

Dec. 19, 1961

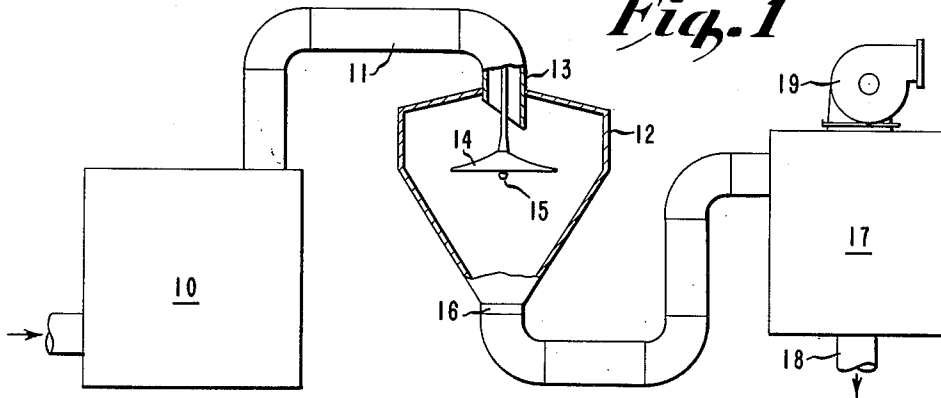
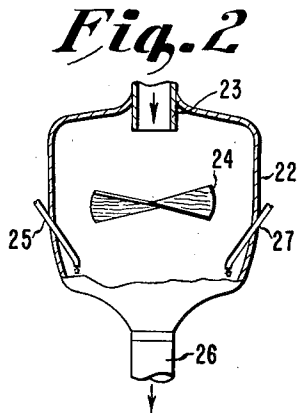
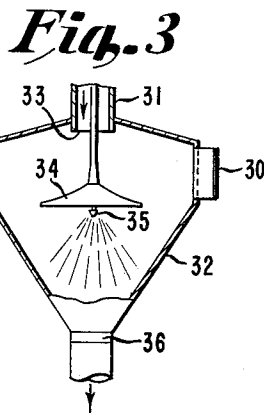
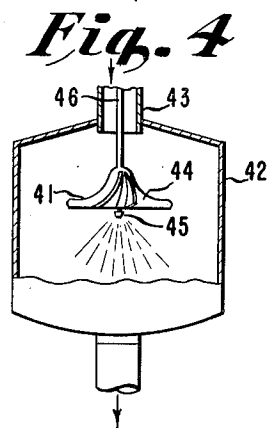
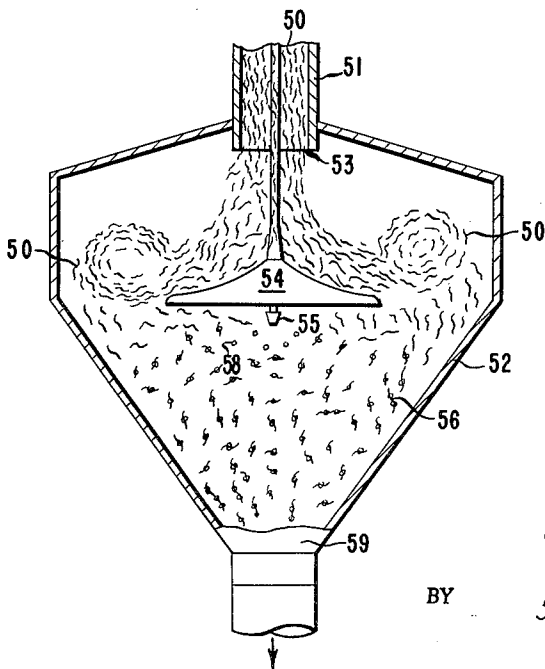
F. F. FULLER ET AL

3,013,525

APPARATUS FOR SPRAYING LIQUID ONTO FIBERS

Filed April 10, 1957

2 Sheets-Sheet 1



INVENTORS

FRANK F. FULLER
JOSEPH M. RULE
CHARLES B. THOMPSON

BY

Fred C. Carlson

ATTORNEY

Dec. 19, 1961

F. F. FULLER ET AL

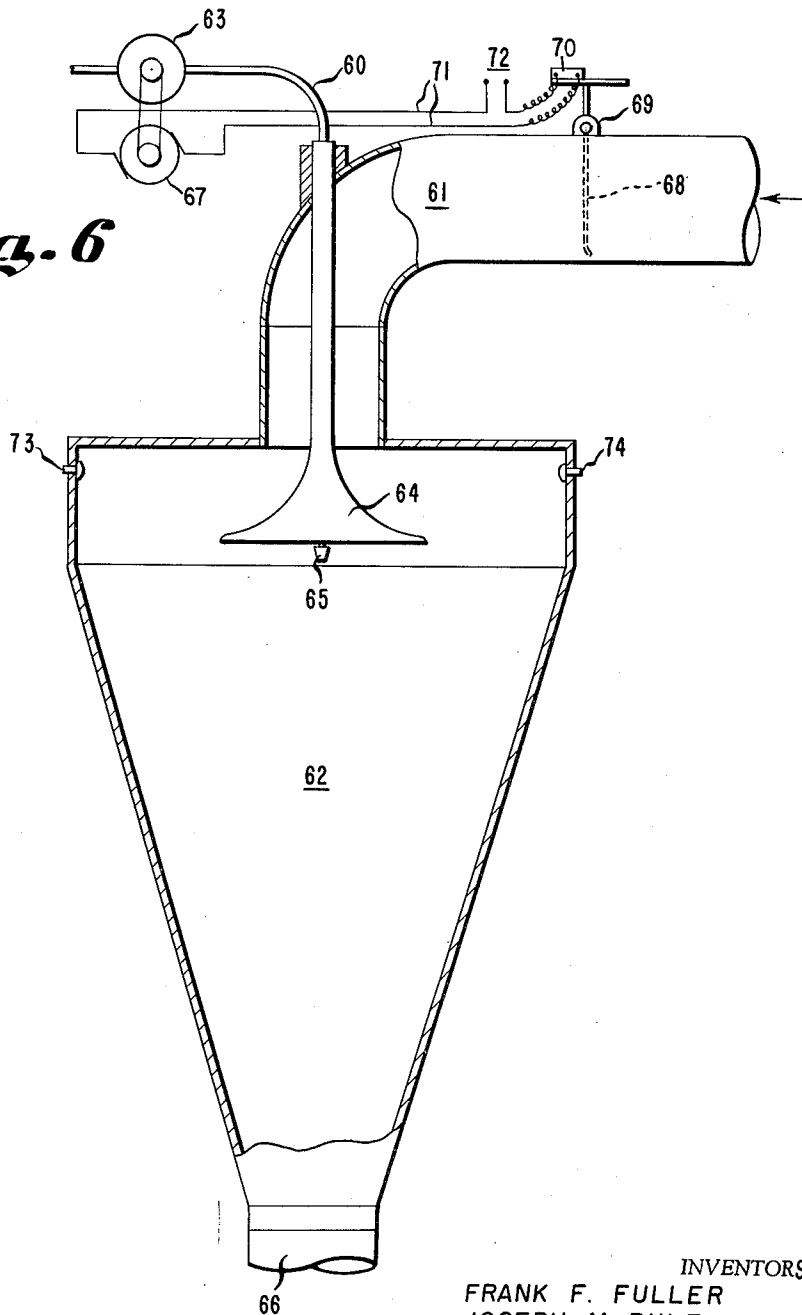
3,013,525

APPARATUS FOR SPRAYING LIQUID ONTO FIBERS

Filed April 10, 1957

2 Sheets-Sheet 2

Fig. 6



INVENTORS

FRANK F. FULLER
JOSEPH M. RULE
CHARLES B. THOMPSON

BY

Fred C. Carlson

ATTORNEY

1

3,013,525

APPARATUS FOR SPRAYING LIQUID
ONTO FIBERS

Frank F. Fuller, Elizabeth, N.J., and Joseph M. Rule,
Brandywine Hundred, and Charles B. Thompson, Chris-
tiana Hundred, Del., assignors to E. I. du Pont de
Nemours and Company, Wilmington, Del., a corpora-
tion of Delaware

Filed Apr. 10, 1957, Ser. No. 651,858

1 Claim. (Cl. 118—8)

This invention relates to apparatus for spraying liquids onto fibers, is more particularly directed to apparatus comprising a duct and means ancillary thereto for conveying air-borne fibers therein, said duct forming an inlet into a chamber having a cross-sectional area about 9 to 100 times that of the duct, a diffuser in the chamber athwart the inlet adapted to divert incoming air-borne fibers from their normal path through the chamber and expand the volume they occupy, a spray nozzle within the chamber downstream from the diffuser, preferably adapted to spray the expanded body of fibers from within, and an outlet from the chamber, and, optionally, means for admitting air to the chamber tangentially to its sidewall, and is further particularly directed to processes comprising dispersing fibers in a gas body flowing at a velocity sufficient to suspend them, suddenly expanding, to about from 9 to 100-fold, the cross-sectional area of the gas body without proportionately increasing its forward velocity, directing the gas body against an obstruction to its forward flow, whereby to divert the fibers suspended therein from their path of forward travel and to expand the volume they occupy, spraying a liquid onto the fibers, preferably from a point centrally located in reference to the cross section of the moving gas body, and optionally, directing another gas stream against the fibers in the flowing gas body tangentially to its direction of motion whereby to divert the fibers further from their path of forward travel, and thereafter decreasing the cross-sectional area of the moving gas body.

In the drawings,

FIGURE 1 illustrates an apparatus of the invention as adapted to the spraying of a liquid onto air-borne cotton fibers at a point between the openers and the lap-formers, and

FIGURE 2 shows in greater detail the expansion chamber, diffuser, and spray nozzles of a preferred form of the invention, and

FIGURE 3 shows another preferred form of the invention which includes louvers on the expansion chamber for admission of auxiliary air, and

FIGURE 4 illustrates an alternative form of diffuser, and

FIGURE 5 shows a suspended, expanded body of fibers upon which a liquid is being sprayed from a centrally located point, in accordance with a method of the invention, and

FIGURE 6 shows an apparatus of the invention equipped with an automatic control on the pump supplying the liquid fed to the spray nozzle, said control being actuated by the flow of air-borne fibers in the inlet duct.

When liquids are sprayed onto individual fibers, such as cotton textile fibers prior to forming a lap, the problem is to secure uniform distribution of an adequate amount of the liquid upon the fibers. When saturation is desired or can be tolerated, a mass of the fibers can be immersed in the liquid, but this requires removal of excess liquid, which is often uneconomical. Spraying can be regulated so as to apply lesser amounts than saturation; hence no excess liquid is put on and the disadvantages of immersion are avoided. However, heretofore no practicable method has been available whereby amounts of liquid up to and approaching the saturation

2

value could be sprayed onto a dispersed mass of fibers with relatively uniform distribution.

Conventionally, loose fibers are conveyed pneumatically in ducts from one operation to another in textile mills. The loose fibers are dispersed in a body of air moving through the ducts with sufficient velocity to keep the fibers suspended. It has been proposed to spray various treating liquids onto the fibers in such duct work, but efforts to do this have resulted in insufficient penetration of the spray droplets into the moving body of fibers. The fibers around the outside edge of the body—that is, those closest to the duct wall—may be adequately covered if only a small amount of liquid is thus sprayed, but if the amount of spray is increased, the result is not increased penetration. Rather, the outside fibers become so wet that they adhere to the duct walls and pile up at elbows, resulting in clogging problems and non-uniform treatment.

It has also been proposed to insert a constriction into a conveyer duct, whereby the velocity of fibers in the duct is increased, and to spray a liquid onto the fibers while they are passing through the constriction. While this practice increases the proportion of fibers brought into contact with the spray, it still has the inherent disadvantage that the spray from the nozzle has a relatively short path to the wall of the constriction, with the result that the wall becomes wet with the spray liquid. This not only entails loss of spray liquid from its intended purpose but also increases the tendency of the fibers to adhere to the constriction wall. Moreover, the distribution density (i.e., the number of fibers per unit volume of air) is not decreased because the elongation of the moving body of fibers is only in proportion to the decrease in cross-sectional area; hence it is just as difficult for the spray to reach remote fibers as without the constriction.

In contrast to such prior art practices, the processes and apparatus of the present invention effect a substantial decrease in distribution density of the fibers, and thereby permit fibers remote from the spray nozzle to be reached by the spray, while at the same time the distance from the spray nozzle to the wall of the expansion chamber is increased sufficiently to minimize the chances of the spray liquid reaching the wall. Furthermore, the residence time of fibers in the spray zone is substantially increased and the path of travel of the fibers through the spray zone is improved, giving better opportunity for contact between the spray droplets and the fibers. The overall result is that uniform distribution of the spray onto the fibers is secured with a minimum of chamber wall wetting and a minimum of agglomerating of the fibers.

Described with particular reference to the embodiments shown in the drawings, the apparatus of the invention illustrated in FIGURE 1, comprises means 10, such as the conventional breakers and openers of a cotton mill, for dispersing fibers in an airstream, a duct 11 connecting said dispersing means, through inlet 13 to an expansion chamber 12 having a cross-sectional area about 36 times that of the duct, a diffuser 14 located within the expansion chamber opposite the inlet, the diffuser being in the form of a bell-shaped baffle plate with the outer edge of the bell directed away from the inlet, an outlet 16 from the expansion chamber connected to a fiber condenser 17 having an exhaust blower 19 adapted to maintain suction through the entire system, and outlet means 18 for discharging treated fibers from the condenser.

FIGURE 2 of the drawings shows another embodiment of the invention in which there is an expansion chamber 22 having an inlet 23 and an outlet 26, a diffuser 24 opposite the inlet and so shaped as to impart a spiral motion to a gas impinging upon it from the inlet, and

spray nozzles 25 and 27 positioned downstream from the diffuser.

FIGURE 3 shows an embodiment of the invention in which there is an expansion chamber 32 having an inlet 33 and outlet 36, a diffuser 34, and spray nozzle 35, all similar to the corresponding elements of FIGURE 1, but also having louvers 30 adapted to admit air to the chamber when the system is under suction.

FIGURE 4 shows a particularly effective type of diffuser 44, in which spiral fins or vanes 41 are provided to impart a spiral motion to an air-stream directed thereon from inlet 43 on expansion chamber 42. A spray nozzle 45 is located on the downstream side of the diffuser. If desired, the diffuser, can be rotated by turning shaft 46, preferably at high speed, said shaft being hollow and also serving as inlet means for liquid to nozzle 45.

FIGURE 5 illustrates the practice of a process of the invention. Fibers 50, suspended in an air-stream in duct 51, enter expansion chamber 52 through inlet 53. Upon entering the expansion chamber the cross-sectional area of the air-stream is suddenly expanded about 34 fold by reason of the larger diameter of the chamber as compared with the duct. The air-stream is directed against an obstacle to its forward flow, viz., diffuser 54. The fibers are thus diverted from their path of forward travel and the volume they occupy is expanded. As the fibers travel beyond the diffuser, liquid droplets 58 are sprayed upon them from spray nozzle 55. The sprayed fibers 56 are then passed out of the expansion chamber and into a duct of lesser cross-sectional area than the chamber through outlet 59.

FIGURE 6 shows an aspect of the invention in which there is an expansion chamber 62 having an inlet duct 61 and an outlet duct 66. In the chamber, opposite the inlet duct, is a diffuser 64, and downstream therefrom is a spray nozzle 65. This spray nozzle is adapted to be supplied with a liquid under pressure through supply pipe 60, from pump 63, driven by electric motor 67. In the inlet duct is a finger 68 mounted on a pivot 69 in such a manner as to be free to rotate through a limited arc. On an extension of finger 68, outside the duct, is a mercury switch 70, so positioned that clockwise rotation of the finger closes an electric circuit to which the switch is connected, and return to normal position opens the circuit. This circuit consists of the leads 71 to motor 67 and a power source 72, connected in series. In operation, flow of air-borne fibers from right to left in duct 61 moves finger 68 in a clockwise direction, thus causing the spray liquid to be supplied to nozzle 65. When the flow of fibers is cut off the finger returns to its normal vertical position, thereby cutting off the feed of liquid to the spray nozzle.

Also shown in FIGURE 6 are nozzles 73 and 74, mounted in the periphery of the expansion chamber. Through these nozzles water can be sprayed into the chamber to effect humidity control.

It will be understood that the drawings merely illustrate certain specific embodiments of the invention and that many variations are possible. Thus, the inlet duct can enter the expansion chamber through the side rather than the end and be directed in an upward manner so that the upper end of the expansion chamber acts as the diffuser. Again, the shape of the diffusion chamber may differ substantially from any of the embodiments shown in the drawings, provided the relationship of its cross-sectional area to that of the inlet duct is as previously discussed.

A number of embodiments of the diffuser have been shown in the drawings but it will be evident that other modifications can be used. The function of the diffuser is to assist the incoming fibers to spread out in the expansion chamber and occupy substantially its full volume prior to being sprayed with the treated liquid. The cooperation between the diffuser, the inlet means, and the expansion chamber, furthermore, is such that uniform distribution

of the fibers in the expansion chamber is encouraged.

The placement of the spray nozzle in the chamber with relation to the diffuser is important. Thus, if the spray from the nozzle is caused to impinge upon the air-borne fibers as they come from the inlet duct in relatively close-packed form, the spray is unable to penetrate into the mass of fibers and non-uniform application results. Any non-uniformity of application of the spray to the fibers is diligently to be avoided because, in addition to the problems of clogging the duct work and interfering with proper operation of the fiber-handling machines, non-uniformity of application results in non-uniformity in the properties of the treated fibers, which in turn gives unsatisfactory carding, drawing, and spinning operations.

The disposition of the spray nozzles downstream from the diffuser, on the other hand, permits the spray to impinge on the fibers when they are in the openest possible condition. This insures maximum facility of subsequent operations and the development of the maximum beneficial properties in the treated fiber relative to the amount of spray material applied.

The outlet from the expansion chamber ordinarily is a duct of approximately the same diameter as the inlet duct, although this is not necessarily the case. As will be evident from the drawings the expansion chamber is preferably so shaped that below the diffuser there are no dead air spaces where fibers can settle or hang up. A round, bell-shaped or conical bottom in the expansion chamber is, therefore, preferred.

For systems operating under high suction or where the suction fluctuates rapidly, it is sometimes desirable to provide means for admitting air to the expansion chamber tangentially to its side wall. The louvers of FIGURE 3, for instance, are adapted for this purpose. Admission of air under these circumstances will assist in obtaining uniform distribution of the fibers in the chamber and can also be used to control the rate of passage of the fibers through the chamber by compensating for sudden increases in the amount of suction.

In the operation of the spraying processes of this invention, the fibers are first dispersed in a gas body flowing at a velocity sufficient to suspend them. This step is conventional in the operation of the pneumatic conveyor systems employed in textile mills. Cotton fibers, for instance, are received in the form of bales and are passed through breakers and openers to effect separation of the fibers. The fibers are thereupon picked up in the air stream of a suction system and conveyed through ducts, usually of circular cross-section, to the lap-making equipment. The apparatus of this invention can advantageously be installed as part of this pneumatic line.

Upon entering the expansion chamber, the velocity of the air stream is retarded by reason of the greatly expanded cross-sectional area. As this happens the fibers are diverted from their forward path and the space surrounding the individual fibers is increased.

The more openly spaced fibers in the expansion chamber then proceed past the diffuser by reason of the continued suction and come into the path of the liquid spray from the spray nozzle. It will be understood that a plurality of nozzles can be employed for maximum distribution of the spray but ordinarily control of the amount of spray applied to the fibers is somewhat simplified using a single nozzle.

When the liquid being applied to the fibers is a suspension or solution of a solid in a liquid, there is a danger that a spray-drying effect on the spray liquid will be encountered. Dilution of the spray will ordinarily avoid this but, of course, dilution also makes more difficult the problem of getting an adequate amount of spray material onto the fibers without making them too wet to handle. This spray-drying effect is also minimized by atomizing the spray liquid with pressure rather than atomizing it by aspirating with air. Moreover, higher

nozzle pressures will favor maximum penetration of the spray droplets before they dry.

A still further method of offsetting any spray-drying tendency is to operate at a constant relative humidity, preferably above about 50%. This can be done by spraying moisture into the air stream. Such moisture can be added through auxiliary nozzles disposed around the periphery of the expansion chamber. The latter method of humidity control is preferred because it is much simpler than to attempt to control the humidity of the air entering the suction system.

After the fibers have been sprayed according to a process of the invention, the cross-sectional area of the moving gas body in which they are suspended can be decreased in order that the fibers may readily be purged from the expansion chamber by the forward movement of the air.

It will be understood that in the operation of textile pneumatic conveying systems the feed of fibers may fluctuate or be interrupted. When this occurs the supply of liquid to the spray nozzles in the apparatus of this invention should be cut off immediately so that the interior of the expansion chamber does not become wet and the spray liquid is not wasted.

This is accomplished in an apparatus of the invention by an automatic cut-off device such as that shown in FIGURE 6 above, in which means cooperative with the moving body of fibers in the inlet duct actuate a shut-off mechanism on the pressure system supplying liquid to the spray nozzle. The operation of such cut-off means cooperatively with the spray mechanism is a valuable aspect of the present invention, and it will be understood that means other than those specifically shown in FIGURE 6 can be used. For example, a light beam may be caused to shine across the inlet duct through openings on each side, and impinge upon a photoelectric cell. In this mechanism the passage of light is interrupted by fibers flowing through the duct, so that when light is able to strike the photoelectric cell the duct is empty and the flow of spray liquid to the nozzle is cut off electrically. Still other cut-off means will be readily apparent from the foregoing description.

The operation of a process of this invention will be better understood by reference to the following illustrative example.

A liquid spray composition for treating cotton fibers was made up as follows:

A colloidal silica sol was prepared according to the teachings of Bechtold and Snyder, U.S. Patent 2,574,902, and having an $\text{SiO}_2\text{:Na}_2\text{O}$ weight ratio of 100:1. The sol analyzed: SiO_2 —30 percent; Na_2O —30 percent; water-soluble sulfated non-siliceous ash—0.10 percent; pH at 25° C.—9.80, viscosity at 25° C.—3.5 centipoises. This sol was stable for long periods of time and had a particle size of about 17 millimicrons.

The above-prepared colloidal silica sol was mixed with a combination of low viscosity mineral oil and a small amount of sulfonated mineral oil. One hundred parts of the sol were agitated slowly and a mixture of 16 parts cotton conditioning low-viscosity mineral oil having a Saybolt universal viscosity of 72.4 seconds at 100° F. and 36.5 seconds at 210° F. and an api gravity of 31.5 and 4 parts of a sulfonated mineral oil having a viscosity of 430 centipoises at 25° C. as measured by the Brookfield viscometer and analyzing 71.2 percent carbon, 11.2 percent hydrogen, and 2.77 percent sulfur, was added.

After addition of the oil, the mixture was a uniform emulsion which was stable for extended periods of time.

The above-described spray emulsion was applied to cotton fibers according to a process of this invention as follows:

Baled Delta Pine cotton having a fiber length of $1\frac{1}{16}$ inches and a fineness of 4.1 was broken on conventional opening equipment and dumped into the hopper of a pneumatic conveyor system. In the duct of the pneumatic conveyor, prior to the point at which the cotton reached the picker hoppers was inserted a spraying apparatus of the type shown in FIGURE 6 of the drawings.

The liquid spray emulsion above-described was sprayed onto the cotton in this apparatus at a rate calculated to apply 0.4 percent by weight of silica calculated as SiO_2 , based on the weight of cotton. The control on the amount of application was accomplished by calibrating and setting metering pumps supplying the spray nozzle, based on cotton flow through the unit. Thus, about 20 lbs. of emulsion were applied per 1000 lbs. of cotton per hour.

The sprayed cotton leaving the spray chamber was conveyed pneumatically to the picker hoppers. The cotton reaching the picker hoppers was found to be apparently dry to the touch and showed no tendency to adhere to or wet the picker hopper wall. No apparent difference in the way in which this sprayed material went through conventional picker and lap-making equipment as compared with unsprayed cotton, was noted. The foregoing characteristics indicated that uniform distribution of the liquid spray material had been achieved and an effective amount of silica had been applied without making the cotton wet or gummy.

We claim:

In an apparatus of the character described for spraying liquids onto fibers, a duct and means ancillary thereto for suspending and conveying air-borne fibers therein, said duct forming an inlet in closed connection with a substantially cylindrical chamber having a cross-sectional area about 9 to 100 times that of the duct, a diffuser in the chamber athwart the inlet adapted to divert incoming air-borne fibers from their normal path through the chamber and expand the volume they occupy, a spray nozzle within the chamber downstream from the diffuser, an outlet from said chamber, and means in the inlet duct adapted to be actuated by air-borne fibers in said duct to admit liquid to said spray nozzle when fibers are moving forward in said duct and to cut off the flow of liquid to said nozzle when no fibers are moving forward to said duct.

References Cited in the file of this patent

UNITED STATES PATENTS

2,071,846	Lamb et al.	Feb. 23, 1937
2,152,901	Manning	Apr. 4, 1939
2,173,032	Wintermute	Sept. 12, 1939
2,324,874	Peters	July 20, 1943
2,568,499	Hood	Sept. 18, 1951
2,725,601	Brenner	Dec. 6, 1955
2,749,736	Powischill et al.	June 12, 1956
2,805,640	Davis et al.	Sept. 10, 1957
2,873,483	Lytton	Feb. 17, 1959

FOREIGN PATENTS

179,514	Switzerland	Nov. 17, 1935
---------	-------------------	---------------