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APPARATUS FOR FORMING AND DEWATERING A FIBROUS WEB

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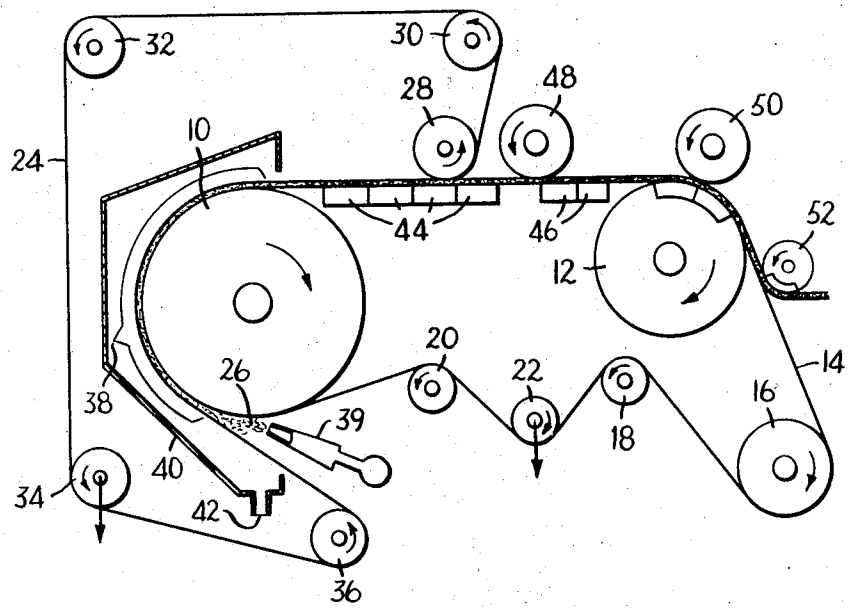
FIG. 1



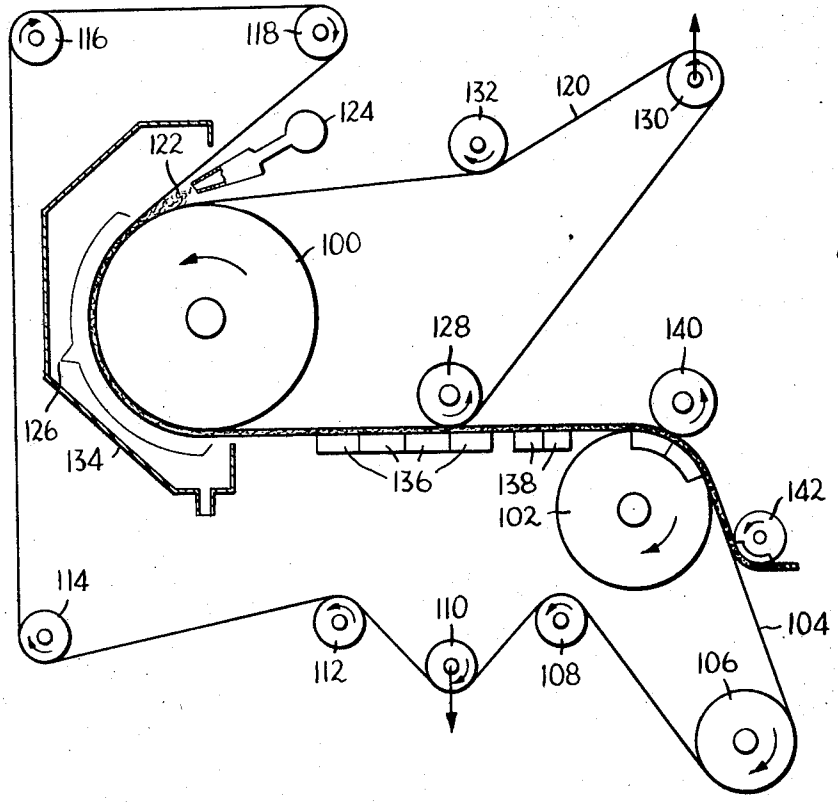


FIG. 2

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APPARATUS FOR FORMING AND DEWATERING A FIBROUS WEB

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Int. Cl. D21f 1/48
U.S. Cl. 162—301 7 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for forming and dewatering a fibrous web comprises, according to the exemplary embodiments, a forming roll and a suction couch roll spaced at substantial distance from each other generally horizontally and a first movable, endless, tensioned foraminous belt trained around a portion of the forming roll and conducted along a straight run to and around the suction couch. A second belt is led around the forming roll and defines with the first belt an arcuate web-forming zone extending along a portion of the forming roll. The two belts are led in convergent directions to the forming roll to define a tapered inlet zone where a ribbon-like jet of fiber stock is introduced. The two belts run tangentially from the forming roll together along a part of the staright path from the forming roll to the couch roll, and the second belt is separated from the web part way along the straight run by leading it out around a carrier roll. One or more pressure or vacuum boxes are provided along the straight run of the belts between the forming roll and the couch roll to establish a differential pressure across the web to dewater it. The first belt, i.e., the belt which runs from the forming roll to the couch roll, is arranged so that it carries the web on its upper surface after the second belt is separated. Press rolls may be provided along the straight run or at the couch.

BACKGROUND OF THE INVENTION

This invention relates to apparatus for forming and dewatering a fibrous web, such as a paper or paperboard web.

For many decades, paper and paperboard have been produced, almost universally, on Fourdrinier machines in which a stock is spread across a moving foraminous belt, usually a metallic wire, and is drained along a run of wire of rather substantial length. Various improvements have been made over the years in the basic Fourdrinier machine. However, there are definite limits on the forming speed, principally because of the limited stock drainage rate that can be obtained.

In recent years, there has been a great deal of experimental and developmental work on a markedly different type of paper-forming device, one in which stock is introduced as a high velocity, ribbon-like jet into a curved space, the outer portion of which is formed by a moving foraminous belt stretched around a curved member, such as a forming roll or a fixed, curved surface. The stock is drained by a combination of centrifugal forces resulting from the movement of the stock over a curved trajectory and the pressure of the tensioned belt, which squeezes the stock in the forming space. Experience with machines of this type has demonstrated that significantly higher speed can be obtained with equipment which is of generally smaller size, lower cost and free of many of the problems of Fourdrinier machines.

Various specific machines of this type, which might be termed the "pressure-forming" type, have been proposed.

In many of them, the newly formed web is removed from the forming region in a manner which takes it into a reverse curve, relative to the original curvature along which it was formed. The movement of the web into a reverse curve before it reaches a relatively high dryness results in displacement and shear of the fibrous material, by virtue of the change in curvature of the respective surfaces of the web, and has adverse effects on the strength, uniformity and other properties of the web. In addition, the dryness of the web when it leaves the forming part is relatively low, and reliance is placed upon conventional presses down line from the forming equipment to further dewater the web prior to final drying. Often, the web is carried from the forming zone to the presses on the underside of a felt or wire running inside of the main, tensioned foraminous belt. This creates a high risk of breaks due to separation of the web from the under surface of such felt or wire.

SUMMARY OF THE INVENTION

There is provided, in accordance with the present invention, a novel and improved apparatus for forming and dewatering a fibrous web which overcomes the above and other problems of pressure-forming type machines proposed heretofore. More particularly, the apparatus, according to the invention, comprises a first rotatable roll, a second rotatable roll spaced a substantial distance generally horizontally from the first roll and, of course, disposed parallel to the first roll and a first movable, endless, tensioned foraminous belt trained around portions of the first and second rolls and running in a straight run between them. A second foraminous endless belt runs generally conjointly with the first belt around the first roll, although it approaches the first roll in a convergent direction, relative to the first belt, so as to define a convergent inlet space where stock in the form of a ribbon-like jet is fed to the forming zone constituted by the region of the first roll where the two belts run together. The second belt moves conjointly with the first belt along a part of the straight run from the first roll to the second roll and is then trained around a guide roll and separated from the first belt leaving the web on the upper surface of the first belt.

The stock is dewatered in the forming zone and is formed into a web by combination of centrifugal force, which drives water out of the stock and out through the outer foraminous belt where it is collected and appropriately recovered, and by the pressure of the outer belt against the stock resulting from the tension of the outer belt. Further dewatering is accomplished along the straight run from the forming roll to the second roll by one or more pressure or suction boxes disposed along the straight run and creating a differential pressure across the web. The first and second rolls are arranged, relative to the two belts, so that the first belt runs to the couch roll with the web carried on its upper surface, thereby eliminating the problem of possible dropoff and breaks that can occur when the web is carried on the undersurface. Preferably, the web is then taken off the first belt somewhere along a free run after it turns around the second roll and prior to the next carrier roll around which it is trained.

In addition to the basic advantage of employing the pressure-forming technique in the initial formation of the web, the apparatus of the invention offers the further advantages, as mentioned above, of providing a straight run of the web along a relatively substantial distance and of further dewatering of the web along the straight run. Consequently, the web leaves the forming and dewatering apparatus with a relatively high dryness, and is not subjected to turning until it reaches a relatively high dryness; thus, the possibilities of disruption of uniformity

and impairment of the strength of the web are materially reduced. The geometric layout of the apparatus may be such as to make it possible to modify an existing Fourdrinier machine, to save many of the rolls and other parts of the machine, and to thereby provide a high speed, effective pressure-forming type machine at a relatively low cost.

DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, reference may be made to the following description of exemplary embodiments, taken in conjunction with the figures of the accompanying drawing, in which

FIG. 1 is a side view in section taken just inside the near side frame of one embodiment, the drawing being of generally schematic form; and

FIG. 2 is a schematic side view in section taken just inside the near frame of another embodiment of the machine of the invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

The embodiment of FIG. 1 comprises a first rotatable roll **10**, which may be termed a forming roll and preferably has a solid cylindrical surface. Spaced at a relatively substantial distance from the forming roll **10** is a second rotatable roll **12**, which is preferably a suction couch roll. An endless formaminous belt **14**, which may be a wire or synthetic mesh or a paper-making felt, is trained around a portion of the surface of the forming roll **10**, say on the order of 180° of the surface. The belt **14** then leads along a straight run around a portion of a couch roll **12** and returns to the forming roll over a series of guide or carrier rolls **16**, **18** and **20** and a tension roll **22**. The tension roll is of the type which provides a constant tension in the belt **14**, such types of rolls being well known to those skilled in the art and therefore not being described or shown in detail. The rolls and belt are driven at uniform speeds so that they move conjointly.

A second movable, endless foraminous belt **24**, preferably a paper making wire, is trained around the forming roll **10** in a manner such that it runs conjointly with the first belt **14** for the major portion of the zone where the first belt runs over the forming roll. The second belt is led to the forming roll **10** so that it converges toward the first belt **14** to define a stock inlet zone **26**, and runs from the roll **10** conjointly with the first belt **14** over a part of the straight run between the forming roll **10** and the couch roll **12**. At an appropriate point along the straight run the second belt **24** is separated from the first belt **14** by guiding it around a guide roll **28**, and it then returns to the inlet part of the forming roll around guide rolls **30** and **32**, a tension roll **34** and a guide roll **36**.

The arcuate region on the forming cylinder **10** where the two belts **14** and **24** run together constitutes a web-forming zone and is designated generally by the reference numeral **38**. Stock is introduced from a nozzle **39** in the form of a ribbon-like jet traveling at a velocity of the same order of magnitude as the speed of the belts **14** and **24** into the converging inlet space **26** and forces its way into the forming space **38** where it is dewatered by a combination of centrifugal force resulting from the movement of the stock with the moving belts **14** and **24** around an arc and the pressure exerted by the tension of the outer belt **24** pulled over the arc. The water thrown off and expressed outwardly from the stock as it is formed into a web in the forming zone **38** is collected in a collector box **40** and is recovered from an outlet **42**.

The arcuate forming zone provides very rapid and efficient removal of water from the web so that it leaves the forming zone with a relatively high dryness. However, the web is further dewatered along the straight run between the forming roll **10** and the couch roll **12** by a

series of pressure or vacuum boxes. More particularly, the embodiment of FIG. 1 shows a series of suction boxes **44** arranged adjacent each other below the upstream portion of a straight run of the belts **14** and **24** for creating by a vacuum a differential pressure across the web. It will be understood that the suction boxes **44** may be replaced by a single box, or that one or more pressure boxes may be utilized in place of the suction boxes. Preferably, however, the differential pressure created across the web during the initial dewatering phase along the straight run between the forming roll **10** and the couch roll **12** is maintained substantially continuously. In the region where the first belt **24** is separated from the second belt **14** (namely at the roll **28**), the suction is kept on to hold the web on the first belt.

Desirably, additional suction boxes are located downstream along the run of the belt **14** between the roll **28** and the couch roll **12** where the web is carried on its upper surface. For example, the embodiment of FIG. 1 includes two adjacent suction boxes **46** along this part of the straight run of the belt **14**. The dewatering apparatus along the straight run may also include a press roll **48**, which is backed up by one of the suction boxes **46**, and, finally, the forming and dewatering apparatus may be assisted by another press roll **50** backed up by the suction couch roll **12**. When the web reaches the suction couch, it will have a relatively high dryness so that it may be turned through an S curve without impairing its quality or strength and may be removed in an open draw by turning it around and picking it off with a suction pick up roll **52**. Advantageously, the web is removed from the belt **14** along a free run between the couch roll and the carrier roll **16**.

The embodiment of FIG. 2 is quite similar to the embodiment of FIG. 1 except for the particular geometry and arrangement of the forming roll and the two foraminous belts. It comprises a forming roll **100**, again preferably of an appropriate construction providing a solid cylindrical surface, a suction couch roll **102** and an endless, tensioned foraminous belt **104** corresponding to the first belt **14** of the embodiment of FIG. 1. The principal difference between the two embodiments is that the belt **104** constitutes the outer belt around the forming cylinder **100**, thus serving as the primary tensioned forming element. The belt **104** is conducted around guide rolls **106** and **108**, a tension roll **110** and guide rolls **112**, **114**, **116** and **118** and back to the forming roll **100**.

A second endless foraminous belt **120** approaches the forming roll **100** along a path convergent to the first belt **104**, thereby providing a stock inlet zone **122** for the introduction of stock in the form of ribbon-like jet from a nozzle **124**, and then turns substantially conjointly with the first or outer belt **104** around the forming roll to define an arcuate web forming zone **126**. The two belts **104** and **120** travel together along a portion of a straight run of the belt **104** between the forming roll **100** and a couch roll **102** to a point where the second or inner belt **120** is separated by turning it around a guide roll **128**. The inner belt **120** is guided around a constant tension roll **130** and a guide roll **132** back to the forming roll **100**.

As in the embodiment of FIG. 1, the jet of stock introduced at the inlet zone **122** defined between the belts **104** and **120** where they converge toward the forming roll **100** is dewatered by a combination of centrifugal forces and the pressure established by the tension in the outer belt **104**, the water thrown off and expressed from the web being captured and recovered by a collector box **134**. The web is then carried in between the two belts **104** and **120** along a series of suction boxes **136** and **138** which may be disposed substantially as in the embodiment of FIG. 1. The embodiment of FIG. 2 omits a pressure roll along the straight run of the belt **104**, but includes a pressure roll **140** backed up by the suction couch roll **102**. The web is separated in the same manner as in the embodiment of FIG. 1 by a suction pickup roll **142**.

I claim:

1. Apparatus for forming and dewatering a fibrous web comprising a first rotatable roll, a second rotatable roll spaced a substantial distance generally horizontally from the first roll and disposed parallel to the first roll, a first movable endless tensioned foraminous belt trained around portions of the first and second rolls and extending tangentially to the first and second rolls and along a straight run between them, a third roll closely adjacent the straight run portion of the first belt, a second movable endless tensioned foraminous belt trained around a part of the first roll, such part including a zone in which the first and second belts run together to define an arcuate web-forming zone, and the two belts leading to the first roll along convergent paths, defining a stock inlet zone and leading from the first roll together and traveling together along a part of the straight run of the first belt with the second belt overlying the first belt, and the second belt being trained around the third roll and being led away from the first belt so that the first belt continues alone along the remainder of the straight run to the second roll, means for introducing stock in the form of a ribbon-like free jet into the stock inlet zone, whereby a web is formed between the two belts in the web-forming zone and is carried with the belts, first dewatering means disposed along the part of the straight run of the belts between the first and third rolls to create a pressure differential across the fibrous web to dewater the web, second dewatering means disposed along the part of the straight run between the third and second rolls to create a pressure differential across the first belt and the fibrous web to further dewater the web, and means for separating the fibrous web from the first belt after they pass over the second roll.

2. Apparatus according to claim 1 wherein the second roll is a suction couch.

3. Apparatus according to claim 1 wherein the first belt is tangent to the first and second rolls at an upper point thereon, and wherein the first belt runs inside the second belt around the first roll.

4. Apparatus according to claim 1 wherein the first belt is tangent to the first roll at a lower point thereon and is tangent to the second roll at an upper point thereon, and wherein the second belt runs inside the first belt around the first roll.

5. Apparatus according to claim 1 wherein the second dewatering means for creating a pressure differential includes a suction box and a press roll between the second and third rolls engaging the web and first belt against the suction box.

6. Apparatus according to claim 2 wherein the second dewatering means for creating a pressure differential comprises a press roll engaging the web and first belt against the suction couch roll.

7. Apparatus according to claim 1 wherein the first dewatering means for creating a pressure differential includes a suction box in the portion of the straight run between the first and third rolls, said suction box also extending beyond the third roll to ensure that the web is retained on the first belt.

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U.S. Cl. X.R.

162—203, 214, 317, 318, 348

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(5,69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,565,757 Dated Feb. 23, 1971

Inventor(s) L. B. Jordansson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 28, "staright" should be --straight--; Column 1, line 68, "speed" should be --speeds--; Column 5, line 31, delete "the first belt and".

Signed and sealed this 31st day of August 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
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Commissioner of Patents