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APPARATUS FOR THE WET TREATMENT OF TEXTILE MATERIALS IN ROPE FORM

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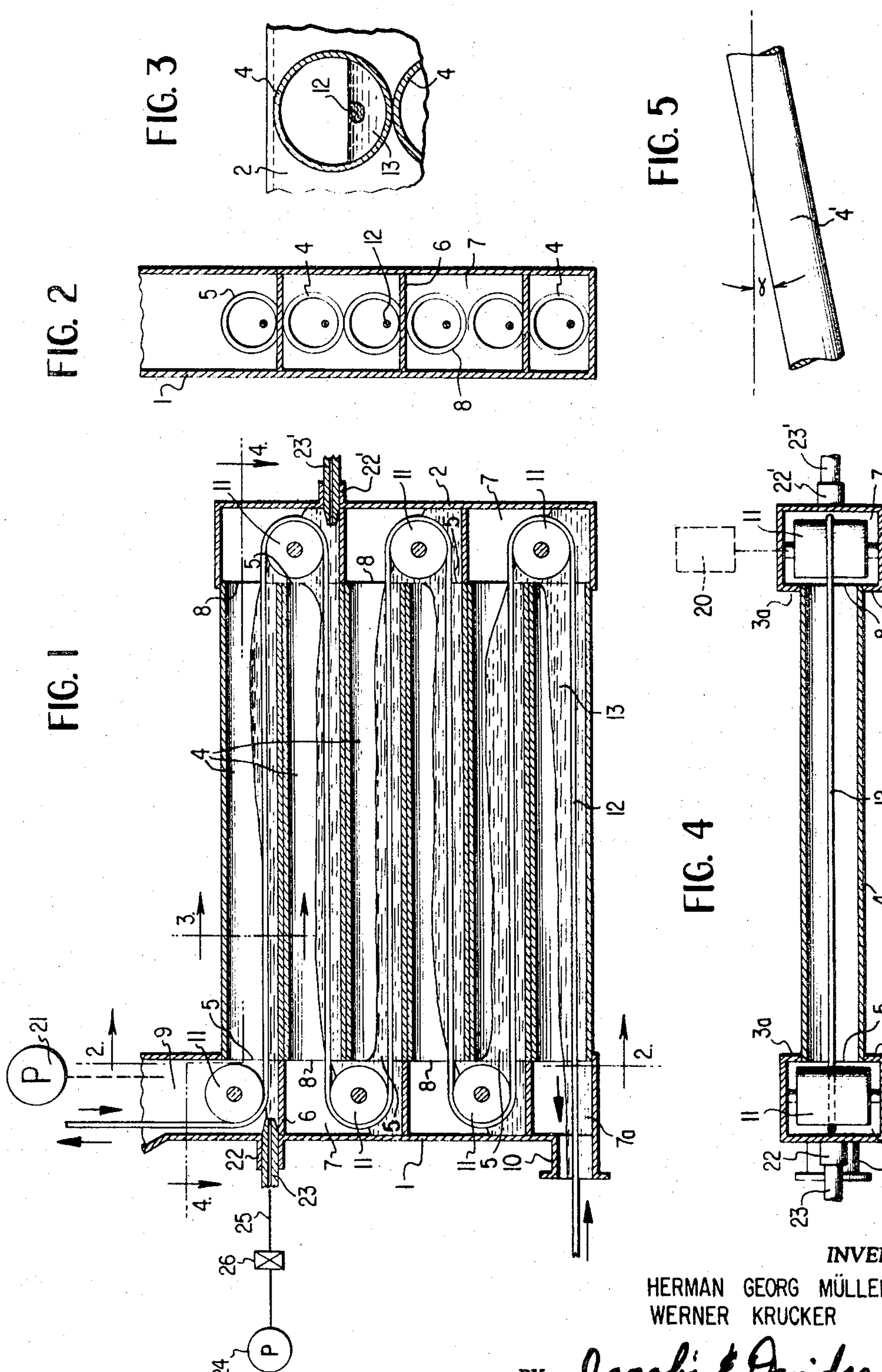

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APPARATUS FOR THE WET TREATMENT OF TEXTILE MATERIALS IN ROPE FORM

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Int. Cl. D06f *13/00, 39/08*
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ABSTRACT OF THE DISCLOSURE

An improved apparatus for the wet treatment of textile materials in rope form. The apparatus comprises a pipe system of at least two superimposed pipe members, the ends of which are open over their entire cross-section, and through which the textile material is drawn countercurrent to a treatment liquid. Compartments are provided communicating each of the pipe members with the next succeeding lower pipe member. Means are disposed in each compartment for conducting a textile material from each pipe member into the next succeeding upper pipe member. Means are provided for feeding treatment liquid into the upper region of the pipe system and for withdrawing same from the lowermost point in the pipe system. The textile material in rope form is fed in through the lowermost end of the pipe system and travels in a zigzag manner upward through successive pipes and out at the upper portion of the pipe system. Treatment liquid feeds in at one or more points in the upper portion of the pipe system and out at the lowermost end of the said system. The amount and velocity of the treatment liquid are regulated in a manner that the pipe cross-section is only partially filled with treatment liquid over substantially the entire length of the pipe system.

The present application is a continuation-in-part of our commonly assigned, co-pending United States application, Ser. No. 330,943, filed Dec. 16, 1963, entitled "Process and Apparatus for the Wet Treatment of Textile Materials in Rope Form," and now abandoned.

The present invention relates to an improved apparatus for the wet treatment of textile materials in rope form (for instance fabrics, knitted goods, and threads), and, more particularly to an improved apparatus in which the aforesaid textile goods are continuously guided through a pipe or tube system through which a treatment liquid flows, such textile goods being continuously advanced in a counterflow relationship to the direction of flow of the treatment liquid.

In a known process and device (U.S.A. Patent No. 2,203,678) for the wet treatment of textile materials in web form the latter is treated in a conduit system through which the treating liquid flows and engages the web to propel the same through said conduit system continuously, without the necessity of mechanical conveying means. Said conduit system comprises a plurality of communicating conduits which may be arranged vertically or horizontally and are filled during operation with a treating liquid bath. In one embodiment that known device comprises a battery of superimposed horizontal or sloping conduits and vertical feeding and discharge conduits, the feeding conduit having at its upper end an overflow rim for admitting treating liquid and the discharge conduit having a discharge opening arranged in a level beneath

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said overflow rim and well above the outlet end of the lowermost of said horizontal conduits. Such an arrangement of the discharge opening is indispensable for achieving the required liquid filling state of the conduit system in said known process. Since in said known process the web material is conveyed through the conduit system by the flow of the treating liquid, the web is fed to the conduit system at its liquid inlet end. Moreover, since in this process the web must be passed in a laterally extended state, it is essential to keep the liquid flow quiet and non-turbulent, and baffles are provided in a particular feeding compartment anteceding said overflow rim. In order to increase the speed of flow in the conduit system, means for injecting the treating liquid at the inlet end of the conduit system and/or means for removing the treating liquid, e.g. a pump, at the discharge opening of the conduit system may be provided.

The web to be treated may be passed through the system at a general rate of speed between 15 and 25 cm./sec.

It is to be understood that the upper limit of the speed which may be used in such a process and system is defined by the condition of non-turbulence and thus by the cross-sectional area of the conduit system so that the upper speed limit is set by the dimensions of the conduit system. Moreover, since in such a process the entire cross-sectional area of the conduits must be filled with treating liquid during operation, the amount of liquid used in the unit time, i.e. a second, is essentially proportional to the speed of the flowing liquid. This is a drawback since it is not possible in such a system to control the liquid speed independently, i.e. without concurrently varying the amount of liquid flowing through the system in the unit time. Thus, the production of a high liquid speed implies a correspondingly high consumption of treating liquid.

In another known method (U.S.A. Patent No. 3,100,-306) for treating endless sheets or webs of filamentary textile material a plurality of superimposed horizontal troughs containing sequential treating baths are provided. Each of those troughs comprises an end wall which defines the liquid level in the trough. With this method and device, the textile material to be treated may be guided in a direction from the lowermost trough to the uppermost trough, and the treating liquid may be passed in counter-current relative to the sheet or web material. Control of the velocity of the treating liquid passing the sequential troughs is limited to a rather small range of speeds since the variation of speed is defined by the maximum depth of the bath in each of the troughs, which, however, are rather shallow. Moreover, independent control of velocity and amount of treating liquid is in this case practically impossible.

Another known device (U.S.A. Patent No. 1,029,866) for dyeing yarn in strand form comprises a battery of vertically arranged pipes filled with treating liquid. This known device operates in a similar way as the first mentioned device (U.S.A. Patent No. 2,203,678) with respect to the flow of the treating liquid, and thus the conditions are similar with respect to the control of the liquid velocity and amount.

Accordingly, it is a primary object of this invention to provide an improved apparatus for the wet-treatment of textiles in strand or rope form, in which independent control of the velocity or speed of the treatment liquid flow and of the amount of liquid flowing through the apparatus or consumed in a definite time interval, e.g. in a second, is possible.

Another important object of the invention is to provision of an improved appartaus for wet-treating strand-like material in which the velocity of the treatment liquid can be varied in a wide range of velocities, e.g. in a range comprising speed rates of 1:10 or even 1:100.

It is a further object of the invention to provide an apparatus for the wet treatment of strand-like textile material in which very high velocities of the liquid flow can be attained, e.g. speeds of 1000 meters per minute or more.

It is still another important object of the invention to provide an improved apparatus for continuously wet treating strand-like textile material in a liquid stream in the state of turbulence which is extremely effective by producing a close engagement of the treatment liquid with the textile material.

A further object of the invention is the provision of an improved apparatus for the wet treatment of strand-like textile material in which the cross-sectional area of the liquid stream can be varied, using one and the same apparatus and without changing the cross section of its conduits, to accommodate said cross-sectional area to the strand material to be treated.

Accordingly, it is another object of this invention to provide an improved apparatus affording at any given time liquid exchange between liquid adhering to the textile material strand and a treatment liquid in a given installation with the smallest quantity of treatment liquid possible.

Another important object of the present invention is the provision of an improved apparatus for the wet-treatment of strand-like material, wherein the velocity of the treatment liquid can be readily accommodated to the material strand cross-section encountered.

Still a further important object of this invention is to provide an improved apparatus for the wet treatment of strand-like textile material enabling altering of the flow velocity of the treatment liquid, the cross-section of the material strand to be processed and the through flow velocity of such material strand, without treatment liquid overflowing at the inlet location of the apparatus.

The inventive apparatus is generally characterized by the feature that in use, the delivered quantity of treatment liquid is guided through a pipe or tube system with such a velocity that the pipe cross-section through at least a portion of the pipe system is only partially filled with treatment liquid. Moreover, the individual pipes or tubes of the pipe system are arranged in such a manner that there is obtained in each individual pipe a liquid level which extends through the entire length thereof, and thereby there is achieved a continuous or coherent liquid stream, whereby the textile material strand is guided through the pipe system such that it is at least partially submerged in the liquid. In consequence thereof, there is achieved the possibility of optionally increasing the velocity of the treatment liquid with a predetermined apparatus, by increasing the inlet or inflow velocity of the treatment liquid, without there thus occuring, as in known apparatus, an undesired increase of the liquid level towards the inlet location for such treatment liquid or overflowing thereof at such location. By increasing the velocity of the treatment liquid it is in fact possible to multiply the quantity of treatment liquid throughflowing per unit of time with constant filling of the pipes. The increase of the inlet velocity of the treatment liquid may be attained by increasing the pressure at the inlet location. The pressure is advantageously generated by means of a pump in the event an insufficient static pressure appears at the water or liquid conduit system.

The improved apparatus of the present invention is generally characterized by the features that it comprises a pipe system incorporating at least two superimposed pipes operably connected to one another at a respective end, the axes of which extend substantially horizontally, or form an angle not exceeding 30° with the horizontal. Furthermore, means are provided for continuously introducing treatment liquid at the upper region or zone of the pipe system, preferably in the uppermost pipe or uppermost two pipes, as well as means for continuously advancing the strand-shaped textile material to be processed through the pipe system from the lower end towards the upper end. The entering treatment liquid is also preferably directed longitudinally to the textile strand.

The inventive apparatus by utilizing partially filled pipes thus provides the advantage that a high liquid velocity is possible, but with small consumption of treatment liquid, since the quantity of treatment liquid flowing through the pipe in the time unit is proportional not only to the liquid velocity, but also to the cross-sectional area of the liquid stream. Another advantage of the partially filled pipe system is provided by the fact that the cross-sectional area of the treatment liquid stream may be varied without varying the velocity of the stream, by altering the amount, or cross-sectional area of the introduced treatment liquid without changing its inlet velocity. This may be performed by using several inlet nozzles of equal or different apertures to produce a treatment liquid stream of varying cross section, but substantially unchanged velocity.

A further advantage of the partially filled pipe system resides in the fact that, by introducing treatment liquid into the pipe system air is sucked along in the direction of the liquid stream. This air which streams along effects a pronounced vorticity or turbulance of the treatment liquid, whereby the exchange effect is increased between soiled liquid to be washed out which is entrained by the textile strand and the treatment liquid. This air only can be carried along in pipe systems which are not completely filled. With filled pipes it is impossible to guide an air current or stream through the pipe system from the top towards the bottom.

Other features, objects and advantages of the present invention will become apparent by reference to the following detailed description and drawing, in conjunction with which a mode of operation of the inventive apparatus will be described by way of example, and in which:

FIGURE 1 schematically illustrates a vertical, longitudinal cross-sectional view of an apparatus designed according to the present invention for the wet treatment of a textile material strand;

FIGURE 2 is a cross-sectional view of the apparatus of FIGURE 1, taken along lines **2—2** thereof, and for purposes of clarity omitting the treatment liquid;

FIGURE 3 is a cross-sectional view of an individual tube or pipe employed in the apparatus of FIGURE 1, and taken substantially along lines **3—3** thereof;

FIGURE 4 is a horizontal, cross-sectional view of the apparatus, taken along lines **4—4** of FIGURE 1; and

FIGURE 5 shows in fragmentary view a modified arrangement of an individual pipe or tube of the inventive treatment apparatus.

Describing now the drawing, the illustrated apparatus embodies two upright end members or boxes **1** and **2** advantageously possessing a rectangular cross-section and formed of sheet metal for example. The confronting parallel side walls **3** of the end boxes **1** and **2** are each provided with a row of, for example, circular or round holes **3***a*. Into these holes **3***a* and between the end boxes **1** and **2**, there are welded or otherwise suitably connected a row of horizontal or slightly inclined tubes or pipes **4** of circular cross-section for example. The end boxes **1** and **2** are advantageously divided into compartments **7** by means of partitions **6** or the like in such a manner that, in each cases an upper liquid outlet location **8** and a lower liquid inlet location **5** of two neighboring pipes **4** merge with or enter a common compartment **7**. The uppermost compartment **7** of the end box **1** is provided with an inlet pipe or connection **9** at its top and the lowermost compartment **7***a* of this same end box **1** possesses a lateral extending outlet pipe or connection **10** for the treatment fluid or liquid. In each of the compartments **7** there is located a guide pulley or roller **11** for the rope- or strand-shaped textile material **12** to be treated, and each such guide pulley is arranged in a manner that the aforesaid textile material strand 12 is guided in a substantially parallel plane to the axis of the associated pipe 4 and in this manner through both of the associated pipes 4 entering each respective compartment 7. These guide rollers 11 can be mounted to be freely rotatable, or one or more of such guide rollers 11, or in fact all of them, can be driven by suitable drive means 20 generally indicated with dotted lines in FIGURE 4, in order to prevent an undesired, excessive longitudinal or lengthwise stress of the material strand 12.

This textile material strand 12 enters the apparatus from below via the liquid discharge or outlet connection 10 and leaves via the liquid inlet connection 9. The treatment liquid 13 may be delivered to the apparatus through the agency of the inlet connection 9, but is preferably introduced through a nozzle 23 inserted in an inlet opening 22 in the uppermost pipe member 4. A still more preferable embodiment incorporates a further nozzle 23' mounted in inlet opening 22' in the second uppermost pipe member 4. The treatment liquid then is forced by the corresponding partition members 6 limiting the compartments 7 to flow over via the pipes 4 to the compartments 7 of the end boxes 1 and 2, continuing in this manner in zigzag or undulating fashion through all of these pipes 4 until it reaches the lowermost compartment 7*a* of the end box 1, from which it then flows out through discharge or outlet connection 10.

The textile material strand 12, for example a length of fabric which has been gathered together in transverse direction and which is to be washed or rinsed out, moves through the same path of travel as the treatment liquid 13, but in the opposite direction, leaving the apparatus via the uppermost guide roller 11 and the inlet connection 9. Above the inlet connection 9 there are arranged two conventional, and for such reason, non-illustrated squeezing rollers between which the textile material strand 12 is guided, and which on the one hand, serve to advance the material strand through the apparatus and, on the other hand, to squeeze out a portion of the liquid entrained by such strand, which then enters the system via the liquid inlet location 9.

The delivered quantity of treatment liquid 13 thereby forms a liquid column or level throughout the entire length of the individual pipes which, with a horizontal or slightly inclined pipe arrangement, appears between the inlet and outlet locations 5 and 8, respectively, for the treatment liquid. According to the selected inlet velocity of the treatment liquid such liquid level extends horizontally or even in somewhat ascending manner and, indeed, depending upon the velocity conditions prevailing at the individual locations of the pipes 4. If the treatment liquid 13 enters the pipe system with a relatively low inlet velocity, then the velocity increase resulting from the freefall is preponderant in comparison with the reduction in velocity produced by the resistance of the pipes 4 and the textile material strand 12. In this case, the velocity of the treatment liquid 13 increases in the individual pipes 4 from the inlet location 5 into the associated pipe to the outlet location 8 out of the corresponding pipe. Consequently, there results a reduced filling of the pipe cross-section with treatment liquid 13 from such inlet location to the outlet location. However, if the velocity components resulting from the force of gravity and the pipe and strand resistances mutually offset one another, then the filling with liquid of the individual pipe 4 with respect to its cross-section, with constant strand cross-section, remains everywhere approximately the same.

On the other hand, if the resulting velocity of the treatment liquid 13 decreases in the individual pipes 4 from the inlet location to the outlet location for such treatment liquid because the resistance of the pipe 4 and the material strand 13 is larger than the force of gravity, which is especially the case with high initial velocities of the liquid and/or high velocities of the textile material strand, then filling of the pipe cross-section increases in the individual pipes 4 from the inlet location to the outlet location for the treatment liquid, whereby, as the case may be, the pipe cross-section at individual locations of such pipe becomes completely filled. The material strand 13 is thus always guided by the guide rollers 11 advantageously in the lower-half of the pipe cross-section, so that it traverses the entire length of the pipe system at least partially beneath the liquid level, as best seen by inspecting FIGURE 3.

With known processes working with a filled pipe system, and as mentioned at the outset herein, it is pratically impossible to effectively influence the velocity of the liquid stream in a given installation and with the treatment of a given textile material strand delivered with a predetermined velocity through the apparatus. In the operation of an apparatus according to such known process, an increase of the liquid quantity introduced per unit of time can thus not appreciably increase the flow velocity of the treatment liquid, but rather, can only bring about an accumulation of the liquid and the running-over thereof at the inlet. The same occurs if a textile material strand of larger cross-section with constant quantity of liquid being introduced is brought for treatment, or the throughput velocity of the material strand is increased.

In contradistinction thereto, the herein-described process provides the possibility of considerably changing the flow velocity of the treatment liquid, the cross-section of the textile material strand and the throughflow velocity of such strand, without the treatment liquid being able to overflow at the inlet connection. Additionally, there appears the advantage that a much smaller consumption of treatment liquid occurs. The flow velocity is dependent upon the pressure appearing at the inlet location for the treatment liquid. Such is achieved when introducing the treatment liquid at inlet 9, for example, by the action of a suitable pump, as generally schematically indicated by reference numeral 21 in FIGURE 1, or by static pressure from a higher elevated reservoir. By means of a pump operation it is easy to obtain pressures of 10 atmospheres and more necessary for the process, and which correspond to a static pressure of 100 meters. However, when water is introduced through nozzle 23, pressure is supplied by pump 24 which is shown schematically in inlet line 25 which also contains valve 26 which is described more fully below. Nozzle 23' is also connected to a similar inlet line with a valve and a suitable pump means which are not shown. Any discussion herein referring to pump 24, inlet line 25, and valve 26 is to be understood to refer also to the corresponding means connected to valve 23'.

It is moreover advantageous to select a relatively high throughflow velocity for the liquid because the exchange effect between liquid adhering to the material strand 12 and treatment liquid 13 increases due to increasing the liquid velocity. If, namely, in a given installation working according to the principles of counterflow, the velocity of the treatment liquid 13 is increased with given velocity of the textile material strand 12, then the liquid adhering to the strand 12 is more strongly removed by the treatment liquid 13 and the exchange effect is increased with constant consumption of treatment liquid.

The described inventive process thus permits achieving a total exchange between liquid adhering to the strand 13 and treatment liquid 12 with a minimum consumption of treatment liquid at a given apparatus for each cross-section of the material strand 13 and each desired velocity of the same, by freely selecting the accommodated or adjusted velocity of the treatment liquid. Particularly favorable is the fact that, the operating efficiency of the apparatus becomes improved with increasing velocity of the textile material strand 13 and/or increasing cross-section of the same. In this manner, the described process advantageously distinguishes itself from the previously mentioned known processes, the efficiency of which—as previously explained—falls off with increasing velocity of the textile material strand and/or increasing cross-section of the same.

In the preferred embodiment two appropriately shaped, and constructed nozzles **23** and **23'** are included in the uppermost two pipes so that the jet of treatment liquid is advantageously directed tangentially to the textile strand but in the opposite direction of movement. The liquid enters under a pressure of about 1 atmosphere to about 10 atmospheres. Since the treatment liquid enters the pipe system laterally or tangentiallly instead of vertically the liquid travels a greater linear distance before being slowed by a turn in the system. By virtue of the liquid's high exit velocity from the nozzles an extremely high flow velocity is obtained which completely surrounds the strand, as a result of which the exchange effect between the liquid in the strand and the treatment liquid is increased tremendously. This is illustrated in the following example.

EXAMPLE

An apparatus comprising two rectangular boxes **1** and **2** connected laterally by fourteen pipes **4** lying above each other, having a diameter of 150 millimeters and a length of 4 meters was used. Two nozzles **23, 23'** having an exit cross-section of 0.10 $cm.^2$ each were inserted into the frontal side of the side boxes **1, 2** directed into the top pipe **4** and the pipe **4** second from the top in such fashion that the exiting liquid met tangentially the strand exiting from the pipe **4** in counterflow thereto. Suitable pump means such as pump **24** applied pressure to the treatment liquid entering nozzle **23** through inlet line **25**. The same is true for the other nozzle **23'**. Furthermore, since the squeeze-out mechanism located above the apparatus, squeeezes water out of the strand, such squeezed-out water entered the apparatus through the upper opening **9**, thus producing a liquid level in the top pipe **4** with the exit of the fluid out of the nozzle **23** below the liquid's level. A pressure of 10 atmospheres was produced in the inlet pipe **25** by means of pump **24**. Between pump **24** and nozzle **23** there was a valve **26** to regulate the quantity of water, and the pressure actually prevailing in the nozzle. When the valve **26** was open, the maximum pressure of 10 atmospheres was permitted which, in this embodiment, resulted in a maximum entry velocity of the liquid of 100 meters per second, or 6000 meters per minute. Even with a cross-sectional area of the nozzle **23** at 0.10 $cm.^2$, the liquid leaving one nozzle **23** did so at the rate of 60 liters per minute. When two such nozzles **23** and **23'** were used the water consumption amounted to 120 liters per minute or 7.2 $m.^3$ per hour. This maximum value represents a tremendous improvement over conventional systems which have to contend with a water consumption of 15 to 50 $m.^3$ per hour. The water quantity can be reduced to about 30 percent through regulation of the valve which simultaneously produces a corresponding reduction of the exit velocity of the liquid. But since even this is an extremely high flow velocity, this circumstance is not material. If the valve **26** would be regulated so that the water left the nozzles **23** at 10 meters per second, or 1 atmosphere pressure, this would be equivalent to using an apparatus 10 meters high.

The liquid jet leaving the nozzle at the rate of 6000 meters per minute tangentially meets the strand moving in the opposite direction and thereby removes from the strand, by reason of the high kinetic energy, the last traces of dirt and chemicals, respectively. On the other hand, the water jet substantially accelerates the squeezed-out water entering through opening **9**. However, this squeezed-out water can only enter into a direct exchange with the liquid to be washed out from the strand in the lower pipes which lack the nozzle since the strand is surrounded by a circulating flow of the liquid leaving the nozzle at a considerably higher velocity. Hence, there are also variable liquid velocities in the pipes with the tangential entry of the liquid from the nozzle with respect to the individual pipe cross-sections. Such velocity is highest directly at the strand. The flow velocity at the strand amounts to more than 1000 meters per minute or 17 meters per second. This enormously high flow velocity can be only achieved by the present system.

If with the present inventive apparatus one would work only with the normal liquid rate of fall, relying only on gravity flow, as in prior art apparatus, and without filling the pipes completely as described in the application, there could be produced, given the pipe cross-section of 150 millimeters, a maximum fall of 15 cm., in an individual pipe between the liquid's entry and exit points, such fall resulting in a maximum flow velocity of 9 meters per minute, or 15 cm., per second, provided that it would be possible to work practically without pipe or strand resistance. Inasmuch as in practical operation, only about half of the fall can be utilized, in this case, one could expect a maximum flow velocity of 4½ meters per minute. In this connection, it must be further considered that with this method of operation, the flow velocity increases as the liquid enters into the pipe until it leaves the pipe so that the maximum velocity mentioned as 4½ meters prevails only at the point of exit. It may be seen from these explanations that pursuant to the present application, the flow velocity in the two uppermost pipes, can be 200 times higher at the strand's cross-section itself than in the prior known process previously discussed.

In addition to the liquid which enters through the nozzles **23, 23'**, the squeezed-out liquid also flows through the apparatus, such liquid being squeezed-out of the strand by the deflecting rollers **11** and the squeeze mechanism located above the apparatus. This strand carries with it at least 300 percent of its weight in the form of liquid, whereas the strand leaves the squeeze mechanism with about 100 percent of liquid. The 200 percent of liquid squeezed out flows through the apparatus together with the newly entering liquid and participates in the contiuous exchange with the soiled or contaminated liquid found on the strand. If one strand of 200 grams per running meter is conducted through the apparatus at the speed of 100 meters per minute, this means that an additional 40 liters per minute of squeezed-out liquid becomes effective, which is in addition to the 2×60 liters of treatment liqud leaving the nozzles, making a total of 160 liters per minute. It can be seen therefrom that the effective treatment liquid per time unit increases as the weight of the product rises and as its speed becomes greater. In the pipes which are not equipped with a nozzle, the flow velocity is braked by the counter-moving strand and the wall of the pipe, so that the filling up of the pipe's cross-section takes place increasingly during the downward movement. If the pipe is half filled, the flow velocity amounts to about 18 meters per minute, or 30 cm. per second, which is still four times the flow velocity obtained in an operation employing merely hydrostatic fall. The flow acceleration appearing as a result of the influence of the nozzles continues under the given conditions throughout the entire pipe system, otherwise the whole cross-section of the pipe would be filled up.

Clearly the flow velocity of the liquid varies throughout the system, with the highest such speed appearing at the uppermost end of the system. The minimum speed of the liquid at the strand in the uppermost pipes according to the preferred embodiment will be about 2 meters per second. In the middle part of the pipe system the liquid velocity ranges from about 100 centimeters per second at the upper middle section to about 20 centimeters per second at the lower middle section, which minimum speeds are at least 3 to 5 times the speed which would prevail in a system utilizing normal hydrostatic fall. At the lowermost section of the pipe system the liquid flow is still lower, so that the exit speed of the liquid from the system may be at least about 7.5 centimeters per second in a system with a pipe cross-section of 15 centimeters wherein the lowermost pipe is half filled. It is permissible in the system described herein to have the treatment liquid at the exit, corresponding to the textile rope inlet, at a velocity equivalent to that resulting from hydrostatic fall since the efficiency of the washing process at that point is naturally lower due to the maximum contamination of the strand and the relative impurity of the wash liquid at such location. Thus, the strand is partially treated before reaching the upper region of the system where the treatment is carried out in a most efficient manner by the incoming treatment liquid.

Quite obviously, the cross-section of the pipes **4** need not be round, rather can also be rectangular or quadrangular for example. Moreover, it is not necessary that the pipe cross-section for all pipes **4** and each cross-section of the individual pipes be the same. It can, in fact, be advantageous to construct the pipes conically or with constrictions.

The pipes **4** which have been shown, by way of example and not limitation, in the drawing to be arranged approximately horizontally, could also be inclined to the horizontal. Such a modified arrangement is depicted in FIGURE 5, wherein such a pipe **4'** is arranged at an angle of inclination to the horizontal. This angle α should not exceed 30°. In no case, however, should such pipes extend vertically, since with such an arrangement there is no longer provided a coherent or continuous liquid stream, and the exchange effect between treatment liquid and textile strand is insufficient.

While there is shown and described present preferred embodiments of the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

Accordingly, what is claimed is:

1. Apparatus for the wet treatment of textile materials in strand form comprising a pipe system provided with at least two superimposed pipe members, the ends of which are open over their entire cross-section, said pipe members being disposed at an angle of from 0° to about 30° with the horizontal and defining a path of travel for the textile material therethrough, means providing a compartment operably communicating a strand inlet location of an upper pipe member with a strand outlet location of a next lower arranged pipe member, means disposed in said compartment for conducting the textile material from said next lower pipe member into said upper pipe member, means for continuously infeeding treatment liquid into the upper region of the pipe system, and a liquid discharge opening located at an end of the lowermost pipe member for continuously removing treatment liquid directly from the lowermost end of the pipe system, said infeeding means including means for controlling both the inflow velocity of the treatment liquid into the pipe system and the quantity of the treatment liquid conducted through the pipe system in a manner that the pipe cross-section is only partially filled with treatment liquid over substantially the entire length of the pipe system.

2. Apparatus for the wet treatment of textile material in strand form according to claim **1** wherein said superimposed pipe members are substantially horizontally disposed.

3. Apparatus for the wet treatment of textile materials in strand form according to claim **1** wherein said conducting means for the textile material comprises freely rotatable roller means.

4. Apparatus for the wet treatment of textile materials in strand form according to claim **1** wherein said conducting means for the textile material comprises rotatable roller means and means for rotating said roller means.

5. Apparatus for the wet treatment of textile materials in strand form according to claim **1** wherein said treatment liquid infeed means is disposed to introduce treatment liquid for movement parallel to the direction of travel of the textile material but in opposite direction thereto.

6. Apparatus for the wet treatment of textile materials in strand form according to claim **5** wherein said infeed means includes at least one nozzle directed laterally into one end of at least one pipe member.

7. Apparatus for the wet treatment of textile materials in strand form according to claim **6**, said infeeding means further including means for applying pressure to said treatment liquid, said pressure applying means and said regulating means being operatively connected in inlet line means leading to said at least one nozzle.

8. Apparatus for the wet treatment of textile materials in strand form according to claim **1** wherein said pipe system further includes a pair of spaced, confronting end members between which said superimposed pipe members are connected.

9. Apparatus for the wet treatment of textile materials in strand form according to claim **1** further comprising fourteen of said pipe members substantially horizontally disposed, each of said pipe members having a diameter of 150 millimeters and a length of 4 meters; and wherein said treatment liquid infeeding means includes at least one nozzle directed laterally into one end of at least one pipe member.

10. Apparatus for the wet treatment of textile materials in strand form according to claim **9** further comprising two nozzles each with an exit cross-section of 0.10 cm.^{2}.

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