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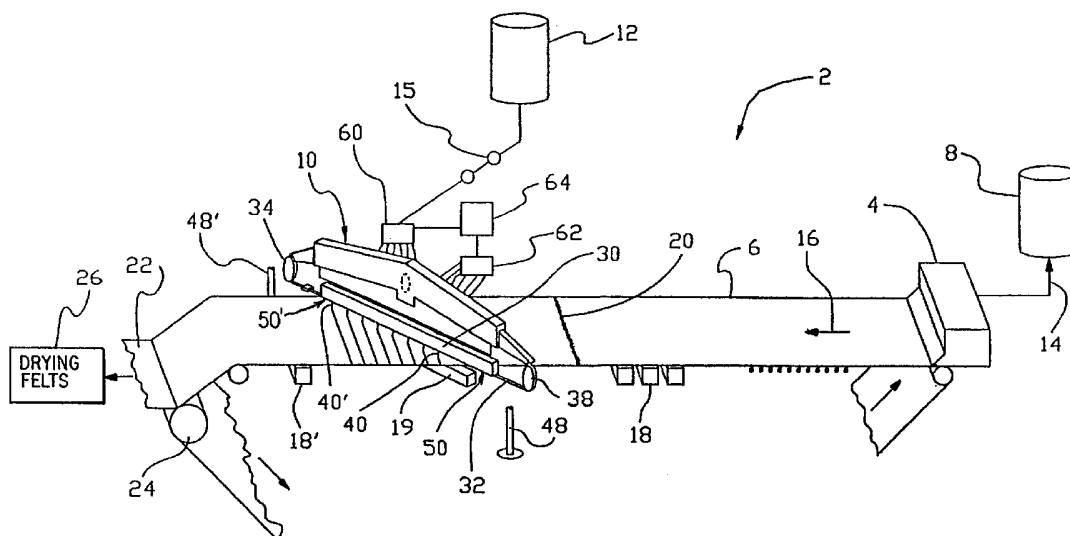
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(54) Title: METHOD AND APPARATUS FOR APPLYING A MATERIAL TO A WEB



(57) Abstract: A method and apparatus of manufacturing a web which is striped with add-on material, comprising: a first slurry supply which forms a sheet of base web and moves the sheet along a first path; a second slurry supply; and a moving orifice applicator operative so as to repetitively discharge the second slurry upon the moving sheet of base web. The moving orifice applicator includes a chamber box arranged to establish a reservoir of the second slurry across the first path, an endless belt having slotted orifices, the endless belt received through the chamber box, and a drive arrangement operative upon the endless belt to continuously move the orifices along an endless path and repetitively through the chamber box. The orifices communicate with the reservoir to discharge the second slurry as bands of add-on material to the base web. The slotted orifices can be spaced apart along the belt and oriented so as to be angled with respect to the travel direction of the belt and parallel to each other.

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METHOD AND APPARATUS FOR APPLYING A MATERIAL TO A WEB

Field of Invention

The present invention relates to method and apparatus for applying a
5 predetermined pattern of add-on material to a base web, preferably in the form of
stripes, and more particularly, to a method and apparatus for producing cigarettes
papers having banded regions of additional material.

Background and Circumstances of Invention

Techniques have been developed for printing or coating paper webs with
10 patterns of additional material. These prior techniques have included printing with
gravure presses, blade coating, roller coating, silkscreening and stenciling.

U.S. Patent No. 4,968,534 to Bogardy describes a stenciling apparatus
wherein a continuous stencil comes into intimate contact with a paper web during
application of an ink or the like. The apparatus includes an arrangement which
15 draws air through the stencil prior to the application of the ink. The mechanical
arrangement is such that to change the pattern, the stencil must be changed.
Additionally, such apparatus are unworkable at the wet-end of paper-making
machines.

In the related, commonly assigned U.S. Patent No. 5,534,114, an
20 embodiment of a moving orifice applicator is disclosed which includes an elongate
“cavity block” or chamber and a perforated endless belt whose lower traverse passes
along the bottom portion of the chamber. The chamber is positioned obliquely
across a web-forming device (such as a Fourdrinier wire). In operation, a slurry of
additional material is continuously supplied to the chamber as the endless belt is
25 looped through the bottom portion of the chamber such that plural streams of
material are generated from beneath the chamber to impinge the web passing

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beneath the chamber. As a result, bands of additional material are applied repetitively to the web. The orientation, width, thickness and spacing of the bands are all determinable by the relative speed and orientation of the endless belt to the moving web.

5 Preferably, the pattern of additional material is applied as uniformly as possible so as to render consistent product across the entire span of the web. Commonly assigned U.S. Patent No. 5,997,691 discloses a slurry applicator which can be used with Fourdrinier machines having a width of 10 to 20 feet or more.

10 In the cigarette papermaking art, it is conventional to convey the sheet of paper on a Fourdrinier papermaking machine at speeds of 1200 to 1400 feet/minute. In contrast, in making sheet paper such as wrapping paper, writing paper and the like, the machine is run at speeds of about 2500 feet/minute. Specialty paper is run at slower speeds. Banded paper such as that described in commonly owned U.S. Patent Nos. 5,417,228; 5,474,095; and 5,534,114 (see also commonly owned

15 European Patent Publication Nos. 486213 A1, 532193 A1 and 559453 A1), the disclosures of which including characteristics of the banded paper and papermaking techniques are hereby incorporated by reference, has been produced at speeds of 400 to 600 feet/minute. In practice, banded cigarette paper having 5 to 6 mm wide bands of add-on slurry material has been produced on a Fourdrinier machine at speeds of

20 about 500 feet/minute using a moving orifice device wherein the belt has 3/32 inch diameter round holes. It has been discovered that when the speed of the paper sheet is increased, the band widths increase due to the high speed and higher stock flow of the material used to create the bands. It has also been discovered that reduction in stock flow for purposes of reducing band width results in lowered add-on weight of

25 the banded regions. In order to increase production output, it would be desirable to provide a moving orifice applicator which achieves a desired band width and add-on weight at high production speeds.

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Objects of the Invention

Accordingly, it is an object of the present invention to provide uniformity in the application of a slurry from a moving orifice applicator onto a sheet traveling at high speed.

- 5 It is another object of the present invention to apply bands of slurry material to the sheet with band width and add-on weight within predetermined tolerance levels.

Summary of Invention

- These and other objects are achieved with the present invention whose
10 aspects include a method and apparatus for the production of a web having banded regions of add-on material, more particularly a cigarette paper having stripes of additional cellulosic material added thereto. A preferred method includes the steps of establishing a first slurry, and preparing a base web by laying the first slurry into a sheet form while moving the base web sheet along a first path. The method further
15 comprises the steps of preparing a second slurry and repetitively discharging the second slurry so as to establish stripes upon the base web. The last step itself includes the steps of establishing a reservoir of the second slurry across the first path, moving a belt having slotted orifices along an endless path, which path includes an endless path portion along the reservoir where the orifices are
20 communicated with the reservoir, and discharging the second slurry from the reservoir through the orifices onto the laid first slurry.

Brief Description of the Drawings

- The above and other objects and advantages of this invention will be apparent upon consideration of the following detailed description, taken in
25 conjunction with the accompanying drawing, in which like reference characters refer to like parts throughout, and in which:

Fig. 1A is a perspective of a paper making machine constructed in

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accordance with a preferred embodiment of the present invention;

Fig. 1B is a perspective view of a paper constructed in accordance with the methodologies and apparatus of the present invention;

Fig. 1C is a perspective view of a cigarette constructed with the paper of Fig. 1B;

Fig. 2 is a side view of the moving orifice applicator constructed in accordance with a preferred embodiment of the present invention;

Fig. 3A is a breakaway perspective view of the applicator of Fig. 2;

Fig. 3B is a top planar view of tracking control system of the applicator as viewed in the direction of the double pointed arrow B-B in Fig. 3A;

Fig. 4 is a cross-sectional view of the chamber box taken at line IV-IV in Fig. 2;

Fig. 5 is a detail perspective view of the endless belt of the applicator shown in Fig. 2;

Fig. 6 is a detail, partial sectional view of an alternate embodiment of a chamber box of the applicator of Fig. 2; and

Figs. 7A, 7B and 7C show details of an exemplary slotted belt arrangement wherein Fig. 7A shows a top view of a belt having a plurality of slotted holes, Fig. 7B shows a top view of an individual slotted hole and Fig. 7C shows a cross-sectional side view of the slotted hole shown in Fig. 7C.

Detailed Description of the Preferred Embodiments

Referring to Fig. 1A, a preferred embodiment of the present invention comprises a cigarette paper making machine 2, which preferably includes a head box 4 operatively located at one end of a Fourdrinier wire 6, a source of feed stock slurry such as a run tank 8 in communication with the head box 4, and a moving orifice applicator 10 in operative communication with another source of slurry such as a day tank 12.

The head box 4 can be one typically utilized in the paper making industry for

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laying down cellulosic pulp upon the Fourdrinier wire 6. In the usual context, the head box 4 is communicated to the run tank 8 through a plurality of conduits 14. Preferably, the feed stock from the run tank 8 is a refined cellulosic pulp such as a refined flax or wood pulp as is the common practice in the cigarette paper making industry.

The Fourdrinier wire 6 carries the laid slurry pulp from the head box 4 along a path in the general direction of arrow 16 in Fig. 1A, whereupon water is allowed to drain from the pulp through the wire 6 by the influence of gravity and at some locations with the assistance of vacuum boxes 18 at various locations along the Fourdrinier wire 6 as is the established practice in the art of cigarette paper making. At some point along the Fourdrinier wire 6, sufficient water is removed from the base web pulp to establish what is commonly referred to as a dry line 20 where the texture of the slurry transforms from one of a glossy, watery appearance to a surface appearance more approximating that of the finished base web (but in a wetted condition). At and about the dry line 20, the moisture content of the pulp material is approximately 85 to 90%, which may vary depending upon operating conditions and the like.

Downstream of the dry line 20, the base web 22 separates from the Fourdrinier wire 6 at a couch roll 24. From there, the Fourdrinier wire 6 continues on the return loop of its endless path. Beyond the couch roll 24, the base web 22 continues on through the remainder of the paper making system which further dries and presses the base web 22 and surface conditions it to a desired final moisture content and texture. Such drying apparatus are well known in the art of paper making and may include drying felts 26 and the like.

Referring now to both Figs. 1A and 2, the moving orifice applicator 10 preferably comprises an elongate chamber box 30 for establishing a reservoir of add-on slurry in an oblique relation across the path of the Fourdrinier wire 6. The moving orifice applicator also includes an endless perforated steel belt 32, whose pathway is directed about a drive wheel 34, a guide wheel 36 at the apex of the

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moving orifice applicator 10 and a follower wheel 38 at the opposite end of the chamber box 30 from the drive wheel 34. The endless belt 32 is directed through a bottom portion of the chamber box 30 and subsequently through a cleaning box 42 as it exits the chamber box 30, moves toward the drive wheel 34 and continues along the remainder of its circumlocution.

As each slotted orifice 44 (Fig. 5) of the belt 32 passes through the bottom portion of the chamber box 30, the orifice 44 is communicated with the reservoir of slurry established in the chamber box 30. At such time, a stream 40 of slurry discharges from the orifice 44 as the orifice 44 traverses the length of the chamber box 30. The discharge stream 40 impinges upon the base web 22 passing beneath the moving orifice 44 so as to create a stripe of additional (add-on) material upon the base web 22. The operational speed of the belt 32 may be varied from one layout to another, but in the preferred embodiment, the belt is driven at 1500 or more feet per minute when the Fourdrinier wire is moving at approximately 800 or more feet per minute (e.g., 1000 to 3000 feet/minute) and the chamber box 30 is oriented at an angle relative to the direction of movement of the base web 22. The spacing of the orifices 44 along the belt 32 and the operational speed of the belt 32 is selected such that a plurality of streams 40, 40' emanate from beneath the chamber box 30 during operation of the moving orifice application, simultaneously. Because of the oblique orientation of the moving orifice applicator relative to the path 16 of the base web 22 and the relative speeds of the Fourdrinier wire 6 and the endless belt 32, each stream 40 of add-on material will create a stripe of add-on material upon the base web 22. By adjusting the speed of the belt and angle of the applicator 10, the moving orifice applicator 10 can repetitively generate stripes of add-on material that are oriented normal to a longitudinal edge of the base web 22. If desired, the angle and/or relative speeds may be altered to produce stripes which are angled obliquely to the edge of the base web 22.

For a particular orifice 44, after it exits from the chamber box 30, the adjacent portions of the belt 32 about the orifice 44 are cleansed of entrained add-on

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slurry at the cleaning station 42 and the orifice then proceeds along the circuit of the endless belt 32 to reenter the chamber box 30 to repeat an application of a stripe upon the base web 22.

Referring particularly to Fig. 1A, the moving orifice applicator is preferably
5 situated obliquely across the Fourdrinier wire 6 at a location downstream of the dry line 20 where the condition of the base web 22 is such that it can accept the add-on material without the add-on material dispersing itself too thinly throughout the local mass of the base web slurry. At that location, the base web 22 retains sufficient
10 moisture content (approximately 85 to 90%) such that the add-on slurry is allowed to penetrate (or establish hydrogen bonding) to a degree sufficient to bond and integrate the add-material to the base web 22.

Preferably, a vacuum box 19 is located coextensively beneath the chamber
box 30 of the moving orifice applicator 10 so as to provide local support for the Fourdrinier wire 6 and facilitate the bonding/integration of the add-on slurry with
15 the base web 20. The vacuum box 19 is constructed in accordance with designs commonly utilized in the paper making industry (such as those of the vacuum boxes 18). The vacuum box 19 is operated at a relatively modest vacuum level, preferably at approximately 60 inches of water or less. Optionally, additional vacuum boxes
20 18' may be located downstream of the moving orifice applicator 10 to remove the additional quantum of water that the add-on slurry may contribute. It has been found that much of the removal of water from the add-on material occurs at the couch roll 24 where a vacuum is applied of approximately 22-25 inches mercury.

The moving orifice applicator 10 is supported in its position over the Fourdrinier wire 6 preferably by a framework including vertical members 48, 48'
25 which include a stop so that the moving orifice applicator 10 may be lowered consistently to a desired location above the Fourdrinier wire 6, preferably such that the bottom of the chamber box 30 clears the base web 22 on the Fourdrinier wire 6 by approximately one to two inches, preferably less than 1.5 inch.

Preferably, the chamber box 30 is of a length such that the opposite end

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portions 50, 50' of the chamber box 30 extend beyond the edges of the base web 22. The over-extension of the chamber box 30 assures that any fluid discontinuities existing arising at the end portions of the chamber box 30 do not affect the discharge streams 40 as the streams 40 deposit add-on material across the base web 22. By
5 such arrangement, any errant spray emanating from the ends of the chamber box 30 occurs over edge portions of the base web 22 that are trimmed away at or about the couch roll 24.

Either or both of the vertical members 48, 48' of the support framework for the moving orifice applicator 10 may be pivotal about the other so as to adjust
10 angulation of the applicator 10 relative to the Fourdrinier wire 6. However, the vertical members 48, 48' of the support framework can be fixed in place and the speed of endless belt 32 can be adjusted in response to changes in operating conditions of the paper making machine 2.

The chamber box 30 receives add-on slurry from the day tank 12 at spaced
15 locations along the chamber box 30. Uniform pressure can be maintained along the length of the chamber box 30 by the interaction of a flow distribution system 60, a pressure monitoring system 62 and a programmable logic controller 64 such that the pumping action of the belt 22 and other flow disturbances along the length of the chamber box 30 are compensated locally and continuously to achieve the desired
20 uniformity of pressure throughout the chamber box 30. A main circulation pulp 15 delivers slurry from the day tank 12 to the flow distribution system 60. Details regarding how the controller initiates and maintains uniform pressure along the chamber box 30 can be found in commonly assigned U.S. Patent No. 5,997,691, the disclosure of which is hereby incorporated by reference.

25 Referring now to Figs. 2 and 3A, the drive wheel 34 is driven by a selectable speed motor 52 which is operatively connected to the drive wheel 34 by a drive belt. Preferably, the motor 52 is supported by the framework of the moving orifice applicator, and both the motor 52 and the drive belt are encased within a housing 53 so as to capture any extraneous material (such as bits of slurry) that may find its way

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to and be otherwise flung from the drive system of the drive wheel 34. Preferably, the motor is an Allen-Bradley Model 1329C-B007NV1850-B3-C2-E2, 7.5 hp., with a Dynapa Tach 91 Modular Encoder. Of course, other types and models of motors that are known to those of ordinary skill in the pertinent art would be suitable for this application.

The drive wheel 34 is advantageously positioned upstream of the chamber box 30 along the pathway of the belt 32 so that the belt 32 is pulled through the chamber box 30. A significant degree of the directional stability is achieved by the close fit of the belt 32 throughout the length of the elongate chamber box 30.

However, precise control of the tracking of the belt 32 about its pathway circuit can be effected by placement of an infrared proximity sensor 54 at a location adjacent the guide wheel 36. The infrared proximity sensor 54 can comprise an emitter 56 and a sensor 58 which are mutually aligned relative to one of the edges of the belt 32 such that if the belt strays laterally from its intended course, a signal from the sensor is affected by a relative increase or decrease in the interference of the edge with the emitter beam. A controller 59 in communication with the sensor 58 can be used to interpret the changes in the signal from the sensor 58 to adjust the yaw of the guide wheel 36 about a vertical axis so as to return the edge of the belt 32 to its proper, predetermined position relative to the beam of the emitter 56.

Suitable devices for the proximity sensor 54 include a Model SE-11 Sensor which is obtainable from the Fife Corporation of Oklahoma City, Oklahoma.

Referring now also to Fig. 3B, the guide wheel 36 rotates about a horizontally disposed axle 36a, which itself is pivotal about a vertical axis at a pivotal connection 57 by the controlled actuation of a pneumatic actuator 61. The actuator 61 is operatively connected to a free end portion 36b of the axle 36a and is responsive to signals received from the controller 59. Preferably, both the pivotal connection 57 and the actuator 61 are fixed relative to the general framework of the applicator 10 during operation of the applicator 10; and a connection 54a is provided between the sensor 54 and the free end 36b of the axle 36a so that the sensor 54

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rotates as the yaw of the guide wheel 36 is adjusted. The connection 54a assures that the sensor 54 remains proximate to the edge of the belt 32 as the guide wheel 36 undergoes adjustments.

5 Preferably, the actuator 61 and the pivotal connection 57 are affixed upon a plate 39a which is vertically displaceable along fixed vertical guides 39b and 39c. Preferably, releaseable, vertical bias is applied to the plate 39a so as to urge the guide wheel 36 into its operative position and to impart tension in the endless belt 32.

10 Along the return path of the endless belt 32, from the drive wheel 34 over the guide wheel 36 and back to the follower wheel 38, the belt 32 is enclosed by a plurality of housings, including outer housings 68, 68' and a central housing 70 which also encloses the infrared proximity sensor 54 and the controller 59 of the tracking system 55. The housing 68, 68' and the housing 70 prevent the flash of errant slurry upon the base web 22 as the belt 32 traverses the return portion of its circuit.

15 Referring particularly to Fig. 2, the housings 68, 68', 70 and various other components of the applicator 10 (such as the wheels 34, 36 and 38; the chamber box 30; the cleaning box 42; and the motor 52) are supported by and/or from a planar frame member 72. The planar frame member 72 itself is attached at hold-points 20 73, 73' to a cross-member (an I-beam, box beam or the like), which cross-member is supported upon the vertical members 48, 48'. In the alternative, an I-beam member or a box beam member may be used as a substitute for the frame member 72, with the chamber box 30 and other devices being supported from the beam member.

25 Referring again to Fig. 3A, in either support arrangement, the chamber box 30 is preferably hung from the support member with two or more, spaced apart adjustable mounts 77a, 77b that permit vertical and lateral adjustment (along arrows y and x in Fig. 3A, respectively) of each end of the chamber box 30 so that the chamber box 30 may be accurately leveled and accurately angled relative to the Fourdrinier wire, and so that the chamber box 30 may be accurately aligned with the

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belt 32 to minimize rubbing.

Referring now to Fig. 4, the chamber box 30 includes at its bottom portion 76 a slotted base plate 78 and first and second wear strips 79 and 80, which in cooperation with the base plate 78 define a pair of opposing, elongate slots 81 and 82 which slidably receive edge portions of the endless belt 32. Preferably, the elongate slots 81 and 82 are formed along a central bottom portion of the base plate 78, but alternatively, could be formed at least partially or wholly in the wear strips 79 and 80.

The central slot 84 in the base plate 78 terminates within the confines of the chamber box 30 adjacent to the end portions 50, 50' of the chamber box 30. Preferably, each terminus of the central slot 84 is scalloped so as to avoid the accumulation of slurry solids at those locations. The width of the central slot 84 is minimized so as to minimize exposure of the fluid within the chamber box 30 to the pumping action of the belt 32. In the preferred embodiment, the slot 84 is approximately 3/8 inch wide, whereas the width of each of the orifices 44 in the endless belt 32 is preferably approximately 2/32 inch.

Each of the wear strips 79, 80 extends along opposite sides of the bottom portion 76 of the slurry box 30, co-extensively with the base plate 78. An elongate shim 86 and a plurality of spaced apart fasteners 88 (preferably bolts) affix the wear strips 79,80 to the adjacent, superposing portion of the base plate 78.

The tolerances between the respective edge portions of the belt 32 and the slots 81, 82 are to be minimized so as to promote sealing of the bottom portion 76 of the chamber box 30. However, the fit between the belt 32 and the slots 81,82 should not be so tight as to foment binding of the endless belt 32 in the slots 81, 82. In the preferred embodiment, these countervailing considerations are met when the slots 81, 82 are configured to present a 1/16 inch total clearance tolerance in a width-wise direction across the endless belt 32. In the direction normal to the plane of the belt, the belt has preferably a thickness 0.020 inch, whereas the slots 81, 82 are 0.023 inch deep. These relationships achieve the desired balance of proper sealing and the

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need for facile passage of the belt 32 through the bottom portion 76 of the chamber box 30.

Preferably, the wear strips 79, 80 are constructed from ultra high molecular weight polyethylene or Dalron.

5 Included within the confines of the chamber box 30 are beveled inserts 89, 90 which extend along and fill the corners defined between the base plate 78 and each of the vertical walls 91, 92 of the chamber box 30. The inserts preferably present a 45 degree incline from the vertical walls 91, 92 toward the central slot 84 of the base plate 78. This arrangement avoids stagnation of fluid in the confines of
10 the chamber box 30, which would otherwise tend to accumulate the solid content of the slurry and possibly clog the chamber box 30 and the orifices 44 of the endless belt 32.

Near the bottom portion 76 of the chamber box 30, a plurality of spaced-apart pressure ports 94 communicate the pressure monitoring system 62 with the
15 interior of the slurry box 30. A detailed discussion of the pressure monitoring system 62 can be found in commonly assigned U.S. Patent No. 5,997,691, the disclosure of which is hereby incorporated by reference.

Along the upper portion of the chamber box 30, a plurality of spaced-apart feed ports 96 are located along the vertical wall 91. The feed ports 96 communicate
20 the flow distribution system 60 with the interior of the slurry box 30. Preferably, the feed ports 96 are located close to the lid plate 31 of the chamber box 30. A detailed discussion of the flow distribution system 60 can be found in commonly assigned U.S. Patent No. 5,997,691, the disclosure of which is hereby incorporated by reference.

25 The feed ports 96 are spaced vertically by a distance (h) above where the endless belt 32 traverses through the bottom portion 76 of the chamber box 30. The feed ports 96 introduce slurry into the chamber box 30 in a substantially horizontal direction. The vertical placement and the horizontal orientation of the ports 96 dampens vertical velocities in the fluid at or about the region of endless belt 32 at

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the bottom portion 76 of the chamber box 30. The arrangement also decouples the discharge flows 40 through the orifices 44 from the inlet flows at the feed ports 96.

The height (h) in the preferred embodiment is approximately 8 inches or more; however, the vertical distance (h) between the feed ports 96 and the endless belt 32 may be as little as 6 inches. With greater distances (h), there is lesser disturbance and interaction between the fluid adjacent the endless belt 32 and the fluid conditions at the feed ports 96.

In order to obtain uniform pressure on the slurry across the slurry box 30, the number of feed ports 96 can be adjusted accordingly. In the embodiment described above, the number of feed ports 96 amounted to twelve (12), but the invention is workable with as fewer or more inlet feed ports 96. The number of feed ports 96 depends upon the width of the paper making machine in any particular application. While a preferred spacing between the feed ports 96 is approximately 12 inches, larger or smaller spacings can be used, e.g., 8 to 24 inches.

Referring now to Fig. 5, each of the orifices 44 along the endless belt 32 includes a beveled portion 45 adjacent the side of the endless belt 44 facing into the chamber box 30. By such arrangement, the solids content of the slurry is not allowed to collect at or about the orifices 44 during operation of the applicator 10. More particularly, slurry fiber is not allowed to collect about the orifice and deflect the jets of slurry being discharged. Accordingly, the beveled portions 45 of the orifices 44 promote consistent delivery of slurry from the applicator 10 and reduce malfunctions and maintenance.

Referring now to Fig. 6, in an alternate embodiment of the chamber box 30', the vertical walls 91', 92', together with the base plate 78' and inclined beveled elements 89', 90' cooperate with retractable armatures 100, 101 which at their operative end portions support an elongate wear strip 79', 80'. The elongate wear strips extend the length of the chamber box 30' and are supported at spaced locations along each side of the chamber 30' by the retractable armatures 100 and 101. In this embodiment, the wear strips 79' and 80' are mounted upon and are

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retractable with the armatures 100 and 101, respectively. In Fig. 6, a plurality of armatures 100 along one side of the chamber box 30 are shown in a retracted position, while the opposed armatures 101 along the opposite side of the chamber box 30' are shown in an engaged position, where the respective wear strip 80' is
5 biased against the base plate 78'. In actual operation, the armatures 100 and 101 are pivoted between the retracted and engaged positions simultaneously.

Each retractable armature 100, 101 is pivotally mounted upon one or a pair of vertical flanges 106, which preferably provides support for an actuator mechanism 107 for moving the retractable armature 100, 101 from an operative,
10 engaging position where the wear strips 79', 80' are urged against base plate 78' to a retracted position where the wear strips 79', 80' are spaced away from the base plate 78' and the endless belt 32'. The actuator mechanism 107 is preferably an air cylinder 108 which is operatively connected to the pivot arms 109, 110 of the armatures 100 and 101, respectively. Other mechanical expediciencies could be
15 selected for pivoting the retractable armatures 100 and 101, as would be readily apparent to one of ordinary skill in the art upon reading this disclosure.

An elastomeric seal 104 is provided between the lower portions of the chamber box walls 91', 92' and the base plate 78' so as to create a fluid-proof seal about the entire periphery of the base plate 78'.

20 In operation, all of the armatures 100, 101 along both sides of the chamber box 30' are pivoted simultaneously so that the wear strips 79', 80' are moved as units to and from their operative and engaged positions. The retractable armatures 100, 101 facilitate quick and speedy maintenance, repair and/or replacement of the endless belt 32', the wear strips 79', 80' and the base plate 78'.

25 Referring now to Fig. 2, after progressing through the chamber box 30, the endless belt 32 enters the cleaning box 42 which is arranged to sweep away any entrained slurry that may have been carried from the box 30 by the belt 32. Preferably, the cleaning box 42 is supported from the planar frame member 72 by a bracket 110 and includes an upper and lower plate which are connected to one

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another so as to be biased toward each other by a spring so as to create a moderate positive clamping action toward the belt 32. Further details of the cleaning box can be found in commonly assigned U.S. Patent No. 5,997,691, the disclosure of which is hereby incorporated by reference.

5 The preparation of the slurry for the production of the cigarette paper using the moving orifice applicator 10 can include cooking of flax straw feed stock, preferably using the standard Kraft process that prevails in the paper making industry. The cooking step is followed by a bleaching step and a primary refining step. The preferred process includes a secondary refining step before the majority of
10 the refined slurry is directed to the run tank 8 of the headbox 4. Preferably, both refining steps are configured to achieve a weighted average fiber length in the flax slurry of approximately 0.8 to 1.2 mm, preferably approximately 1 mm. Preferably, a chalk tank can be communicated with the run tank 8 so as to establish a desired chalk level in the slurry supplied to the headbox .

15 Preferably, a portion of the slurry from the second refining step is routed to a separate operation for the preparation of an add-on slurry for application by the moving orifice applicator 10. This operation begins with the collection of refined slurry in a recirculation chest wherefrom it is recirculated about a pathway including a multi-disc refining step and a heat exchanging step before returning to the
20 circulation chest. Preferably, in the course repeating the refining step and the heat exchanging step, heat is removed from the slurry at a rate sufficient to prevent a runaway escalation of temperature in the slurry, and more preferably, to maintain the slurry at a temperature that is optimal for the refining step, in the range of approximately 135 to 1450°F, most preferably approximately 1400°F for a flax
25 slurry. The add-on slurry is recirculated along this pathway of steps until such time that the add-on slurry achieves a Freeness value of a predetermined value in the range of approximately -300 to -900 milliliter °Schoppler-Riegler (ml °SR). The upper end of the range is preferable (near-750 ml °SR).

An explanation of negative freeness values can be found in "Pulp

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Technology and Treatment for Paper”, Second Edition, James d’ A. Clark, Miller Freeman Publications, San Francisco, CA (1985), at page 595.

Upon completion of the recirculation operation, the extremely refined add-on slurry is ready for delivery to the day tank 12 associated with the moving orifice applicator 10, wherefrom it is distributed along the length of the chamber box 30 of the moving orifice applicator as previously described. However, it is usually preferred to undertake a further recirculation step wherein the add-on slurry is recirculated from the second chest again through the heat exchanger with little or no further refining so as to achieve a desired final operational temperature in the add-on slurry (preferably, approximately 95°F) prior to delivery to the day tank 12 and the applicator 10. Accordingly, the heat exchanger is preferably configured to serve at least dual purposes, to maintain an optimal temperatures in the add-on slurry as it is recirculated through the refiners and to remove excess heat in the add-on slurry at the conclusion of refining steps in anticipation of delivery to the applicator 10.

The second slurry chest also accommodates a semi-continuous production of slurry.

Preferably, the multi-disc refining of the recirculation pathway is performed using refiners such as Beloit double multi-disc types or Beloit double D refiners. The heat exchangers used in the recirculation pathway avoid the build-up of heat in the slurry which might otherwise result from the extreme refining executed by the multi-disc refiners. Preferably, the heat exchanger is a counter-flow arrangement such as a Model 24B6-156 (Type AEL) from Diversified Heat Transfer Inc. For the preferred embodiment, the heat exchanger is configured to have a BTU rating of 1.494 MM BTU per hour.

Fines levels in the add-on slurry range from approximately 40-70% preferably about 60%. Percentiles of fines indicate the proportion of fibers of less than 0.1 mm length.

Preferably, the slurry that is supplied to the head box 4 (the “base sheet slurry”) is approximately 0.5% by weight solids (more preferably approximately

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0.65%); whereas the slurry that is supplied to the moving orifice applicator 10 (the “add-on slurry”) is preferably at approximately a 2 to 3% by weight solids consistency. For flax pulp, the Freeness value of fibers in the base sheet slurry at the head box 4 is preferably in the range of approximately 150 to 300 ml °SR, whereas the add-on slurry at the chamber box 30 is preferably at a Freeness value in the range of approximately -300 to -900 ml °SR, more preferably at approximately -750°SR. Preferably, the solids fraction of the base sheet slurry is approximately 50% chalk and 50% fiber, whereas in the add-on slurry, the relationship is 0 to 10% chalk and 90% or more fiber. Optionally, the add-on slurry may include a 5 to 20% chalk content, preferably a Multiflex that is obtainable from Speciality Minerals, Inc. or the add-on material can be chalk-free.

As previously described in reference to Fig. 1A, the add-on slurry is applied to the base web by the applicator 10, whereupon water is further removed and the sheet is dried upon passage through the drying felts 26. Referring now also to Fig. 1B, at the conclusion of the paper making process, a paper is constructed having a base sheet portion 3 and a plurality of uniformly applied, uniformly spaced, mutual parallel banded regions 5 of highly refined add-on cellulosic material of weighted average fiber length in the range of approximately 0.15 mm to 0.20 mm. In these banded regions 5, the cigarette paper has a reduced air permeability in comparison to that of the regions of the base sheet 3 between the banded regions 5. Referring now also to Fig. 1C, the paper is wrapped about a column of tobacco to form the tobacco rod of a cigarette 7, which will at the banded regions exhibit a slower burn rate in comparison to those regions of the base sheet 3 between the banded regions 5.

The operation of the cigarette paper making machine and method of the preferred embodiment has been described with respect to flax feedstock. The apparatus and associated methodologies are readily workable with other feedstocks such as hardwood and softwood pulps, eucalyptus pulps and other types of pulps used in the paper making industry. The alternate pulps may have different characteristics from flax, such as differences in average fiber length, which may

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necessitate adjustment of the degree of refining in the preparation of the base sheet slurry with some pulps. With an alternative pulp, it may be acceptable to skip one or both of the refining steps, particularly if the pulp exhibits a very short average fiber length in comparison to flax. However, in order for the preparation of the add-on
5 slurry to progress satisfactorily, the slurry which is to be diverted to the recirculation chest should exhibit an initial weighted average fiber length approximating that previously described for the refined flax base sheet slurry, that is, having a weighted fiber length of approximately 0.7 mm to 1.5 mm and more preferably approximately 0.8 mm to 1.2 mm. With these alternative pulps, the add-on slurry is recirculated
10 through the refining step and the heat exchanging step until a comparable desired Freeness value is obtained (in the range of -300 to -900 ml °SR, preferably approximately -750 ml °SR). As with flax, the extreme degree of refining of the add-on slurry avoids fiber build-up at or about the orifices 44 of the belt, which in turn avoids jet deflections at the orifices 44.

15 Because the flow of the fluid stream 40 emanating from each orifice 44 as the orifice 44 passes along the bottom portion of the chamber box 30 is proportional to the pressure differential across the orifice 44, it is desirable that fluid pressure be established and then held as uniformly as possible along the entire journey of each orifice 44 along the bottom portion 76 of the chamber box 30. Details of suitable
20 flow controls of the slurry add-on material can be found in commonly assigned U.S. Patent No. 5,997,691, the disclosure of which is hereby incorporated by reference.

It will be apparent from the foregoing that the invention provides a slotted orifice device for use in applying banded regions to a sheet of material such as a sheet of cigarette paper during high speed production of the sheet. The slotted
25 orifice device can be used with large-capacity (e.g., widths of 8 feet and greater) papermaking machines which tend to operate at high machine speeds (e.g., over 800 feet/minute).

In a preferred embodiment, the slurry applicator 10 includes a slotted belt 202. The slotted belt 202 discharges slurry from beneath the chamber box 30 as

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spaced apart bands across a sheet of cigarette paper with the bands extending transversely (preferably perpendicularly) to the travel direction 16 of the base web of the paper. The slotted belt includes slots which are spaced apart and parallel to each other. For example, the slots are preferably inclined relative to a direction of travel
5 of the belt, e.g., the slots 200 can be elongated so as to define a longitudinal axis 203 in directions forming an angle (designated 205) of 15 to 75°, preferably 25 to 65° with respect to the travel direction of the belt (or center line cl of the belt). The slots preferably have the same size and are preferably at the same angle with respect to the direction of belt travel. The slot dimensions may be tailored to execute various
10 applications by selecting total area of an orifice sufficient to achieve a desired flow rate at desired operational pressure and by selecting an orifice width that provides a desired band width at the same desired flow rate and desired operational pressure.

In general, the slots can be identical in size and parallel to each other. A preferred slot length is approximately 1/16 to 3/16 inch and a preferred slot width is
15 approximately 1/16 to 3/32 inch. As an example, to make 3 to 10 mm wide bands such as 5 to 6 mm wide bands on a base web of a paper sheet traveling at speeds of 800 feet/minute and higher on a Fourdrinier wire, the slots can have dimensions of 2/32 inch by 4/32 inch. Further, in order to provide bands perpendicular to the travel direction of the base web, the slotted orifice device is preferably oriented at an angle
20 to the travel direction of the base web such that the slotted belt travels in a direction which deposits the bands perpendicular to the travel direction of the base web.

Figs. 7A, 7B and 7C show details of an exemplary slotted belt arrangement wherein Fig. 7A shows a top view of a belt having a plurality of slotted holes, Fig. 7B shows a top view of an individual slotted hole and Fig. 7C shows a cross-
25 sectional side view of the slotted hole shown in Fig. 7C. In an exemplary embodiment, the slotted holes 200 in Fig. 7A are spaced apart by about 1 inch (e.g., 27 mm), the long axis of the holes are angled at about 25 to 30° (e.g., 27°) with respect to the centerline "CL" of the belt, and located along the center line of a 2 inch wide stainless steel belt 202. As shown in Fig. 7B, each hole 200 can include

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parallel side walls 204, 206 and semi-circular end walls 208, 210. In the exemplary embodiment, the holes are tapered by wall 212 which extends 0.01 inch to one-half the thickness of the 0.02 inch thick belt, as shown in Fig. 7C and the holes have a length of 0.125 inch and a width of 0.063 inch.

5 In operation of the slurry applicator 2, the centerline CL of the belt 202 is arranged at an angle with respect to the direction 16 of the base web, and that angle and the relative speeds of the Fourdrinier wire and the belt 202 are selected such that each band 40 of add-on material is applied in a transverse direction, preferably at a 90 degree angle to the base web direction 16. Preferably, the longitudinal axis 203
10 ("length") of each slot 200 is oriented at essentially the same angle (designation 205 in Fig. 7A) with respect to the centerline CL of the belt 202 such that the longitudinal axis 203 aligns with (is parallel to) the aforementioned transverse direction of the band 40 being created by the flow of add-on material from the slot 200 onto the base web. Accordingly, the length of the slots 200 are aligned with the
15 cross-machine direction of the bands 40.

 The slotted belt can provide advantages over a belt having round holes in that bands of desired width at increased levels of add-on weight can be applied to a sheet traveling at high speed. If higher add-on weight is desired while maintaining a desired band width, the slots can be made longer in the direction of its longitudinal
20 axis 203 of the slots 200. If wider bands are desired, the slots can be made wider in a direction transverse to the longitudinal axis 203. Conversely, if narrower bands are desired, the slots can be made narrower. The slots are preferably tapered (chamfered) so as to become more narrow in a direction facing away from the hopper (e.g., 40 to 80° taper, preferably 60° taper) and the ends of the slots are
25 preferably rounded to minimize clogging of the slurry passing through the slots.

Example I

Three runs were carried out using slurry flow rates of 4.7, 3.7 and 5.7 gallons/minute with a round holed belt and a slotted hole belt, each belt having the

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same open area of the holes. The perforated belt was a steel belt having 3/32 inch diameter holes tapered 60° and extending therethrough. The slotted belt included 60° tapered 2/32 by 4/32 inch slots located at an angle of 27° to the direction of travel of the belt. The slurry passing through the circular holes and slotted holes formed bands on grade 603 cigarette paper having a basis weight of 25 grams/m², 33 corresta unit, and 28% filler. The slurry add-on material had a solids content of 2.59%, a freeness value of -740 ml °SR, 61.73% fines, 21 "FLI" and 0% Albacar chalk. Both belts were located 0.75 inch above the Fourdrinier wire. As a result of these tests, it was surprisingly discovered that the slotted belt provided a reduction in band width of about 8 to 10% compared to the round holed belt.

Table 1

Belt Design		Belt with Holes (3/32") dia)			Belt with Slots (2/32 x 4/32")		
Variant #		<u>328</u>	<u>328A</u>	<u>328B</u>	<u>328C</u>	<u>328D</u>	<u>328E</u>
Target Stock Flow	gpm	4.7	3.7	5.7	4.7	3.7	5.7
Actual Stock Flow	gpm	4.65	3.70	5.74	4.63	3.68	5.62
Pressure	Inch (Water)	9.5	6.7	13.1	8.5	6.0	11.3
Band Width							
Average	mm	5.72	4.74	6.70	5.28	4.44	6.03
Standard Deviation		0.37	0.38	0.38	0.44	0.44	0.46
Band Permeability							
Average	CU	8.03	10.2	9.4	8.4	9.1	9.0
Standard Deviation		2.32	2.11	2.28	1.40	2.10	1.35

Example II

A high speed trial was conducted using the following three slotted belt designs wherein the slots were oriented at 45° to the travel direction of the belt:

- A. 2/32 x 1/8 inch area = 1 x 3/32 inch diameter hole
- B. 1/32 x 2/8 inch area = 1 x 3/32 inch diameter hole
- C. 1/32 x 3/8 inch area = 1.5 x 3/32 inch diameter hole

As a result of the test, it was determined that as slot width decreases (e.g.,

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from 2/32 inch to 1/32 inch), the width of the resulting bands also decreases.

While the invention has been described in detail with reference to specific
embodiments thereof, it will be apparent to those skilled in the art that various
changes and modifications can be made, and equivalents employed, without
5 departing from the scope of the appended claims.

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What it claimed is:

1. A method of manufacturing a web having an applied pattern of add-on material, the method comprising the steps of:
 - moving a base web along a first path;
 - 5 preparing a slurry of add-on material;
 - repetitively discharging the add-on slurry upon the moving sheet of base web by establishing a reservoir of the add-on slurry across the first path and moving a belt having at least one slotted orifice along an endless path, said belt moving step including the step of moving said belt along a first portion of said
 - 10 endless path where said orifice is communicated with said reservoir so as to discharge said add-on slurry from said reservoir through said orifice onto said base web as said slotted orifice traverses said first path portion.
2. The method as claimed in claim 1, wherein the slotted orifice
- 15 includes parallel side edges joined by arcuate end edges, the add-on slurry being discharged from the slotted orifice as a non-circular stream.
3. The method as claimed in claim 1, wherein the at least one slotted orifice comprises a plurality of spaced apart slotted orifices, the add-on slurry being deposited as a plurality of streams simultaneously traveling across the moving sheet
- 20 of base web.
4. The method as claimed in claim 1, wherein the slotted orifice is tapered, the slurry entering the slotted orifice at a wider portion thereof and exiting the slotted orifice at a narrower portion thereof.
5. The method as claimed in claim 1, wherein the add-on slurry is
- 25 applied to the moving sheet of base web as bands of add-on slurry having band

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widths of 3 to 10 mm.

6. The method as claimed in claim 1, wherein the moving sheet of base web is traveling at a speed of 1000 to 3000 feet/minute.

7. The method as claimed in claim 1, wherein the add-on slurry is deposited as bands of add-on slurry on the moving sheet of base web, the bands extending perpendicular to the direction of travel of the moving sheet of base web.

8. The method as claimed in claim 1, wherein the add-on slurry has a 2 to 3% by weight solids content with at least 40% of the fibers therein less than 0.1 mm in length.

9. The method as claimed in claim 1, wherein the add-on slurry has a Freeness value of -300 to -900 ml °SR.

10. The method as claimed in claim 1, wherein the add-on slurry has a weighted average fiber length of 0.15 to 0.20 mm.

11. The method as claimed in claim 1, further comprising preparing cigarette wrapping paper by drying the moving sheet of base web with add-on slurry thereon, and manufacturing a cigarette by wrapping a tobacco rod with the wrapping paper.

12. The method as claimed in claim 1, wherein the base web comprises a base web of fibrous cellulosic material and the add-on slurry comprises a highly refined form of said cellulosic material, said highly refined cellulosic material having a weighted average fiber length in the range of approximately 0.15 mm to 0.2 mm, said fibrous cellulosic material of said base web having a weighted average

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fiber length in the range of approximately 0.7 mm to 1.5 mm.

13. The method as claimed in claim 1, wherein the at least one slotted orifice comprises uniformly spaced apart slotted orifices located along the belt and oriented with a major axis thereof at an angle of 15 to 75° with respect to a direction of travel of the belt.

14. The method as claimed in claim 1, wherein the at least one slotted orifice comprises spaced apart slotted orifices, each of the slotted orifices having a length at least 1.5 times longer than its width and rounded end walls.

15. The method as claimed in claim 1, wherein the at least one slotted orifice comprises spaced apart slotted orifices having the same dimensions, the dimensions providing a desired flow rate of the add-on slurry therethrough to provide a band of predetermined width on the base web.

16. A slurry applicator comprising a chamber box, an arrangement for supplying slurry to the chamber box and an endless belt arranged to pass through a lower portion of the chamber box, the endless belt having at least one slotted orifice, the orifice being optionally beveled on a side of the belt facing into the chamber box.

17. The slurry applicator of claim 16, wherein the chamber box includes sloped elements along an interior of the bottom portion, the sloped elements arranged to direct slurry toward a central portion of the endless belt.

18. The slurry applicator of claim 16, wherein the chamber box includes a plurality of feed ports at spaced locations along an upper portion of the chamber box.

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19. The slurry applicator of claim 16, wherein the at least one slotted orifice comprises uniformly spaced apart slotted orifices located along the belt and oriented with a major axis thereof at an angle of 15 to 75° with respect to a direction of travel of the belt.

5 20. The slurry applicator of claim 16, wherein the at least one slotted orifice comprises spaced apart slotted orifices, each of the slotted orifices having a length at least 1.5 times longer than its width and rounded end walls.

 21. The slurry applicator of claim 16, wherein the at least one slotted
10 orifice comprises spaced apart slotted orifices having the same dimensions, the dimensions providing a desired flow rate of the slurry therethrough to provide a band of predetermined width on a base web traveling beneath the endless belt.

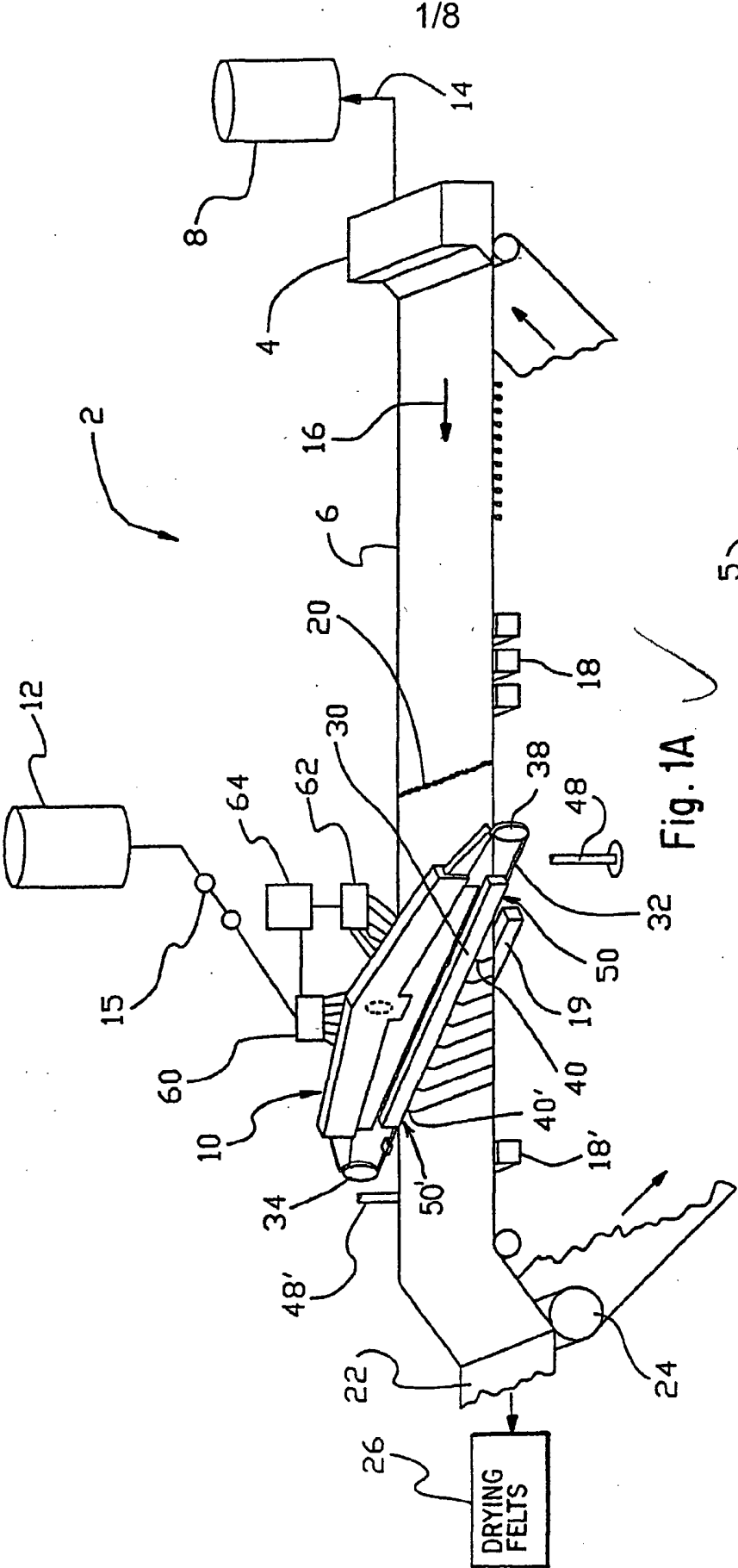


Fig. 1A

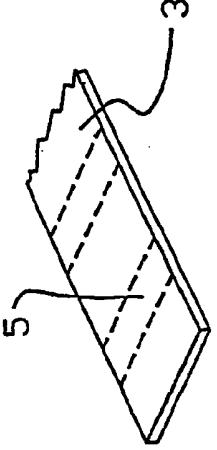


Fig. 1B

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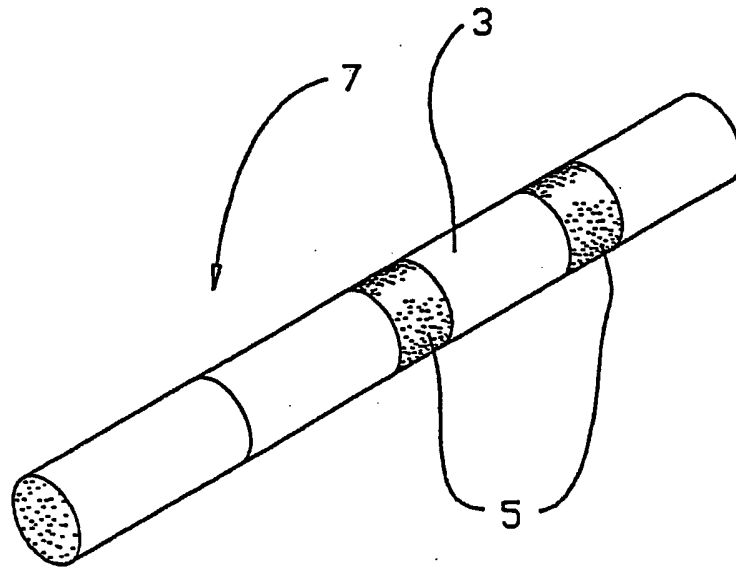


Fig. 1C

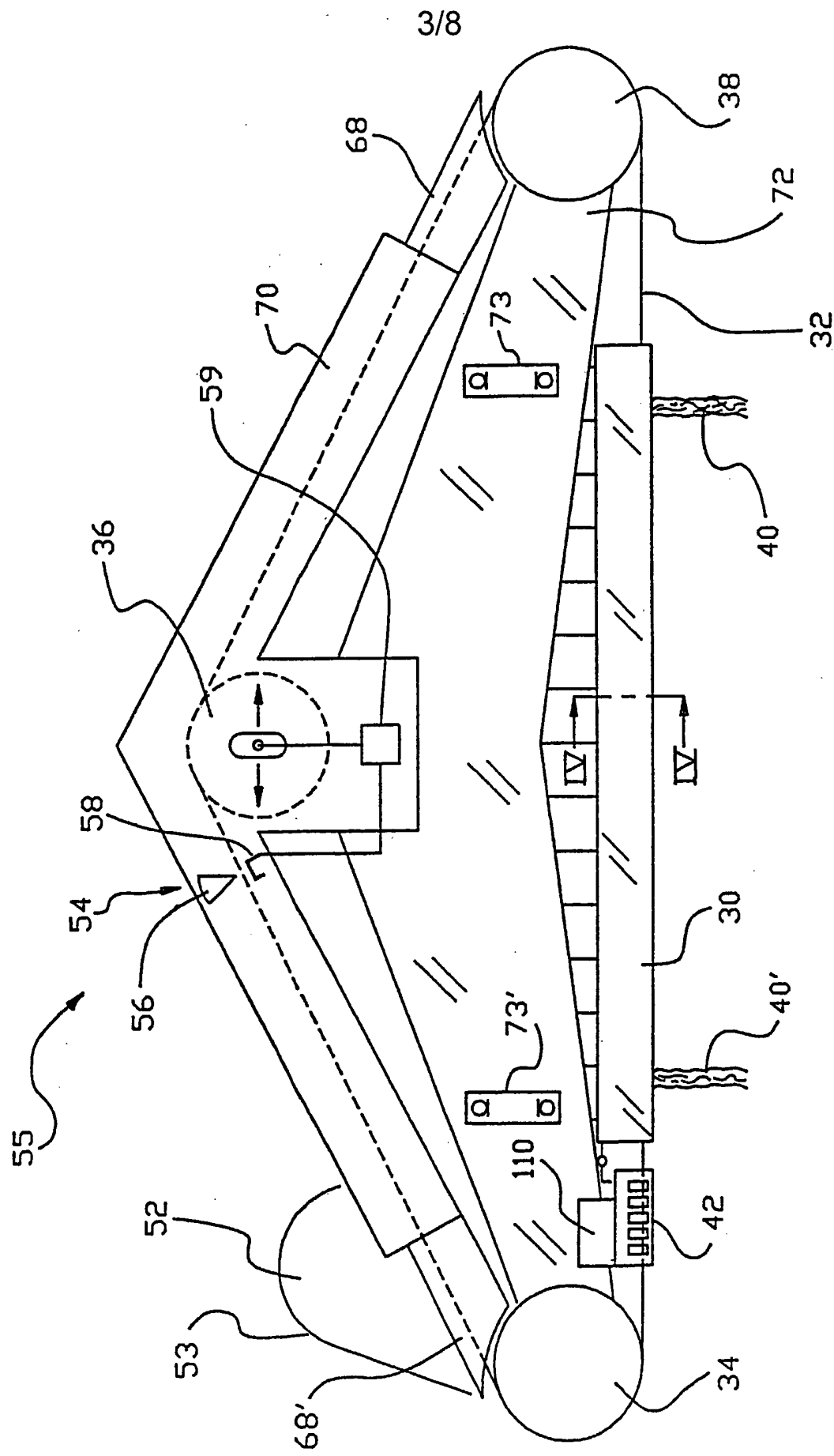
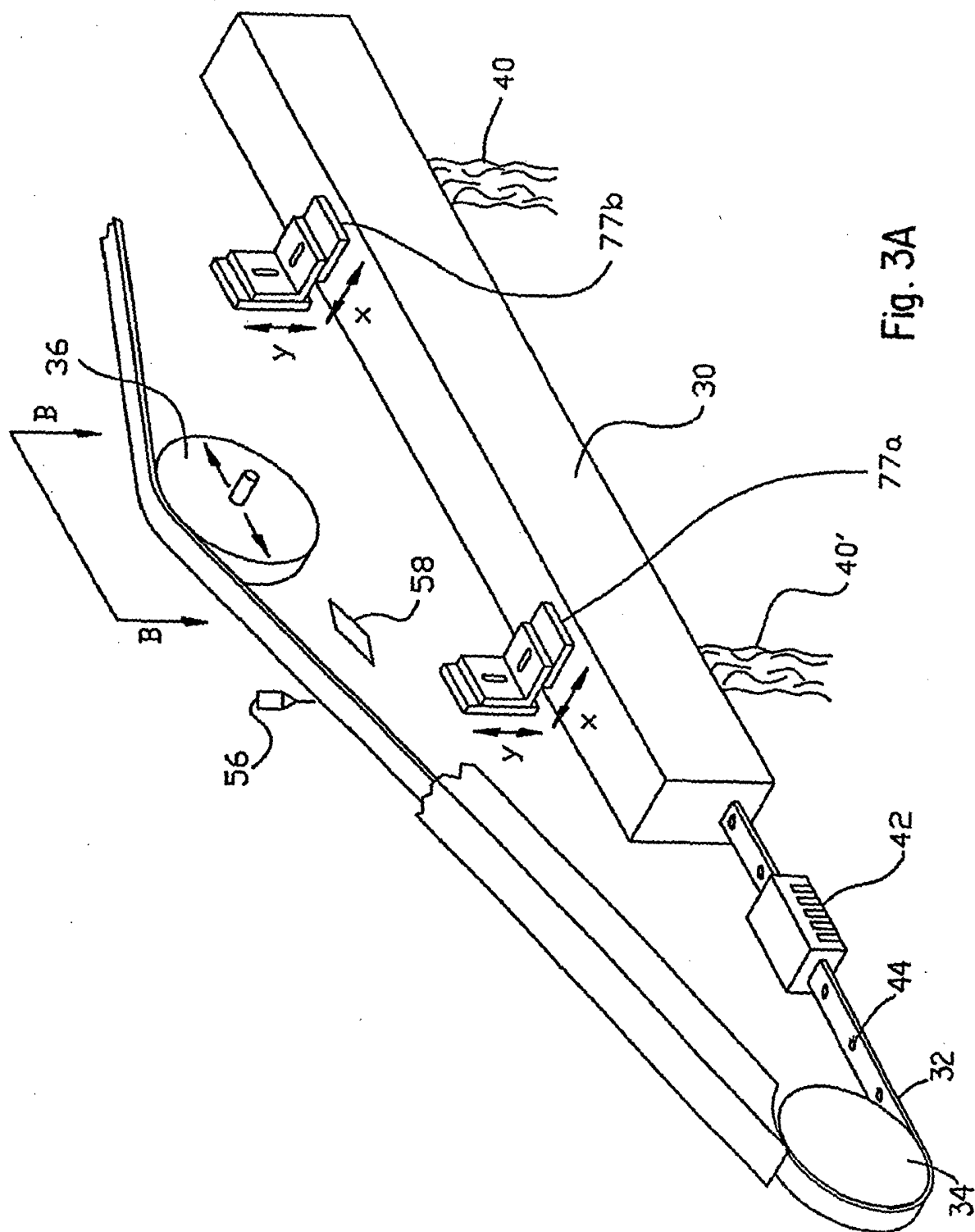


Fig. 2



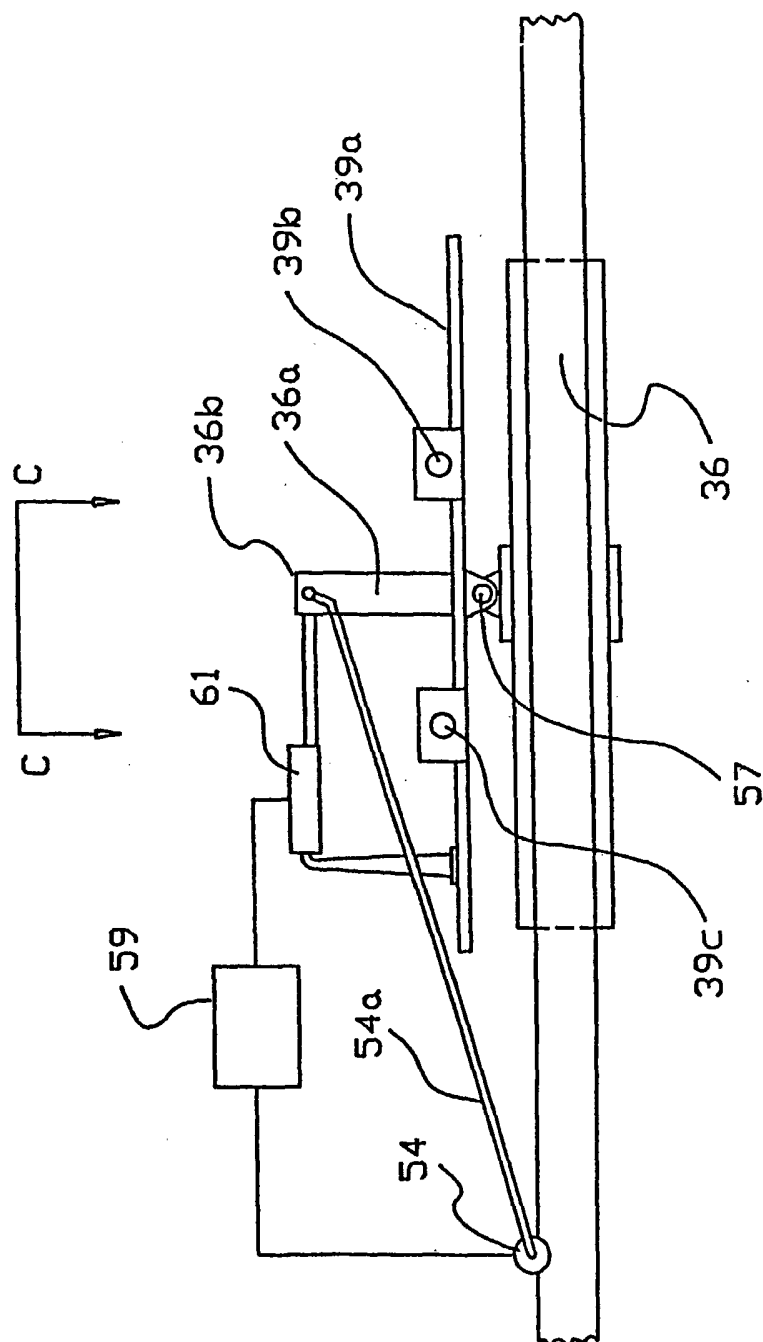
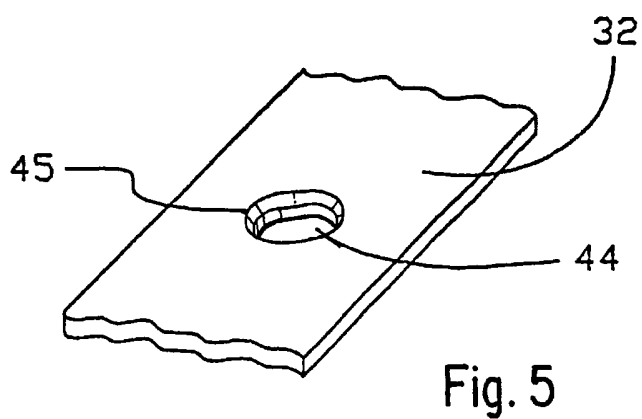
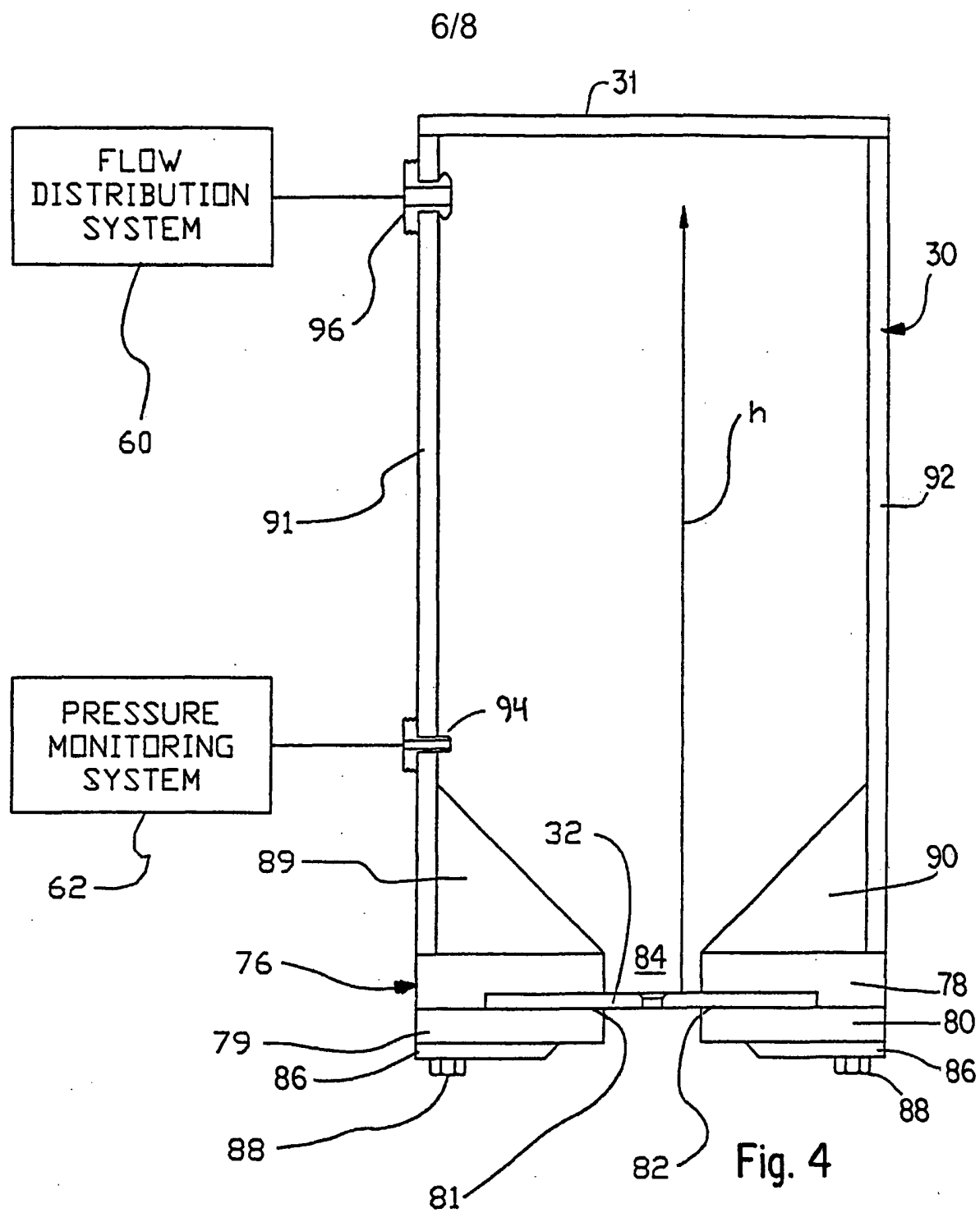
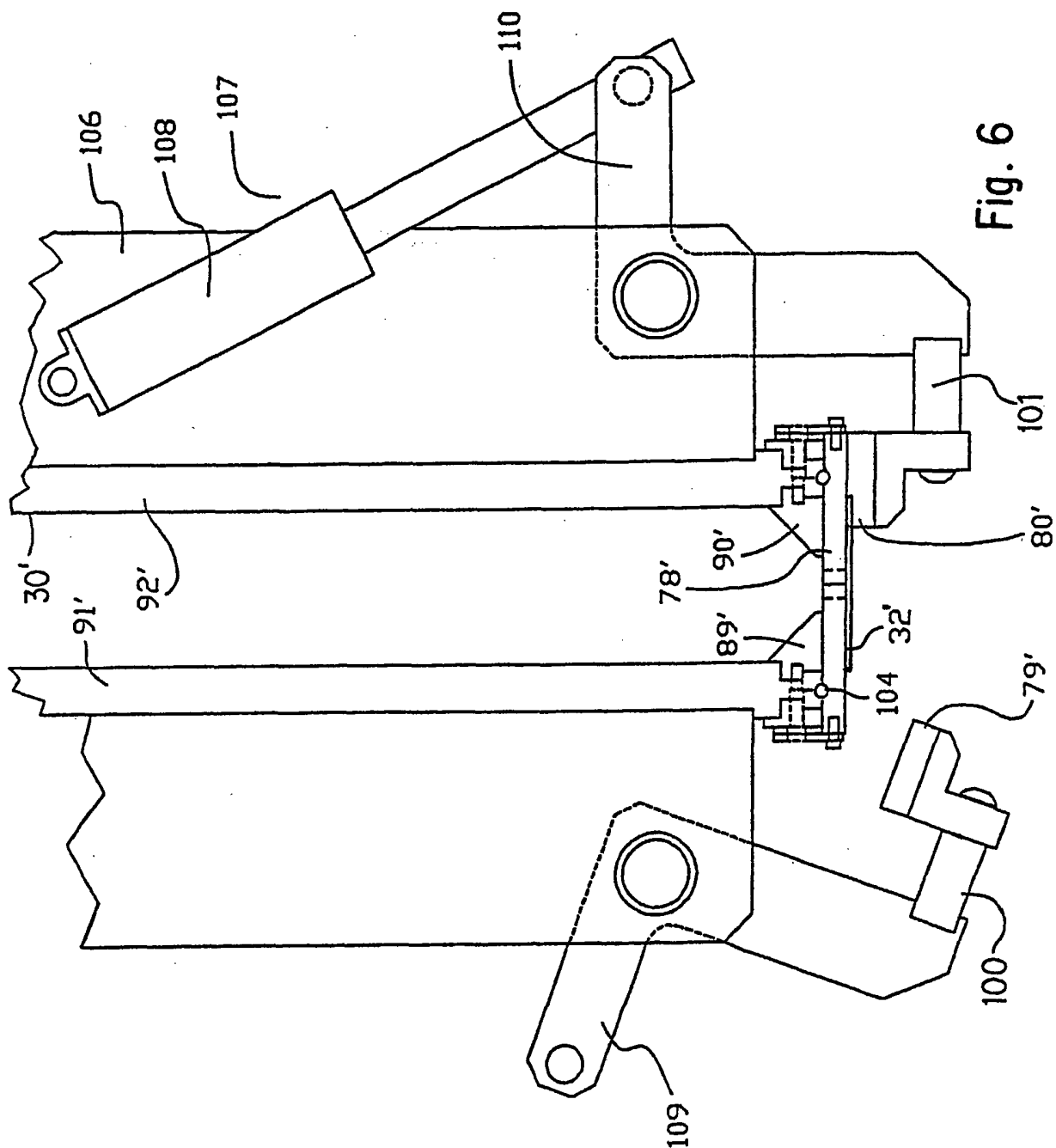


Fig. 3B





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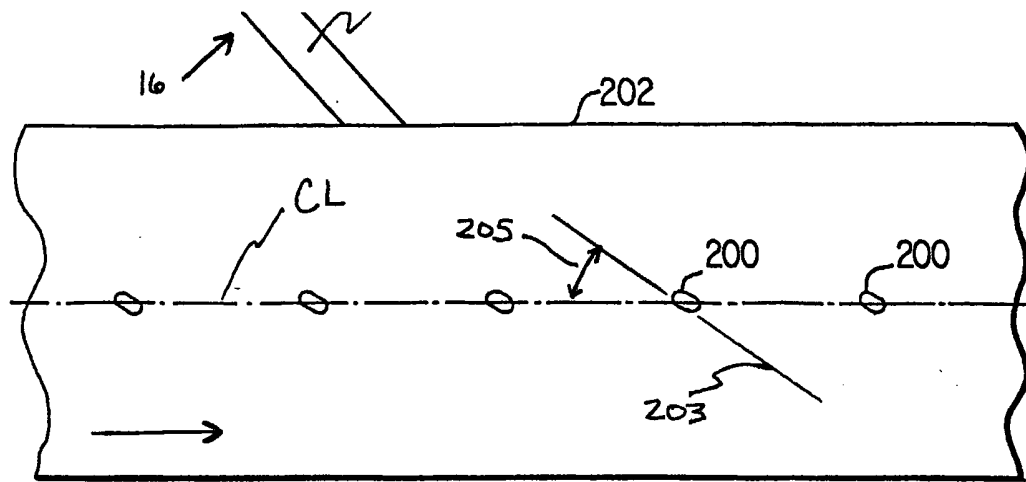


Fig. 7A

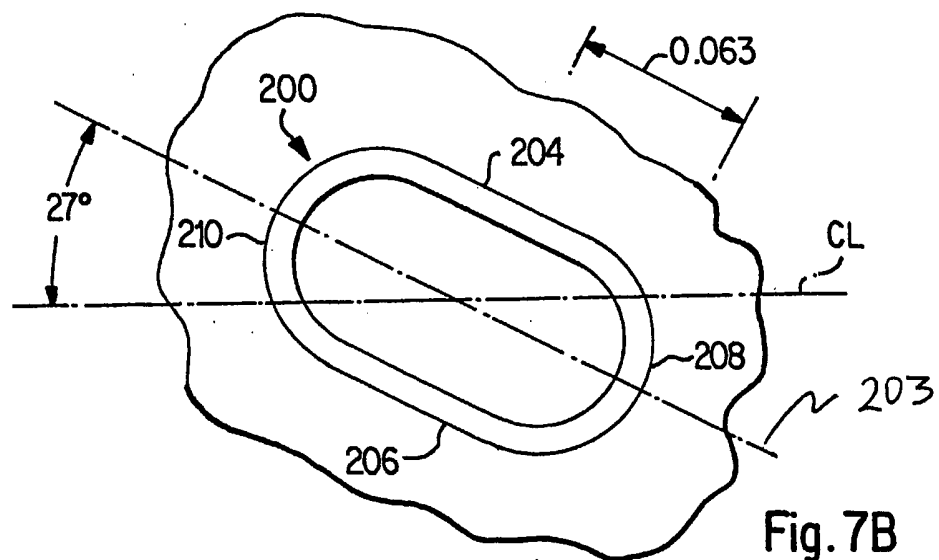


Fig. 7B

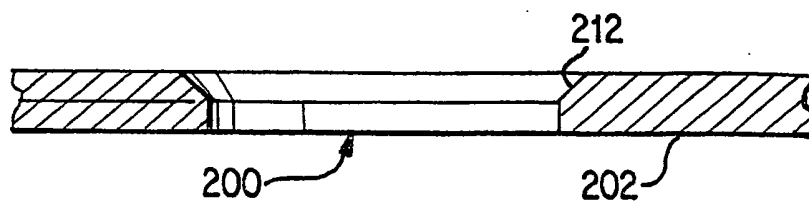


Fig. 7C