sides of the sheet have a surface of substantially identical quality.

A further object of this invention is to provide a high speed paper machine of the aforesaid type which removes the liquids from the pulp stock at a rate substantially above that heretofore known, and further to provide such a machine which is much less expensive

2

and complex, as well as considerably shorter in length as compared to the conventional Fourdrinier machines.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings:

FIG. 1 is a diagrammatic illustration of a high speed paper machine in accordance with the invention;

FIGS. 2 through 4 are schematic illustrations at successive stages in the formation of the paper sheet;

FIG. 5 is a schematic illustration of the forming wires passing over a turning roll;

FIG. 6 is a view similar to FIG. 5 showing the forming wires being turned in the opposite direction through a larger angle; and

FIG. 7 is a view similar to FIGS. 2 through 4 illustrating the sheet as it leaves the paper machine.

Referring to the drawings wherein a preferred embodiment is illustrated, FIG. 1 shows a bottom endless forming wire 10 onto which the pulp stock of fiber, water, and the usual additives is to be deposited from a conventional headbox 11. The bottom wire 10 has a first substantially horizontal initial run 12 which extends from the breast roll 13 disposed immediately below the headbox 11, over a forming board 14 of usual construction and a plurality of supporting rolls 15, to a first of the series of deflector rolls 16, 17 and 18.

The forming wire 10 proceeds through a series of progressively steeper downwardly inclined runs 19 and 20 guided by the deflector rolls 16, 17 and 18, respectively, and deflector strips 21 and 22 disposed therebetween. The wire 10 then passes through a downwardly directed vertical run 23 between the deflector 18 and a turning roll 24, and a downwardly offset horizontal run 25 between the turning roll 24 (FIG. 6) and a suction couch roll 26. The wire 10 is then diverted downwardly along a downwardly sloping run 27 between the couch roll 26 and a guide roll 28, and returns to the breast roll 13 along a downwardly inclined return run 29 extending between the turning roll 28 and return roll 30, a run 31 between the return roll 30 and return roll 32 wherein the wire 10 is tensioned by the stretcher roll 33, and a long upwardly inclined return run 34 between the guide roll 32 and the breast roll 13.

Coacting with the bottom wire 10 is an upper forming wire 35 which has a very shallow inclined initial run 36 between the roll 37 and the first deflector roll 16 so that the wires 10 and 35 are gradually moved together until they are spaced apart a predetermined distance to form a sandwiched layer with the stock. The top wire 35 is deflected with the wire 10 around the deflector rolls 16, 17 and 18, and the turning roll 24. Thus the progressively steeper inclined runs 39 and 40 overlie the runs 19 and 20 of the bottom wire 10, and the vertical and horizontal runs 41 and 42 conform, respectively, to the runs 23 and 25 of the bottom wire 10. The turning roll 43, the return rolls 44 and 45, and the stretcher roll 46 guide the upper wire 35 to the breast roll 37 along a rising vertical run 47, an upwardly inclined return run 48, a stretcher run 49, and a downwardly inclined return run 50, respectively.

In one practical example of the present invention, the forming wires 10 and 35 are driven at 1500 feet per minute or higher and may have mesh sizes of 68-52 wires per linear inch for newsprint and 54-36 wires per linear inch for liner board. In this example, the supporting rolls 15 are preferably of dandy type construction to prevent suction on the downstream side thereof, and may be fourteen-inch diameter rolls. It will be appreciated that if the supporting rolls 15 are solid rolls, they will create enough vacuum at very high speeds to vaporize the water

and to pull pulp fibers through the bottom wire 10. The deflector rolls 16, 17 and 18 may be approximately twenty-four inch dandy type rolls, and may be equally spaced approximately thirty-five inches between roll centers and positioned to dispose the substantially planar downwardly sloping runs 19 and 20 at 30° and 60°, respectively, to the horizontal.

The spacing and diameter of the deflector rolls 16, 17 and 18 is not critical, but the rolls must be of sufficient strength to minimize roll deflection with wire tension of about fifteen pounds per linear inch. It should be apparent that one large diameter roll could replace the deflector rolls 16, 17 and 18 without departing from the scope of the invention. In this example, the approximate distance from the center of the breast roll 13 to the first deflector roll 16 may be about ten feet, and the turning rolls 24 and 38 may be approximately 34-inch diameter dandy type rolls, and the couch roll 26 should be of the suction type.

As will be apparent, a drip pan 51 underlies the forming wire 10 over a major portion of the run 12, the entire runs 19, 20 and 23 and a major portion of the downwardly offset run 25, and a drip pan 52 is disposed to receive water expelled from the sheet by centrifugal force produced at the declining runs 19 and 20. A vacuum pick-up roll 53 engages the sheet at an intermediate point along the run 27 to pick up the sheet and transfer it to the usual press section.

In the operation of the invention, the watery pulp stock flows by gravity or pressure from the headbox 11 onto the bottom forming wire 10 at the right end of the initial run 12 thereof in the region of the forming board 14 so that a uniform layer of stock covers this wire. The covering wire 35 converges gradually onto the layer of stock on the bottom wire 10 so that part of the water and other liquid is expressed from the pulp by the squeezing action of initial runs 36 and 12. As this sandwiched layer progresses toward the deflector roll 16, these liquids are thus forced through both the top and bottom forming wires, and the water which is forced upwardly through the top wire 35 remains thereon until the wires reach the first deflector roll 16.

FIGS. 2, 3 and 4 illustrate three successive steps of this squeezing action, with FIG. 2 showing the sandwiched layer of wires and stock approximately above the right-hand support roll 15 (FIG. 1), before any substantial amount of water is removed therefrom. FIG. 3, on the other hand, illustrates an intermediate step, approximately above the left-hand support roll 15 (FIG. 1) where the stock fibers are closer since the squeezing action has removed a substantial volume of liquid, and FIG. 4 illustrates the pulp stock prior to the turn around the roll 16.

As the sandwiched layer passes around the deflector rolls 16, 17 and 18 at high speed, the water in the pulp stock is subjected to centrifugal force sufficient to remove a substantial portion of the water from the stock, and throw it into the pan 52. As shown in FIGS. 1 and 5, the rolls 16, 17 and 18 turn the sandwiched layer through a right angle so that each roll effects a thirty degree turn. Also the water which was expressed by the squeezing action of the wires over the runs 12 and 36 and remained on and followed the top wire 35 is thrown by centrifugal force into the pan 52 at this stage. It will be noted that over the course of the turn identified by the runs 19 and 20, the water is being drawn by centrifugal force through the top wire 35.

The wires 10 and 35 then make a turn in the opposite direction about the turning roll 24 (FIG. 6) wherein water is thrown by centrifugal force through the bottom wire 10 into the pan 51. The centrifugal force which is imparted to the water in the stock is proportional to the square of the angular velocity of this water, and since this angular velocity is determined by the speed of the wires 10 and 35, the latter speed becomes an important consideration in the proper operation of the invention.

However, the amount of water to be removed, the particular type of stock being used, and the diameter of the rolls 16, 17, 18 and 24 are also factors which must be considered in determining the speed of the wires. As a practical matter, the minimum speeds at which the invention will function properly appear to be approximately 1500 feet per minute for light weight paper, with higher speed being more desirable.

Conventional drive means or motors D₁, D₂ (indicated diagrammatically) drive the wires 35 and 10, respectively; the drive D₂ turning the couch 26 and turning roll 28 to drive the wire 10 in conventional manner and the drive D₁ turns corresponding rolls 24 and 38 to drive the wire 35.

The newly formed sheet S (FIG. 7) is then carried between the wires 10 and 35 along the runs 25 and 42, and over the suction couch roll 26 which pulls the sheet from the top wire 35 and causes it to adhere to the bottom wire 10 along the downwardly sloping run 27. The sheet is then picked up by the vacuum roll 53 which is disposed above the turning roll 28, and then carried to a press section (not shown) or the like for additional processing in the conventional manner well known to the paper making art.

It will be apparent that by employing the use of centrifugal force in the regions of the deflector rolls 16, 17 and 18 and the turning roll 24 to expel water from both sides of the sheet, the complete elimination of vacuum producing table rolls becomes possible. This greatly increases the life of the forming wires 10 and 35 since abrasive friction between the vacuum boxes and the wires, and between the table rolls and the wires is eliminated, and consequently there is a substantial reduction in power consumption due to the reduction in drag on the wires.

Additionally, improved formation of the sheet of paper is realized, as the two-sidedness produced by the former methods is eliminated because of the even distribution of fine fibers adjacent the top and bottom surfaces (FIG. 7) of the newly formed sheet S which is achieved by drainage from both the top and bottom sides of the sheet. Also, a considerably shorter machine with correspondingly shorter wires may be used, as compared to the length of machinery required when a table roll section and a suction box section are present, thus resulting in a much cheaper installation.

While the method herein described, and the form of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Apparatus for forming a web of paper or the like, comprising a frame, a bottom forming wire, a plurality of guide rolls on said frame for directing said bottom forming wire through a substantially horizontal run, headbox means for feeding watery pulp stock onto said bottom forming wire at the upstream end of said horizontal run, an upper forming wire substantially identical to said bottom forming wire, guide rolls for directing said upper forming wire through an initial run wherein it gradually converges into sandwiched relation with said bottom forming wire and stock to progressively express the liquids from the stock through each of said wires, first turning roll means for guiding the sandwiched forming wires and stock through a first turning path in one direction, second turning roll means for guiding said sandwiched forming wires and stock through a second turning path in an opposite direction, drive means for moving said wires at a predetermined speed sufficient to discharge the liquids in the stock by centrifugal force through one of said wires as said sandwiched wires and stock pass around said first turning roll and then through the

5

other of said wires as said sandwiched wires and stock pass around said second turning roll to remove substantially all of the liquids from the stock by centrifugal force to produce a sheet of paper or the like, and means for separating said forming wires and removing the newly formed sheet therefrom.

2. Apparatus for forming a web of paper or the like, comprising a frame, a bottom forming wire, a plurality of guide rolls on said frame for directing said bottom forming wire through a substantially horizontal run, headbox means for feeding watery pulp stock onto the surface of said bottom forming wire at the upstream end of said horizontal run, an upper forming wire substantially identical to said bottom forming wire, guide rolls for directing said upper forming wire through an initial run wherein it converges into sandwiched relation with said bottom forming wire, first turning means for guiding the sandwiched forming wires and stock through a first turning path in one direction, second turning means for guiding said sandwiched forming wires and stock through a second turning path in an opposite direction, drive means for moving said wires at a predetermined speed sufficient to discharge the liquids in the stock by centrifugal force through one of said wires as said sandwiched wires and stock pass around said first turning roll and then through the other of said wires as said sandwiched wires and stock pass around said second turning roll to remove substantially all of the liquids from the stock and produce a sheet of paper or the like, means for separating said superimposed forming wires and causing the newly formed sheet to adhere to one of said forming wires, and pickup means for removing the newly formed sheet from said one wire.

3. Apparatus for forming a web of paper or the like, comprising a frame, a bottom forming wire, a plurality of guide rolls on said frame for directing said bottom forming wire through a substantially horizontal run, headbox means for feeding watery pulp stock onto said bottom forming wire at the upstream end of said horizontal run, an upper forming wire substantially identical to said bottom forming wire, guide rolls on said frame for directing said upper forming wire through an initial run wherein it converges into superimposed relation with said bottom forming wire and stock, a plurality of deflector rolls on said frame for guiding said superimposed forming wires and stock through a first turning path including a series of succession of more steeply inclined runs, second turning roll means for guiding said superimposed forming wires and stock through a second turning path in an opposite direction, drive means for moving said wires at a predetermined speed sufficient to discharge the liquids in the stock by centrifugal force through one of said wires as said sandwiched wires and

6

stock pass around said first turning roll and then through the other of said wires as said sandwiched wires and stock pass around said second turning roll to remove substantially all of the liquids from the stock and produce a sheet of paper or the like, and means for separating said superimposed forming wires and removing the newly formed sheet therefrom.

4. Apparatus for forming a web of paper or the like, comprising a frame, a bottom forming wire, a plurality of guide rolls on said frame for directing said bottom forming wire through a substantially horizontal run, headbox means for feeding watery pulp stock onto said bottom forming wire at the upstream end of said horizontal run, an upper forming wire substantially identical to said bottom forming wire, guide rolls for directing said upper forming wire through an initial run wherein it converges into sandwiched relation with said bottom forming wire and stock, turning roll means on said frame for guiding the sandwiched forming wires and stock through turning paths in opposite directions, drive means for moving said wires at a predetermined speed sufficient to discharge the liquids in the stock by centrifugal force through one of said wires as said sandwiched wires and stock pass through a path in one turning direction and then through the other of said wires as said sandwiched wires and stock pass through a path in an opposite turning direction to remove a substantial portion of the liquids from the stock and produce a sheet of paper or the like, and means for separating said wires and removing the newly formed sheet.

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