July 23, 1968 R. L. SHARP 3,393,661

APPARATUS FOR APPLYING LIQUID TO MOVING SHEETS OF FIBER

Filed April 6, 1967 2 Sheets-Sheet 1

FIG. 1

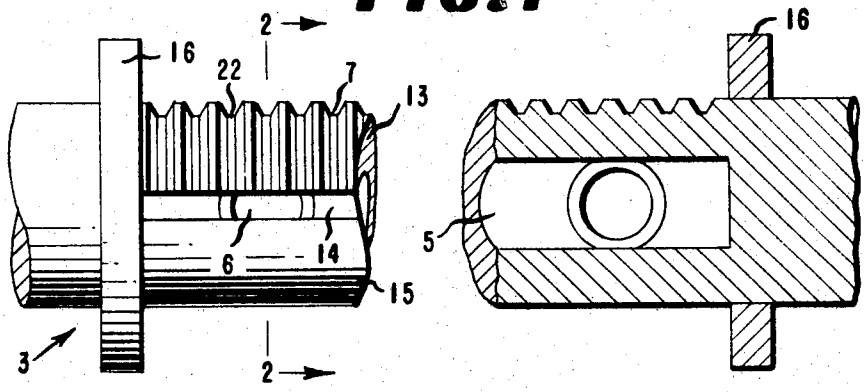


FIG. 2

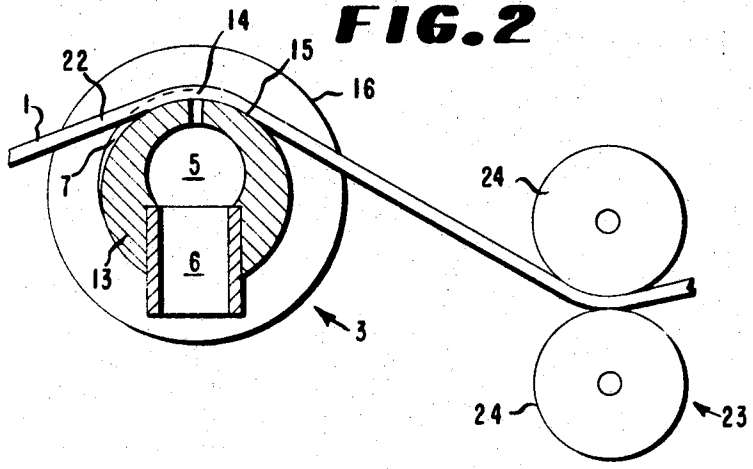


FIG. 3

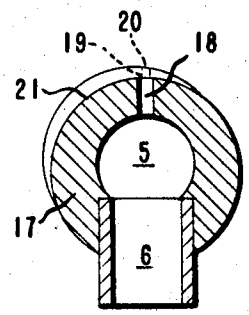
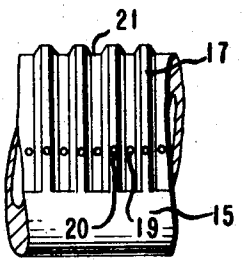


FIG. 4



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FIG. 5

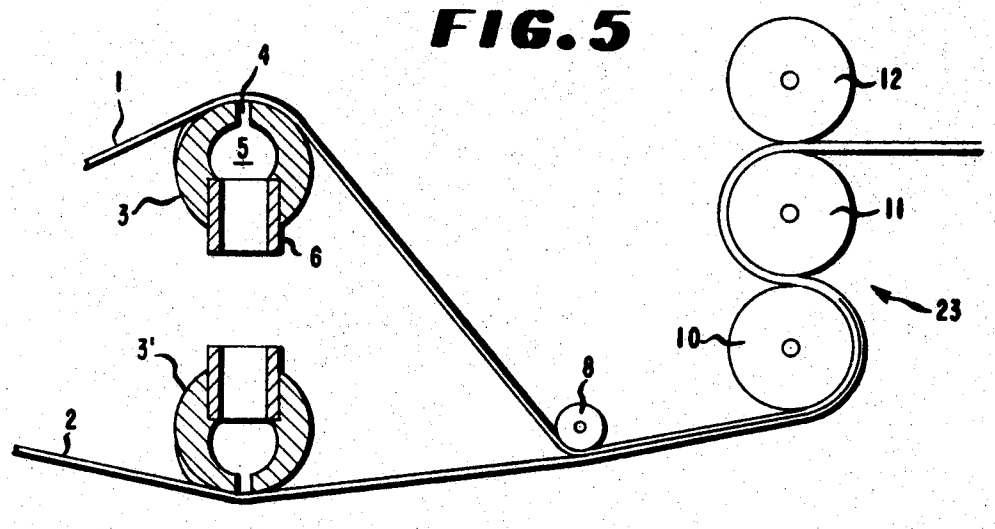


FIG. 6

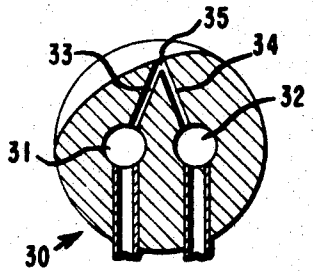
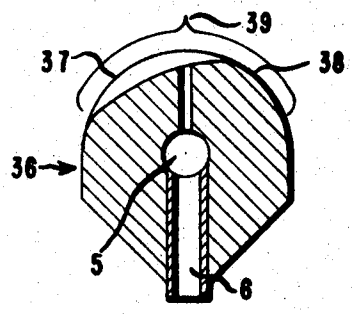


FIG. 7



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3,393,661

APPARATUS FOR APPLYING LIQUID TO MOVING SHEETS OF FIBER

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14 Claims. (Cl. 118—411)

ABSTRACT OF THE DISCLOSURE

Apparatus for applying liquid to moving sheets of fiber comprising a cylinder having grooved and smooth portions. Forwarding means cause the sheet to contact the applicator at the grooved portions. Fluid outlets in the grooved portions, connected to the cylinder's internal conduits, apply liquid to the sheet while the sheet is "opened up" by the grooves. After the fluid is applied, the sheet is transferred away from the cylinder at the smooth portions of the cylinder to minimize filament breakage.

This invention relates to an apparatus for applying liquid to a moving sheet of fibers which opens the sheet for efficient and uniform application of liquids without breaking filaments in the sheet.

Background of the invention

In the application of liquids such as finishes, antistatic agents, and other coating compositions to moving sheets of fibers, the sheet of fibers may be wet thoroughly by passing it through a bath of the liquids; but there is no positive control of the amount of liquid applied to the fiber. To obtain such positive control, Latour described in his U.S. Patent 3,199,492 the method of metering liquid onto a moving sheet of fibers by passing the liquid at a constant rate through a slot in a plate over which the fiber sheet is being passed. However, although application of the liquid may be set at a constant rate on a gross basis by metering, improved uniformity of application on a fiber-to-fiber basis has been desired. Hitherto, when dense sheets of fibers have been treated in this way, a significant portion of the product has frequently been found to have received only a small amount or none of the treating liquid. The liquid may be applied to each side of the sheet of fibers in turn, but penetration to the center of the sheet is difficult. Grooving the slotted applicators to improve penetration by opening the fiber sheet has been proposed, but broken filaments have been a problem with such applicators. This breakage is caused by contact of the sheet with the grooves especially in the passage of the sheet over the grooved surface's outlet means (e.g., a longitudinal slot orifice terminating on the grooved surface) and in the "take-off" of the sheet from the grooved surface.

Statement of the invention

The invention provides an apparatus for applying liquid to moving sheets of fiber. The apparatus comprises at least one cylinder, the outer surface of which has a grooved and a smooth portion. Forwarding means is adapted to move the sheet in contact with the grooved portion (to "open up" the sheet) and to cause transfer of the sheet, after the liquid is applied, away from the cylinder at the smooth portion (to minimize filament breakage). The cylinder has at least one internal conduit which is connected by outlet means with the grooved portion of the outer surface of the cylinder where the outlet means terminate. The internal conduit(s) has at least one inlet port.

The apparatus provides a more uniform liquid distribution due to the grooves' "opening up" the fiber sheet, causing greater penetration of the liquid into the sheet and leveling the liquid flow across the width of the outlet means, and reduces the incidence of broken filaments to a surprisingly low level as compared with applicators grooved around the entire contact area of the fiber sheet.

Preferred embodiments

The cylinder is preferably a right circular cylinder. The term "cylinder" is used herein as defined in its broad sense to comprehend a surface traced by a straight line parallel to another straight line (in particular, the axis of the cylinder). Although a right circular cylinder is preferred, cylinders of other cross-sections may be employed as long as the portion of the cylindrical surface to be in contact with the moving sheet of fibers is essentially a convex arc in cross-section. The convex arc may contain one or more straight sections. The cross-section of the cylinder may be such that the grooved portion of the surface is at a greater distance from the axis of the cylinder than the smooth portion, as in FIGURE 3. Although a cylinder having one grooved portion and one smooth portion is preferred, multiples of such portions on a single cylinder are also suitable. For example, each of two grooved and smooth portion pairs (each pair being provided with outlet means) on the same cylinder could suitably be contacted by the same or separate sheets of fiber. The outlet means would preferably be connected to a common internal conduit and forwarding means would provide the required contact and transfer at each grooved and smooth portion pair. The roots of the grooves preferably form a continuous curve with the smooth portion of the surface of the cylinder. The grooved portions preferably have from 4 to 16 grooves per inch having a groove depth of from 1/32 to 1/4 inch.

The use of one cylinder is preferred in some instances; however, the use of two or more cylinders is preferred in others. For example, two cylinders may be positioned on opposite sides of a sheet of fiber; one cylinder applies liquid to one side of the sheet and the second cylinder applies liquid to the other side of the sheet. In a particularly preferred embodiment (as further shown hereinafter), two separate sheets, after contact with the cylinders are converged together forcing their wetted sides into contact causing liquid in the interior of the converged sheets to pass or diffuse into the exterior portions thereof which further enhances the uniformity of the liquid distribution within the sheets of fiber.

In a preferred embodiment of the apparatus of the invention, the outlet means is a longitudinal slot orifice. It is most preferred that the slot orifice terminate on the surface of the cylinder contacting both the grooved and smooth portions thereof i.e., the slot orifice is at the intersection of these portions. In another preferred embodiment, the outlet means is a plurality of channels terminating in orifices at the grooves. In the latter case it is preferred that the orifices lie in a straight line parallel to the axis of the cylinder and terminate at both the crest and the root of each groove.

Any conventional forwarding means may suitably be used. A great variety of such means will be evident to those skilled in the art. A preferred forwarding means is a pair of driven rolls (or a plurality of pairs of such rolls) which forward the sheet of fiber by the force imparted to the sheet in passing through the nip of the rolls. Such means must cause the sheet to move in contact with the grooved portion of the cylinder and also transfer the said sheet after the liquid has been applied from the cylinder at the smooth portion thereof. The spacial positioning of the forwarding means (e.g., the driven rolls) with respect to cylinders easily provide such con-

tact and transfer. Alternatively guides may be used in conjunction with the forwarding means to provide such contact and transfer by their spacial positioning with respect to the cylinder. Neither the particular "string-up" necessary nor the particular forwarding means used are essential parts of this invention; any may be used as long as the required contact and transfer are provided.

The sheet must contact the grooved portion of the cylinder which is connected to the internal conduit through the outlet means. Although the sheet need not contact the entire grooved portion, it must contact a sufficient portion thereof to pick up the desired amount of liquid. The optimum arc of contact which should be followed depends on factors such as the depth of the grooves, the tension on the sheet, the thickness thereof, as well as the affinity for the particular liquid for the particular fiber. Routine experimentation will determine the optimum contact for a particular use.

The sheet, after the liquid has been applied, must be removed at the smooth portion of the cylinder. In a preferred embodiment of this invention, the sheet contacts the smooth portion of the cylinder (after the liquid has been applied in the grooved portion) and is transferred from the smooth portion. The movement of the sheet over the smooth portion allows for a more adequate pressure build up and forces the liquid into the sheet to a greater extent. In another suitable embodiment, wherein the outlet means terminate on the outer surface of the cylinder where the grooved and smooth portions intersect, the sheet of fiber may be transferred from this point of intersection before it contacts the smooth portion. A smooth transfer is possible because the absence of grooves on one side of the outlet means. It is to be understood that the transfer of sheets from the cylinder "at" the smooth portion is intended to include this embodiment as well as the preferred embodiment which includes the transfer of sheets which were in actual contact with the smooth portion of the cylinder.

The term "smooth" is used herein to indicate an even surface i.e., essentially devoid of surface roughness to minimize filament breakage during transfer from the cylinder. In particular the term is used to characterize the portions of the cylinders not having grooves. While no particular degree of smoothness is considered essential, one skilled in the textile art can adequately choose such smoothness as is necessary to provide a "smooth take-off" in any particular use. An applicator with a polished metal smooth portion is preferred. However, the particular material of construction used is not critical; any substance which can be forged, molded, etc., into a cylinder as described (e.g. grooved and smooth portions, internal conduit) is suitable.

In another preferred embodiment the cylinder has at least two internal conduits with outlet means separately connecting each of the conduits with the cylinder's grooved portion. These separate connections preferably provide a single orifice which conveniently allow for the application of two or more liquids which are not in contact until applied to the sheet.

The liquid(s) is delivered at a uniform predetermined rate by a means such as a positive displacement pump. The pump is preferably actuated by the same signal which actuates the means for forwarding the sheet of fibers into and away from the apparatus, so that no liquid is delivered when the sheet of fibers is not moving.

In other preferred embodiments, various additional features are present in the apparatus. It is preferred that the apparatus include guide means, such as collars at each end of the outlet means, to limit the spread of the fiber sheet to the width of the outlet means.

Drawings

The deails of the apparatus of the invention will be more clearly apparent by reference to the following detailed description when taken in connection with the accompanying drawings, in which:

FIGURE 1 is a broken top view of one preferred cylinder of the invention, with the right-hand portion of the cylinder seen in cross-section;

FIGURE 2 is a cross-sectional view **2—2** of the cylinder of FIGURE 1 in conjunction with the other apparatus elements;

FIGURE 3 is a cross-sectional view of a modification of the cylinder shown in FIGURES 1 and 2, wherein the outlet means is a plurality of channels terminating in orifies;

FIGURE 4 is a top view of a portion of the cylinder of FIGURE 3;

FIGURE 5 is a preferred illustration of this invention where two cylinders are employed as shown in FIGURES 1 and 2;

FIGURE 6 is a cross-sectional view of a modified version of a grooved cylinder adapted for supplying two different liquids; and

FIGURE 7 is a cross-sectional view of a modified cylinder.

Considering each of the figures more specifically FIGURE 1 is a top view of a preferred embodiment of an applicator **3** comprised of cylinder **13** with an outlet means **14** shown as a longitudinal slot parallel to its axis. A portion **22** of the cylinder's surface contains grooves **7** on the side of the slot upon which the sheet of fibers is led in across the slot. A smooth portion **15** is provided on the other side of the slot, i.e., the side from which the sheet of fibers is taken off after passing in contact with the slot. The right-hand portion of the cylinder is seen in cross-section, illustrating interior conduit **5** having an inlet port **6**. Collars **16** limit the spread of the sheet of fibers to the width of the longitudinal slot.

FIGURE 2 illustrates a sheet of fibers **1** being passed over applicator **3** (shown as a cross-sectional view **2—2** of the cylinder of FIGURE 1) for applying liquid. Liquid is applied to the moving sheet of fibers from outlet means **14**, the liquid being delivered by way of interior supply chamber **5** from inlet port **6**. The fiber sheets are opened by grooves **7** as the sheet passes in contact with the outlet means **14**. The forwarding means **23** illustrated as a pair of driven rolls **24** is spacially positioned to cause the sheet of fibers **1** (from a source not shown) to move in contact with the grooved portion **22** and to be transferred, after liquid application, away from the cylinder at the smooth portion **15**. (In the embodiment shown the sheet **1** is also caused to contact the smooth portion **15** prior to transfer.)

FIGURES 3 and 4 illustrate a suitable cylinder **17** having another type of outlet means. The cylinder is similar to the cylinder previously described except that the outlet means comprises channels **18** terminating in orifices **19** at the roots and orifices **20** at the crests of the grooves **21**, which in this embodiment extend slightly past the outlet means.

FIGURE 5 illustrates a preferred embodiment where two cylinders are used. A sheet of fibers **1** is passed over applicator **3** and a sheet of fibers **2** is being passed simultaneously under applicator **3'**. Both applicators **3** and **3'** are as shown in FIGURES 1 and 2, applicator **3'** is identical with applicator **3** but turned upside-down and end-for-end. (The outlet means **4**, internal conduit **5**, and inlet port **6** are as shown in the said figures.) Forwarding means **23** similar in principle to those illustrated in FIGURE 2 provides the required contact and transfer for both applicators. In the embodiment shown, triple rolls **10**, **11**, and **12**, in conjunction with tension bar **8**, provide the necessary contact and transfer for both sheets **1** and **2**. The two sheets of fibers are brought together by passing them under tension bar **8** to form a single sheet of fibers **9**, double the size of the initial fiber sheets. Sheet **9** is brought half-way around roll **10** and between rolls **10** and **11** with application of pressure, then between rolls

11 and 12, again with application of pressure. The squeezing of the fiber sheets as it passes between these rolls completes the diffusion of the liquid from the inside of the sheet to the fibers in its outer faces. From rolls 11 and 12 the sheet of fibers, with the liquid uniformly applied throughout, is forwarded to the next processing stage (not shown), such as cutting to staple fibers.

FIGURE 6 is a cross-sectional view showing another grooved cylinder 30 having two internal supply conduits 31 and 32, outlet means 33 leading from internal conduit 31 and outlet means 34 leading from internal conduit 32 intersecting in a single orifice 35. This cylinder design is extremely useful for coating fibers with two different compositions which react with one another or form systems of poor stability.

FIGURE 7 is a cross-sectional view of another cylinder 36 which illustrates a suitable type which is not of circular cross-section. The grooved portion 37 and the smooth portion 38 of the cylinder surface define a convex arc 39.

Utility

The apparatus of this invention is useful in many situations where the uniform distribution of liquid throughout a sheet of fibers is desired. This excellent distribution of liquid with the surprising minimization of filament breakage is highly useful in particular fields such as the application of finishes and antistatic agents particularly to continuous filament tow.

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not to be limited by the specific illustrations except to the extent defined in the following claims.

What is claimed is:

1. Apparatus for applying liquid to moving sheets of fiber comprising:

at least one cylinder, the outer surface of said cylinder having a grooved portion and a smooth portion, and

forwarding means adapted to cause said sheet to move in contact with said grooved portion and to cause transfer of said sheet containing the applied liquid

said cylinder having at least one internal conduit thereaway from said cylinder at the said smooth portion, in, said internal conduit having at least one inlet port,

said cylinder having outlet means terminating on the outer surface of said cylinder and connecting said internal conduit with said grooved portion which contacts said sheet.

2. Apparatus according to claim 1 wherein said cylinder is a right circular cylinder.

3. Apparatus according to claim 1 wherein said outlet means is a longitudinal slot orifice.

4. Apparatus according to claim 1 wherein said outlet means comprises a plurality of channels terminating in orifices at the said grooves.

5. Apparatus according to claim 4 wherein said channels terminate in orifices at the crests and roots of said grooves.

6. Apparatus according to claim 4 wherein said orifices are positioned along a straight line parallel to the axis of said cylinder.

7. Apparatus according to claim 1 wherein said outlet means terminates on the outer surface of said cylinder and contacts both the said grooved portion and the said smooth portion.

8. Apparatus according to claim 1 wherein said outlet means terminates on the outer surface of said cylinder and contacts only the said grooved portion.

9. Apparatus according to claim 1 wherein said forwarding means is adapted to cause said sheet containing the applied liquid to contact said smooth portion prior to the transfer of said sheet away from said cylinder.

10. Apparatus according to claim 1 wherein said outlet means is a longitudinal slot orifice which terminates on the outer surface of said cylinder and contacts both the said grooved portion and the said smooth portion to form the intersection of said portions and said forwarding means is adapted to cause said sheet containing the applied liquid to contact said smooth portion prior to the transfer of said sheet away from said cylinder.

11. Apparatus according to claim 1 having at least two internal conduits, said outlet means separately connecting each of said conduits to the said grooved portion which contacts the said sheet.

12. Apparatus acording to claim 11 wherein said separately connecting outlet means join to form at least one single orifice at the said grooved portion which contacts the said sheet.

13. Apparatus according to claim 1 further comprising feed means connected with said internal conduit to supply liquid thereto at a predetermined uniform rate.

14. Apparatus according to claim 1 further comprising collars at each end of said cylinder to maintain said sheet at constant width and to prevent shifting of said sheet.

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J. P. McINTOSH, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,393,661 July 23, 1968

Roger Lee Sharp

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

Column 5, line 43, cancel "away from said cylinder at the said smooth portion," insert the same after "liquid" in line 41, same column 5.

Signed and sealed this 3rd day of February 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents