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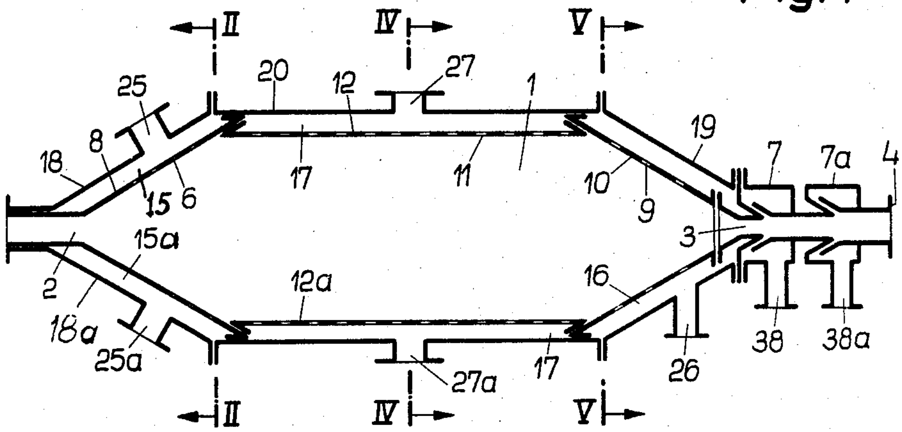
July 25, 1972 W. CHRIST ET AL 3,679,357

METHOD FOR WET TREATMENT OF ELONGATED TEXTILE MATERIAL

Filed June 4, 1969 8 Sheets-Sheet 1

Fig. 1



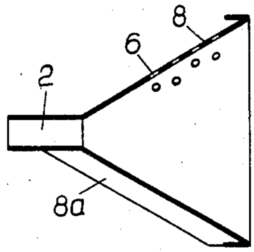


Fig. 3

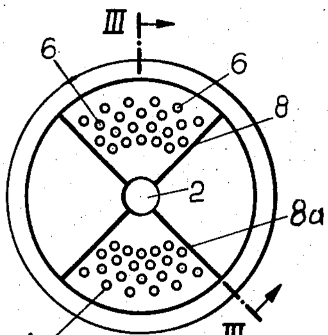


Fig. 2

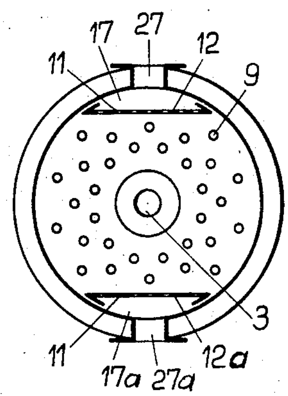
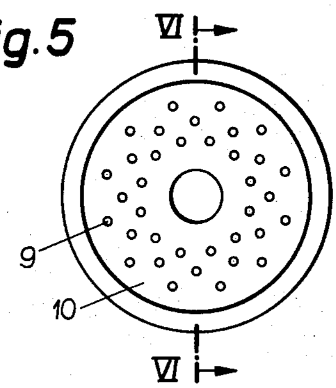


Fig. 4

Fig. 5



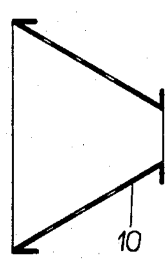


Fig. 6

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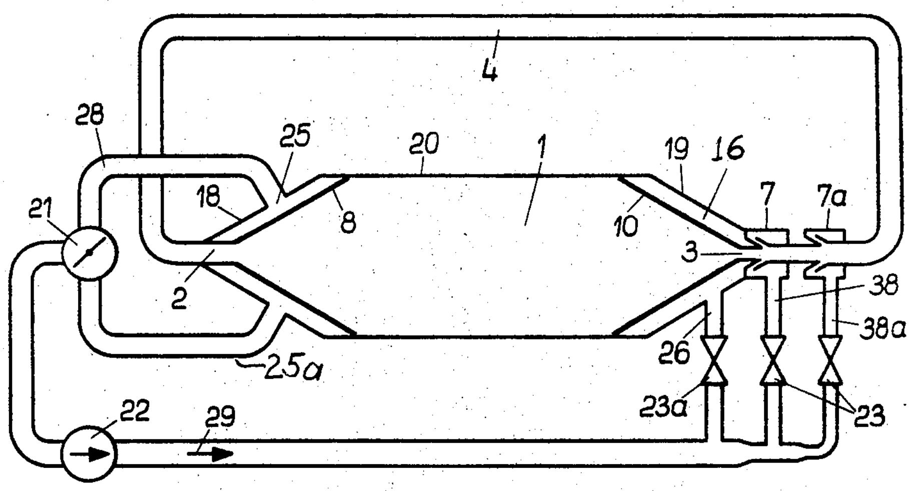
by Flynn & Frishauf
Attys

Fig. 7


4
28
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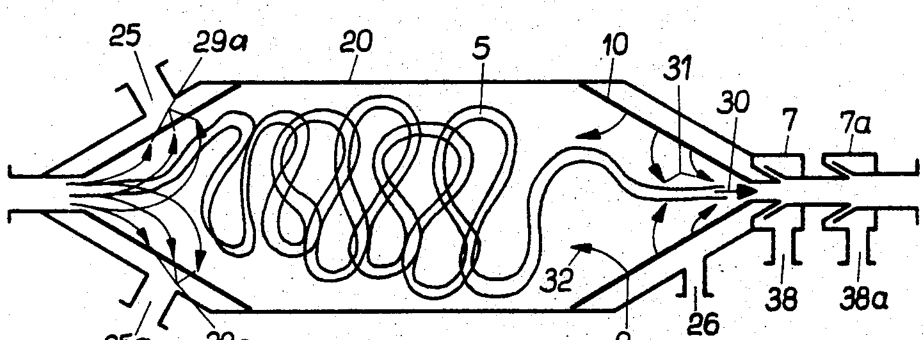
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Fig. 8

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Fig. 9

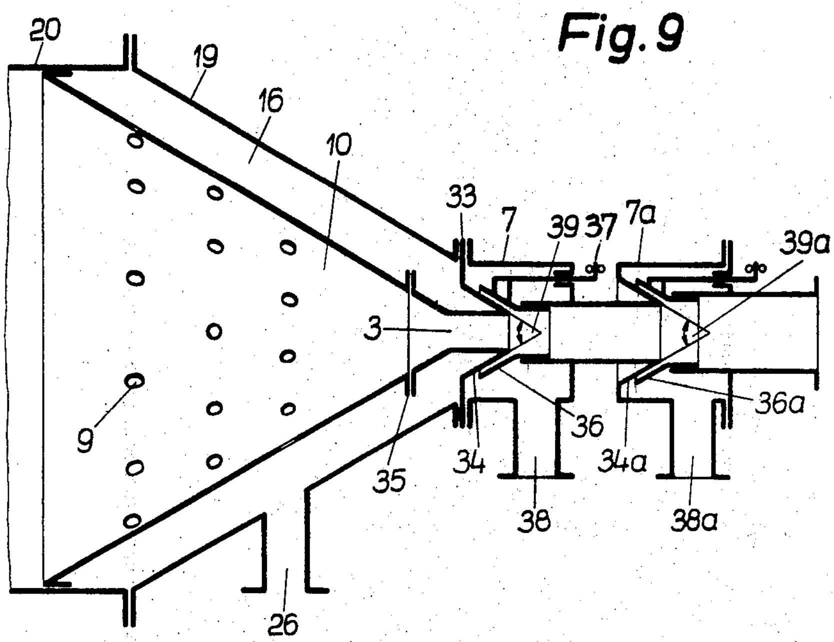
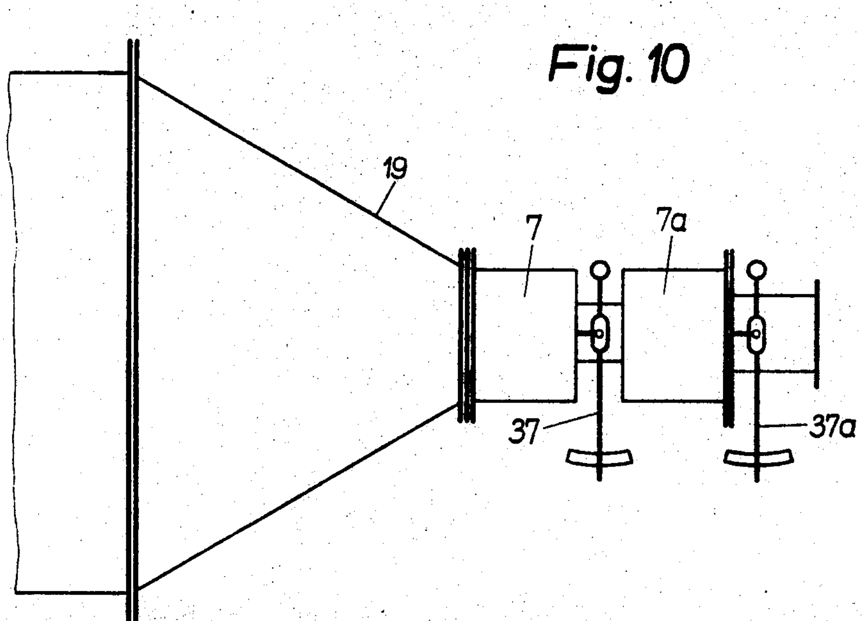


Fig. 10



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METHOD FOR WET TREATMENT OF ELONGATED TEXTILE MATERIAL

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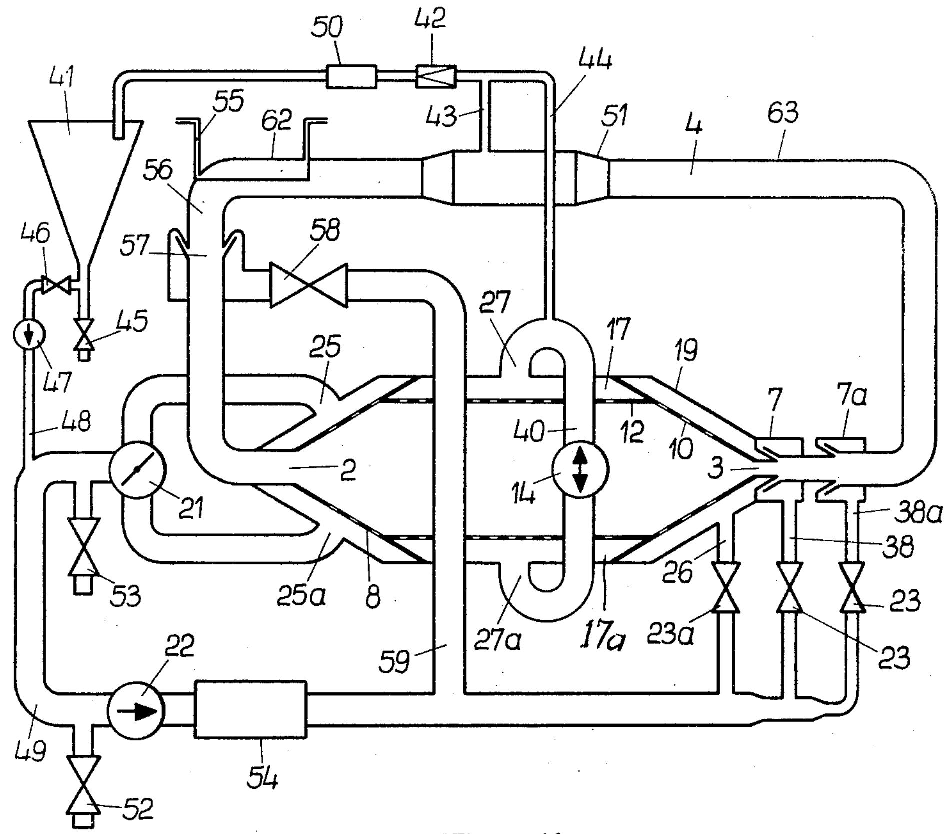

Fig. 11

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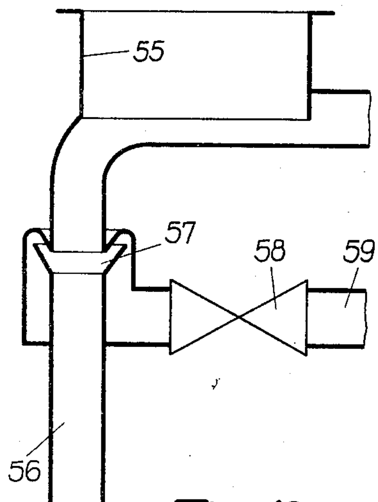


Fig. 12

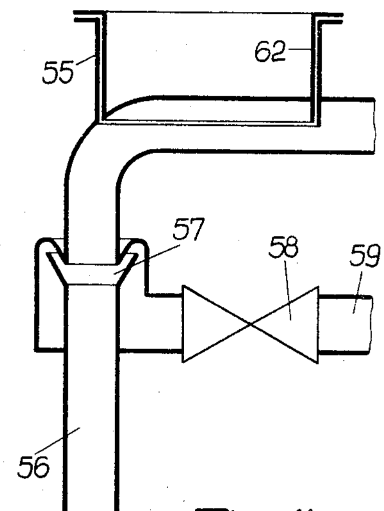


Fig. 14

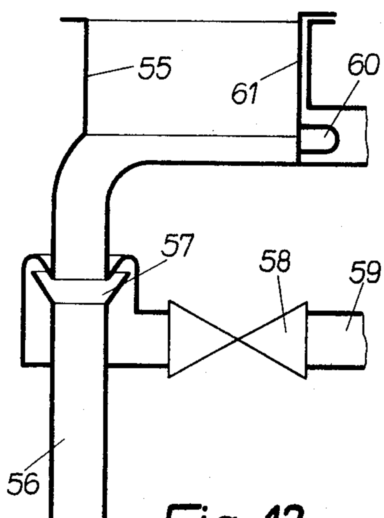


Fig. 13

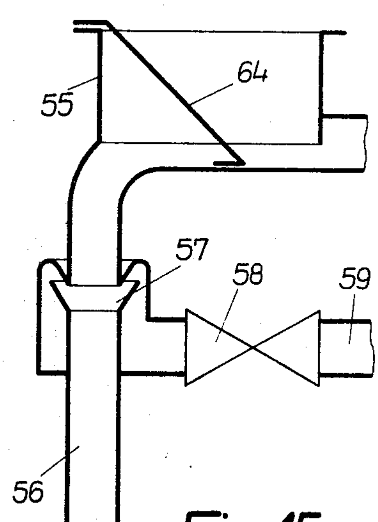
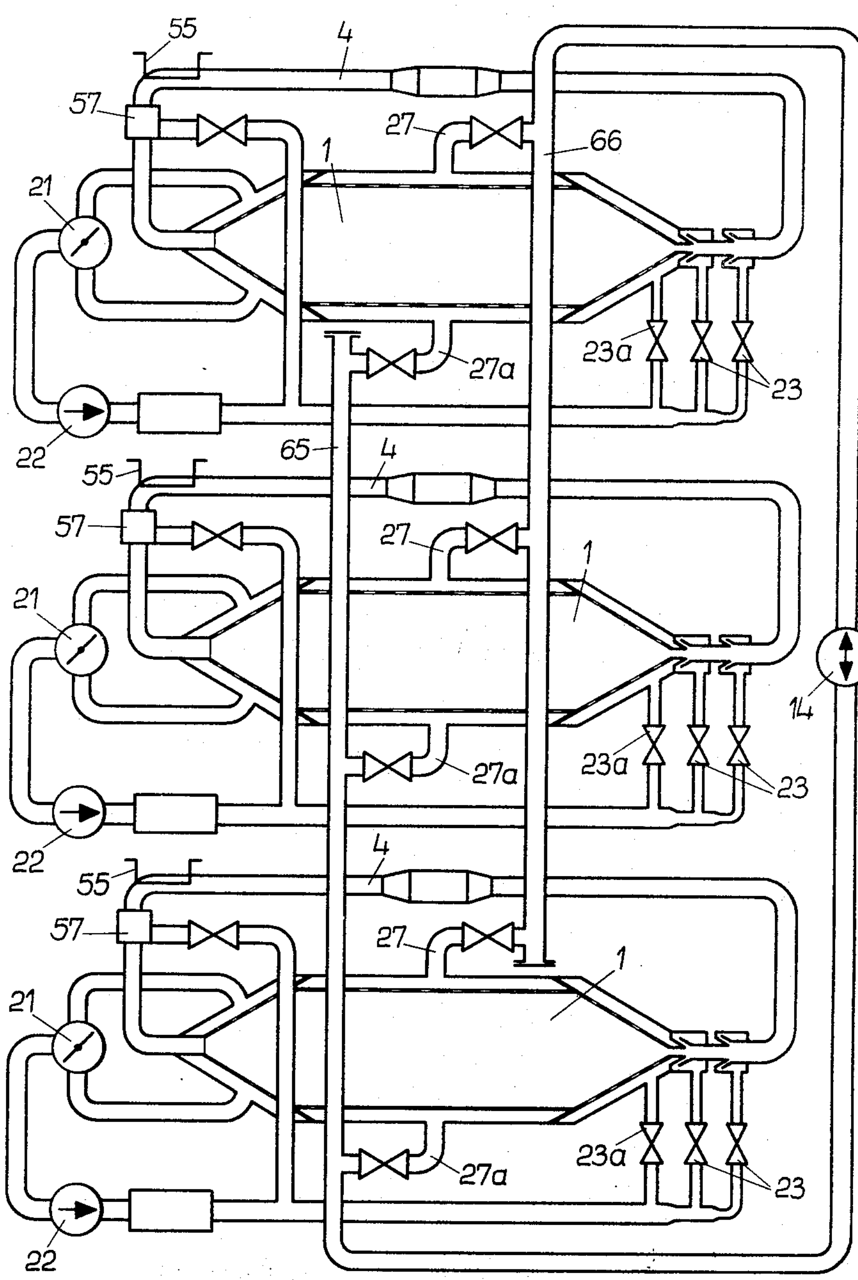


Fig. 15

Fig. 16


55
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23
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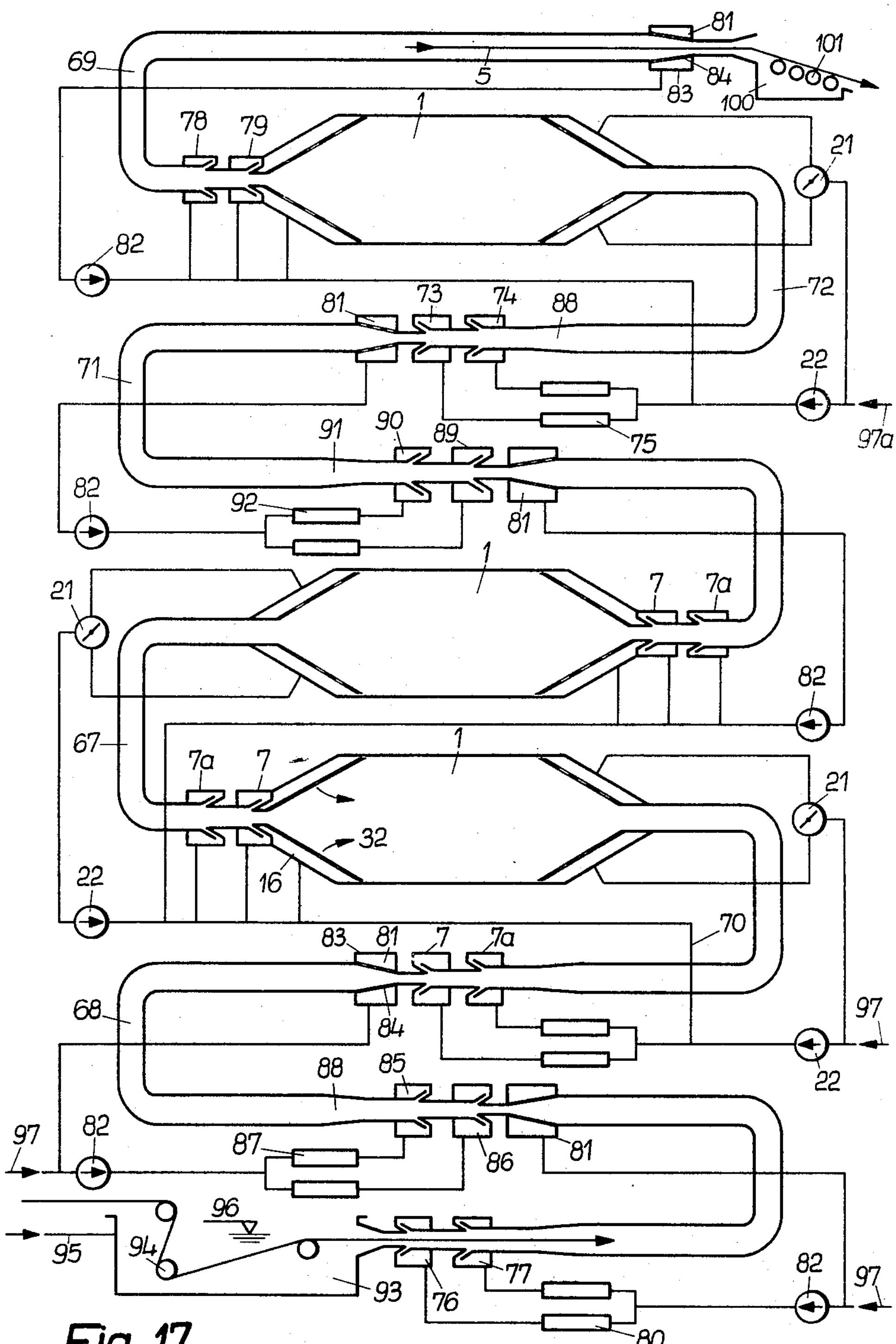

Fig. 17

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METHOD FOR WET TREATMENT OF ELONGATED TEXTILE MATERIAL

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Fig. 18

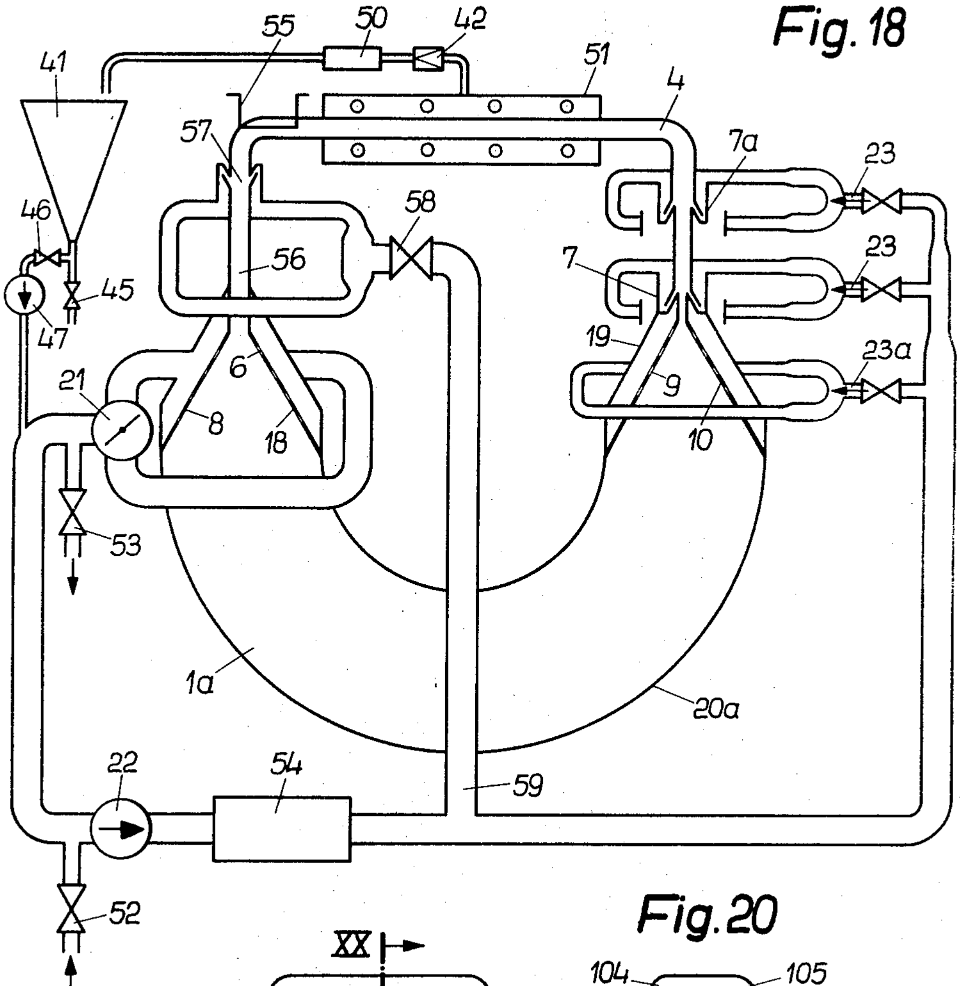


Fig. 20

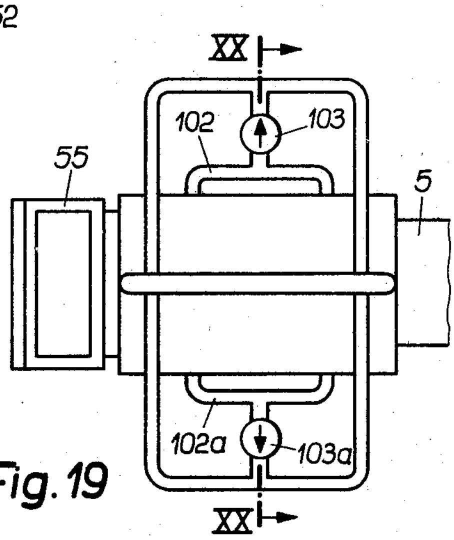
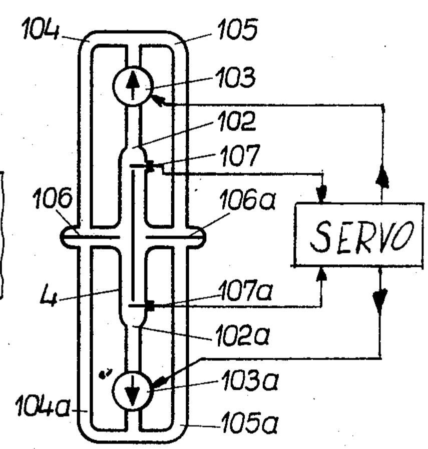


Fig. 19



United States Patent Office

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METHOD FOR WET TREATMENT OF ELONGATED TEXTILE MATERIAL

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Claims priority, application Germany, June 6, 1968, P 17 60 576.4
Int. Cl. D06c *29/00;* B05c *3/04*
U.S. Cl. 8—152 9 Claims

ABSTRACT OF THE DISCLOSURE

A method of treating elongated textile material in a treatment vessel which has double walls, the inner wall being perforated; the treatment vessel having conical (or pyramidal) inlet and outlet sides, textile material being introduced at the inlet and removed, by suction, at the outlet side; the inner walls of the vessel are perforated, and treatment liquid introduced therein is removed alternately from one opposite lateral side, or the other, to set up cross currents of flow and bunch textile material, totally immersed in treatment liquid in the vessel; the removed liquid is re-introduced adjacent a portion of the outlet side by an injector nozzle, to additionally create a flow of liquid through a transport system which may be open, or closed.

The present invention relates to a method, and to an apparatus for liquid treatment of textile material which is in elongated form, for example textile webs, textile strands, cables, ropes, ribbons, tapes, or the like, and more particularly to a method for such treatment, and to an apparatus in which the treatment is carried out by immersing the textile material into the liquid retained within a treatment vessel, from which the textile material is again removed after a predetermined treatment period.

Textile treatment arrangements are known in which the textile material is introduced from below into a treatment vessel by means of a liquid current which carries the textile material along, so that a certain section, or region, of the textile material will travel upwardly into the treatment vessel, where it is lifted above the level of the treatment liquid, by the pressure of the moving liquid, in order to be removed over rollers, or the like. The vessel is formed with an injector nozzle at the inlet side of the textile material, so that treatment liquid which is injected will impinge on the textile material to move it into the treatment vessel. The treatment liquid which is injected at that point can be removed from the vessel at a distant point, to form a closed liquid circuit. Such an arrangement requires a mechanical removing device, such as a roller, which is undesirable for certain very fine textile materials, and further exposes the removed textile material to air, which is undesirable if further treatment of the textile material in an additional vessel may have to be carried out.

It has previously been proposed to utilize injectors to carry strand-shaped textile material along within a treatment liquid; for example, a curved tube is located in the treatment vessel, extending above the normal level of the liquid, through which the textile material is introduced. As the textile material leaves the curved tube, it is deflected at the lower part by the treatment vessel, and again guided to an injector by a stream of treatment liquid. Such an arrangement may be used even with elevated temperatures, for example above 100° C. The treatment vessel need not be completely filled with liquid, so that, again, textile material may be exposed to air which is undesirable. It is difficult to completely exclude air from the injector nozzle arrangement which is detrimental to uniformity of treatment. In another arrangement, a treatment vessel may be shaped in a U-form, connected to the suction side of a pump at the bend of the U, the pressure side of the pump being connected to a collection vessel located at the upper end of the U-shaped treatment vessel. The textile material, while passing through the U-shaped vessel, is bunched together, thus increasing the capacity of the arrangement. The textile material is removed from this vessel again by rollers; it is difficult to increase the pressure within the container above atmospheric.

It is an object of the present invention to provide a method of treating textile materials, and an apparatus therefor, in which the treatment liquid acts uniformly and effectively on the textile material. Particularly, the material is to be bunched within the treatment vessel so that any longitudinal stresses on elongated textile material are avoided, and treatment by the liquid will be uniform.

It is a further object of the present invention to provide a method, and an apparatus, to treat textile material which is versatile in that it can be used in a closed, or open loop system, in which the textile material is completely immersed in treatment liquid at all times and in which exposure to air of the textile material, between various treatment steps, can be avoided.

SUBJECT MATTER OF THE PRESENT INVENTION

Briefly, a closed vessel is provided which is completely filled with treatment liquid, the vessel having inlet and outlet ends, preferably tapering in conical, or pyramidal form to material inlets and outlets shaped somewhat like the material to be treated, that is, for example, having longitudinal slits or circular openings, or the like. A material treatment path, in the form, for example, of a closed tube which is re-connected to the inlet, is connected to the outlet side of the vessel; interposed between the transport path and the outlet is an injection nozzle, through which a stream of liquid can be directed against the textile material to carry it along through the transport path. A cross-current of treatment liquid, transverse to the direction of the textile material from inlet, to outlet side is caused to arise adjacent the inlet side of the vessel, for example by providing perforated openings close to the inlet side, and at opposite transverse sides of the vessel, from which liquid is alternately removed by a suction pump. This same liquid is then re-introduced into the closed circuit at the injection nozzle at the outlet. Removal of liquid, alternately, from one side or the other across the treatment tank will cause the material to bunch, or fold in accordion shape, thus increasing the amount of material within the treatment vessel and the passage of time of any given section of material through the treatment vessel.

The treatment vessel may be connected, in series, or in parallel with other similar treatment vessels, with injection nozzles provided at suitable intervals to carry the material along. In one form of the invention, a closed loop is provided, the material being introduced by means of a leader into the treatment system, which leader is then connected to the trailing end of the material so that an endless loop of material to be treated can travel around the liquid circuit including the treatment chamber.

The apparatus of the present invention is useful for treatment of textured mesh, or net material of polyester fiber, in which stabilization of the mesh, or net structure is required; in the dyeing art, and particularly in connection with dyes which may have the tendency to fold; in bleaching, or in any other textile treatment step in which wet, or liquid treatment of textile material is desired. Control of the speed of travel, or the extent of folding, or bunching of the textile material can readily be obtained by adjusting the intensity of the stream of liquid removed, or injected; the intensity of treatment can likewise be adjusted by additionally providing cross currents of treatment liquid within the treatment vessel, that is currents transverse to the direction of travel of the texile material, for example by additional reversing pumps, pumps with reversing valves, or the like. Any liquid removed from one side of the vessel can be reintroduced at the other, or liquid removed from the inlet can be reintroduced at other points of the vessel or in the injectors in the transport path.

The invention will be described by way of example with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic longitudinal sectional view through a treatment vessel;

FIG. 2 is a transverse section along lines II—II of FIG. 1;

FIG. 3 is a sectional view along lines III—III of FIG. 2;

FIG. 4 is a transverse section along lines IV—IV of FIG. 1;

FIG. 5 is a transverse section along lines V—V of FIG. 1;

FIG. 6 is a sectional view along lines VI—VI of FIG. 5;

FIG. 7 is a schematic diagram of the vessel, in a liquid circuit;

FIG. 8 is a transverse schematic view illustrating bunching and folding of the textile material, and liquid streams and flow paths within the vessel;

FIG. 9 is an enlarged view of the outlet end of the vessel of FIG. 1, in section;

FIG. 10 is a top view of the outlet of FIG. 9;

FIG. 11 is a conduit diagram to illustrate flow paths of liquid, of the vessel in accordance with FIG. 1, in a closed loop;

FIGS. 12 to 15 are detail views of material injectors, illustrating a series of steps in introducing, treating, and removing textile material in the system of FIG. 11;

FIG. 16 is a conduit diagram illustrating fluid flow in a plurality (three shown) of parallel-connected treatment systems similar to FIG. 11;

FIG. 17 is a conduit diagram of a plurality (three shown) of treatment vessels connected in series, with interposed injection arrangements, for an open-loop system for treatment of textile material;

FIG. 18 is a sectional view, in schematic form, of a modified form of treatment vessel, in U-shape, and illustrating a closed treatment circuit;

FIG. 19 is a detail view of an opening arrangement and to maintain web-material flat; and

FIG. 20 is a sectional view along lines XX–XX of FIG. 19, illustrating the arrangement, in schematic form, to maintain web-material floating, while flat, and without bunching.

Referring now to the drawings, and more particularly to FIGS. 1 to 9. The treatment vessel will be described first, and the system and method of treatment will then be easily understood.

Vessel **1** is elongated and has a textile inlet **2** and textile outlet **3**, located at opposite ends. Textile outlet **3** is connected to a transport path **4** (see FIG. 7) which, in certain embodiments of the invention, is connected back to the inlet to form a closed loop. The vessel is provided with suction openings **6**, located in the region at the inlet. The suction openings may, for example, be formed by a second, inner wall **8** which is preforated, to provide a chamber between wall **8** and the outer wall **18** of the end portion of vessel **1**. The chambers **15** and **15*a***, formed between the inner walls **8**, **8*a***, and the outer walls **18**, **18*a*** of the vessel are each connected by pipe stubs **25**, **25*a*** to a fluid circuit, to be described. The end portions of the vessel, that is walls **18**, **18*a*** at the inlet end, as well as the outlet portion **19**, are conical. A cyclindrical jacket **20** interconnects the conical ends. The sheet metal inserts **8**, **8*a*** are likewise of conical form, the suction openings **6**, **6*a***, being limited to sector-shaped regions as best seen in FIG. 2. These sector-shaped regions are located at opposite sides with respect to each other, and are directed towards textile material **5**, entering through the inlet opening **2**. By creating liquid stream within the vessel, the textile material is deflected and flolded, to bunch, as best seen in FIG. 8. Chambers **15**, **15*a*** are separated from each other by sheet metal strips **8*a***.

A conical insert **10** of sheet metal is located adjacent the outlet end **3** of the vessel. Sheet metal **10** forms, together with the outer wall of the vessel end **19**, a chamber **16**, which is in fluid communication with the liquid system by means of a pipe stub **26**. Sheet metal **10** is perforated, as best seen in FIG. 5, the perforations extending over the entire circumference (contrary to the arrangement adjacent the inlet end). The perforations serve as outlets for treatment fluid under pressure.

The treatment chamber itself is formed by a cylindrical jacket **20** interconnecting the inlet **2** and outlet **3**. Jacket **20** likewise has a pair of perforated sheet metal inserts **12**, **12*a*** located therein, as best seen in FIG. 4, and so arranged that liquid may communicate transverse to the general extent of the elongated treatment vessel through openings **11**. The sheet metal inserts **12**, **12*a*** fit adjacent the inner wall of the cylindrical jacket **20**, and form chambers **17**, **17*a*** therewith, which are each supplied with a fluid duct stub **27**, **27*a***, respectively.

A pair of fluid injection nozzles **7**, **7*a*** are located adjacent the outlet of the vessel, and connect the vessel with transport path **4**. The injection nozzles **7**, **7*a*** (see also FIG. 9) are arranged to inject fluid against the textile material leaving at the exit opening and entering the transport path, and to carry it along by means of a fluid stream, as will be described in detail below.

FIG. 7 illustrates a simplified form of the treatment vessel, in which the inner sheet metal partitions **12**, **12*a*** have been omitted to simplify the explanation of the method of treatment.

The two inlet stubs **25**, **25*a*** are interconnected by means of a duct **28** in which a switch-over valve **21** is inserted. Switch-over valve **21** enables connection of chamber **15**, or **15*a***, selectively, with a pump **22**, which pumps fluid in the direction of the arrow. By alternately changing the valve **21**, suction will be applied through either holes **6**, **6*a***, alternately, sucking the textile material entering at **2** away from a straight line path, so that the material will fold and bunch as best seen in FIG. 8. The outlet of the pump **22** is connected over valves **23** to injector valves **7**, **7*a*** where fluid will be supplied in the direction of arrow **29**. An additional valve **23*a*** interconnects the outlet line from the pump with pipe stub **26**, and thus with chamber **16** at the outlet end of vessel **1**. Textile material is introduced into the closed loop, in a manner to be described, and then the entire system is completely filled with treatment liquid.

Textile material, for example in form of a closed loop, is transported over transport path **4** to the inlet **2** of vessel **1**. Pump **22** constantly removes liquid, by suction, while the switch-over valve **21** changes the side at which liquid is removed, so that a suction current will arise within the vessel, periodically changing from one side of the vessel towards the other. This periodically changing stream indicated in FIG. 8 schematically by arrows **29*a***, has a component transverse to the general direction of travel of the textile material **5**. The material **5** will be folded and bunched, so that elongated material will pleat, or zig-zag into accordion shape, thus extending the time during which any particular area of the material to be treated will be in the vessel. Pump **22** supplies the liquid removed from the inlet side, under pressure, towards the outlet. A suction stream, schematically indicated by arrow **30** in

FIG. 8 will arise close to the outlet end, due to the introduction of liquid, under pressure, through the injection nozzles **7**, **7***a*, adjacent the outlet of the vessel, and textile material will be sucked into the transport path **4**. The extent of the suction current can be regulated by adjusting valves **23**. A part of the liquid supplied by pump **22** is additionally supplied to chamber **16** of vessel **1**, so that openings **9** within the vessel will have fluid, under pressure, introduced into the vessel, causing additional streams as indicated by arrows **31** (FIG. 8). The pressure stream (arrows **31**) is primarily desirable to prevent adhesion of the textile material against the walls of the vessel adjacent the outlet **3**, and to ensure proper placement of the textile material into the outlet and then into the transport path. A further portion of the liquid will take the path indicated by arrows **32**, in a direction counter to the direction of travel of the textile material **5**. This stream contributes to the pleating and bunching of the textile material and thus to increase the intensity of treatment. The entire liquid loop is closed, so that in any one period of time, the amount of liquid removed by pump **22** from the inlet end is again re-introduced through injector nozzles **7**, **7***a* and through chamber **16** into the closed system. The extent of the streams **31**, **32** can be regulated by operation by valve **23***a*, and since the entire liquid circuit is a closed loop, the particular form and liquid distribution of the streams **31**, **32** as well as the flow through nozzles **7**, **7***a* is automatically predetermined. The frequency of switch-over of valve **21** may be selected in accordance with the material to be treated and the nature of treatment.

FIGS. 9 and 10 illustrate the injection valves **7**, **7***a* in detail. Chamber **16** is separated from a portion of the housing **34** formed similar to a nozzle by means of a flange **33**, which interconnects with sheet metal funnel **10** at another flange **35**. A longitudinally adjustable member **36**, which can be manually operated for example by a lever **37** is provided to adjust the openings through which liquid can be introduced in the injection nozzle. The liquid, supplied by pump **22** is introduced at stub **38**, and forced into the conical gap between adjusting member **36** and the housing portions **34**, to be accelerated therein. The direction of the stream carrying along the textile material is influenced by the conical angle **39**. By changing the position of the adjustable member **36**, the speed of the streams carrying the textile material, as well as the quantity of liquid supplied can be adjusted in accordance with the load curve of pump **22** when taking into consideration the amount of liquid bled off by valve **23***a* and chamber **16**.

The second injector **7***a* is, in all respects, similar to injector **7** and like parts are shown with like reference numerals, with the subscript *a* added. A position servo mechanism can be used in automatic operation to provide continuous control over the streams introduced through nozzle **7**, **7***a*.

FIG. 11 illustrates an entire system utilizing a vessel as described in connection with FIG. 1, and containing the cylindrical sheet metal inserts **12**, **12***a* in the region of the cylindrical section of vessel **1**. Loading of the system will also be described in connection therewith. Elements previously described have been given the same reference numerals and will not be described again.

Chambers **17**, **17***a*, each connected to pipe stubs **27**, **27***a* are interconnected by a duct **40** in which a reversing pump **14** is interposed, which provides a transversely extending fluid stream acting on the bunched textile material, the transversely extending stream periodically changing its direction. This further increases the intensity of treatment obtained in the vessel. In order to compensate any increases in volume due to increases in temperature, possibly desired during treatment, an open container **41** is provided into which pressure relief lines **43**, **44** are connected, with a check valve **42** and, if desired, a condenser **50** interposed. Venting the system thus prevents undesired pressure increases. Container **41** may be drained through a valve **45**; the treatment liquid therein may also be applied over the valve **46** and an auxiliary pump **47**, connected to line **48**, back to a suction line **49** connected to pump **22**, for re-introduction of liquid into the closed system. Any air which may be trapped in the system, or carried along by the textile material **5** is removed in the transport path **4**. The transport path **4**, formed of a conduit **63**, is formed with an enlargement at **51**, to which pressure relief stub **43** connects. A water supply valve **52** is connected to the inlet of pump **22**, and a water outlet **53** is connected just beyond switch-over valve **21** in order to enable rinsing of the system, and also to introduce rinse liquid to the treatment vessel **1**, to rinse textile material introduced therein. If the treatment material is to be heated, a heat exchanger, or heating unit **54** may be interposed in the outlet from pump **22**.

Textile material is introduced into vessel **1** and into the transport path through an opening **55** (see also FIGS. 12 to 15). An injection nozzle **57** is arranged just beyond a short pipe stub **56** leading from opening **55**, the fluid to nozzle **57** being obtained over a valve **58** connected by means of pipe **59** to the outlet of pump **22**.

To introduce strand, or web-shaped elongated textile material into the system, a leader is first connected to the leading end of the textile material. The other end of the leader is retained loose or, for example, connected to an eye **60** of an insert **61** introduced into the opening **55** (see FIG. 13). Vessel **1** is then totally filled with liquid; valve **58** is opened to introduce fluid through injection nozzle **57**. Valves **23** will remain closed. The textile material, with the leader attached, will be sucked through opening **55** by injector **57**, and, if switch-over valve **21** is already operating, textile material will be folded or bunched as illustrated in FIG. 8. Opening of valve **23***a* will create a counterflow, so that the predetermined material will bunch within vessel **1**. When the textile material is suitably compacted, that is when the desired amount of textile material is retained within vessel **1**, insert **61** (FIG. 13) is removed. Valves **23** are then opened, valve **58** is closed and the leader together with the leading end of the textile material will automatically be sucked out of the vessel **1**, to again appear at opening **55**. The leading end of the textile material may then be sewn together with the trailing end of the material, to form a completely closed loop. It is preferred that this seaming is so done that any appreciable thickening of the textile material is avoided. A cover **62** is then inserted in opening **55** (see FIG. 14) and the apparatus, with the system closed, is ready to commence treatment of the textile material. Valves **23**, **23***a* are opened, until the desired streams arise within the vessel **1**, providing the desired treatment time for any particular section, or area of the textile material **5**, as bunched and folded in the vesssel **1**. Additives, dies, chemicals and the like can be introduced into the system through container **41**, as well as through the pressure pump **47**. The injector nozzles **7**, **7***a* ensure complete mixing of any existing treatment liquid with additives, and thus provide for high reliability of the uniformity of distribution of such additives, for example dispersions of dyes on the textile material. The intensity of treatment is further enhanced by starting the reversing pump **14** to provide additional cross-flow of treatment liquid within the storage vessel **1**.

The cross-sectional area of the outlet pipe **63**, located between the outlet **3** of vessel **1** and the air removal enlargement **51**, is preferably slightly less than that of the pipe stub **56** located between the enlargement **51** and the inlet **2**. The speed of liquid travel in pipe **56** will thus be slightly less, which further decreases the longitudinal stress applied to the textile material. The enlargement **51** reduces the speed of travel even more; due to the venting, and thus pressure release at enlargement **51**, the textile material will open up more, thus releasing any air entrapped therein, which can additionally be vented to atmosphere through line **43**.

The textile material may be rinsed by opening valves **52**, **53** simultaneously, so that rinse water supplied over valve 52 effectively acts on textile material 5 within the region of injector nozzles 7, 7*a*.

Opening 55 is also used to remove textile material which has been treated. A splice detector, or the like, which may be photoelectric or mechanical, is used to detect the splice between the leading, and the trailing end of the textile material and to cause pump 22 to be stopped. Cover 62 is removed and the splice between leading and trailing edge is severed. Thereafter, a mesh or grid 64 is inserted into opening 55 (see FIG. 15) and pump 22 started again with, however, only a small amount of liquid being supplied through the injection nozzles 7, 7*a*, for example by throttling valves 23, 23*a*. The textile material will be guided out of the transport tube 4, and may be removed from the treatment system by any suitable apparatus.

The capacity of an entire treatment system can be increased by increasing the size of the vessel 1, up to a certain limit only since increasing the size of the vessel may also increase the treatment time period of the textile material by an undue extent. Increased material capacity is thus preferably obtained by using more than one treatment vessel. All the treatment vessels of a group, that is of an entire treatment system, can be connected in a single fluid circuit, for example in a parallel fluid circuit as illustrated in FIG. 16 in which like parts, previously described, will not be described again and have been given the same reference numerals.

The transport paths associated with the various vessels 1 are independently interconnected from the outlet to the inlet of the associated treatment vessels. The closed fluid loop for each one of the pumps is also independent, and specific to each treatment vessel. The treatment liquids in the various treatment vessels are interconnected through connecting pipes 65, 66 which are used to cause the transverse cross currents within the treatment vessels, the pipes 65, 66 being respectively connected to pipe stubs 27*a* and 27 over suitable isolating valves. Pipes 65, 66 are then, in turn, connected to the reversing pump 14. Transverse fluid streams are thus caused to arise within each one of the treatment vessels 1. Any number of such treatment vessel systems can be interconnected in parallel, as required by plant capacity and in accordance with available fluid capacity.

FIG. 17 illustrates a system for the treatment of textile material 1, sequentially, in a group of treatment chambers interconnected in series. The outlet side of any one treatment vessel is interconnected with the inlet side of a next subsequent one; thus, the outlet of the lowest treatment vessel 1 is interconnected by pipe 67 with the inlet of the next higher treatment vessel (with respect to the alignment of the drawing of FIG. 17). Before the textile material reaches the inlet of the lowermost treatment vessel in FIG. 17, it must first pass through an entrance path 68; connected to the outlet of the topmost treatment vessel is an outlet path 69. The fluid streams and currents within the various treatment vessels 1 are the same as those discussed and described in connection with FIG. 1, and thus need not again be referred to. Circulating pump 22, schematically indicated in FIG. 17, are connected by means of pipe lines 70 with pipe stubs 26 and thus with chambers 16 at the outlet side of the treatment container. Since the sum of the fluid reaching the outlet side of any treatment container must be equal to the fluid supplied to its inlet side, pumps 22 will at any time supply the necessary fluid for counter currents 32 (FIGS. 1, 8).

Subsequent treatment steps may require a change in temperature and of the static pressure within the treatment vessel. In order to isolate the treatment vessels, an intermediate isolating line 71, 72 is interposed between the second and the topmost treatment vessel. The isolating line 71, 72 includes injector stages 73, 74 which receive injected liquid supplied by pump 22 over heat exchangers 75, so that liquid supplied to injection nozzles 73, 74 will have a predetermined desired temperature and pressure. Similarly, the inlet line 68 to the lowermost treatment chamber may be supplied with similar injection nozzles 76, 77, over a heat exchanger 80, from a pump 82. The outlet from the last, that is the topmost treatment chamber may likewise have separate injection nozzles 78, 79. Each one of the injection nozzles is preferably of essentially the same construction and is illustrated in FIG. 9. Liquid must be removed from the transport path before new liquid can be injected; to this end, a counter current liquid removing arrangement 81, coupled to a pump 82 is provided which removes by suction a quantity of liquid which corresponds to the quantity being injected in the subsequent injection nozzles. The liquid removed from elements 81 is re-introduced into the system by an appropriate injection stage, for example injection nozzles 89, 90, to form a completely closed circulating fluid system. Liquid removal element 81 is preferably formed as a housing 83 (see lower part of FIG. 17) surrounding a perforated, tapered pipe section 84, from which excess treatment liquid can readily be removed, uniformly over the surface of the transport pipe. If the static pressure should be increased, for example in the inlet section 68, for example to increase the boiling point of the treatment liquid, then a second injector stage, for example as illustrated at 85, 86 is preferably supplied from pump 82 over heat exchangers 87, and a diffusor 88 is added to injection stage 85, which transforms dynamic energy (speed of flow) into static pressure of liquid. Similarly, injection stage 89, 90 located in connecting line 71 is formed with a diffusing section 91, fluid being delivered to injection nozzles 89, 90 from pump 82 over heat exchangers 92.

The system illustrated in FIG. 17 is an example only, and the particular arrangement of injection nozzles, diffusers, and treatment vessels can readily be changed in accordance with the treatment to which the textile material is to be subjected. The number of the series-connected treatment vessels 1 will depend on the treatment process, and the physical parameters thereof and of the textile material. Pressure, temperature and concentration of treatment liquid can be maintained at predetermined values in any section of the entire system, and the continuity and constancy of the treatment parameters can readily be maintained so that the textile material travelling through the entire system is treated uniformly.

Textile material 5 is introduced into the system of FIG. 17 in the inlet line 68. Before actually reaching line 68, the material 5 is wetted in a bath 93, through which it is guided by idler rollers 94. The bath 93 has pre-treatment liquid, or wetting liquid applied thereto through an inlet line 95, the level of which can be maintained constant for example by a constant-level supply as indicated schematically at 96; such constant-level supplies are known, may include overflow tubes, floats, and the like. Pre-treatment liquid can be supplied through a line 97, at which time treatment chemicals or dyes might be added. Line 97 is connected to the suction side of pump 82, supplying the lowermost injection nozzles 76, 77 over heat exchanger 80. Chemicals and dyes are thus introduced into the fluid circuit where they are mixed in completely. The series connection of a number of injection nozzles, or stages 76, 77 increases the static pressure over and above atmospheric pressure, so that treatment temperatures in excess of 100° C. can be used.

After the material has passed through the inlet lines 68, it is conducted into the first vessel 1. Initially only pump 22 and the associated switch-over valve 21 is connected to operate. Additional treatment liquid can again be introduced through a branch of line 97. The outlet from pump 22 is applied as a counter flow 32 in treatment vessel 1; the textile material is thus folded and bunched as previously described and guided to the outlet nozzles 7, 7*a*. The counter-current is connected over line 70 before injection nozzles 7, 7*a* are opened; a similar procedure is used for counter-current **32** in the second treatment vessel. The subsequent injection nozzles **7**, **7***a* at the outlet ends of the treatment vessels are connected only when the preceding treatment vessel is filled with the desired amount of textile material.

After the lowermost vessel **1** has retained the desired amount of textile material, the second treatment vessel **1** is filled in like manner.

The textile material **5** then passes through the connecting lines **71**, **72**, and the interposed liquid removal and injection stages **81**, **89**, **90**, diffusor **91** and the next injection stage **81**, **73**, **74** and diffusor **88**. The textile material will then reach the topmost (with respect to FIG. 17) treatment vessel **1** similarly as before, and at the exit textile material **5** will travel through exit path **69**. The textile material then passes through a final liquid removal stage **81**, **83**, **84**, over a series of drip-off rollers **101**, where liquid may drip off into a tank **100**, and then to a suitable storage device.

The number of treatment stages can be varied, as desired; additional injection stages, heating stages and liquid removal stages may be interposed, as required by the method of treatment for the textile material.

FIG. 18 illustrates a different embodiment of the invention, in which the system is similar to that of FIG. 7; the embodiment of FIG. 18 is particularly useful for web-shaped textile material. A treatment vessel **1***a* has the approximate width of a textile web, and is of essentially rectangular cross section. The entire vessel is, as seen in FIG. 18, essentially U-shaped. The portions of the vessel, and of the jacket **8**, **18** correspond to those in FIG. 1, and all parts which are similar have been given the same reference numerals and will not be described again. These parts, of course, have to be suitably shaped to fit the bent form of the vessel; their function is, however, similar to that previously described. The transport path **4**, injection nozzles **7**, **7***a* essentially correspond to the same elements described in connection with FIGS. 1 to 7. The system in which the vessel of FIG. 18 can be used is also similar to that discussed in connection with FIG. 11; except for reversing pump and the connections to create a cross current of liquid (elements **14**, **40**, **44**) other parts of the system are the same. Elements **14**, **40** and **44** may, of course, also be used in the embodiment of FIG. 18, the treatment vessel of course also being suitable for use in the system of FIGS. 16 and 17.

To maintain web-shaped textile material centered and flat within the transport path, an arrangement as illustrated in FIGS. 19 and 20 is preferably utilized.

Referring now to FIGS. 19 and 20, the region of the edges of the material, **102**, **102***a* is subjected to liquid suction by pumps **103**, **103***a*. The liquid pumped by pumps **103**, **103***a* is supplied over lines **104**, **104***a*, **105**, **105***a* back to the top, and underside of the web-shaped textile material **5**, and directed to the center of the textile material by distribution vanes **106**, **106***a*. Sensing devices **107**, **107***a* sense deviation of the textile material **5** from a center position. Deflection of any one of the sensing devices **107**, or **107***a* causes control, over a control loop (or servo), and well known in the art, of the amount of liquid being pumped by either one of pumps **103**, **103***a* to remove more, or less liquid from one side, so as to move, by suction, the material more or less towards one side or the other. Rather than controlling the pumps, a controlled valve, or similar liquid controller can be arranged in the various lines, not specifically shown; other arrangements to maintain the web in a centered position may be used.

The construction described in connection with FIG. 1 shows round, or elongated slit-form perforations **6**, **9**, **11** (FIGS. 1 to 4) formed in sheet metal inserts. It is, of course, equally possible to form similar, or other suitable openings in the jacket of the vessel **1**, and to interconnect the outside of the vessel to the respective pumps, so that chambers **15**, **16**, **17** are constituted by the supply lines themselves. The slits may be interconnected in various other configurations, as required by appropriate design specifications, to form chambers **15**, **16**, **17**, connected to pipe stubs. As another alternative, perforated fluid ducts may be introduced into the storage vessel directly, to guide and direct liquid to, or from the interior of the vessel.

For many applications it is preferred to have a pair of injection nozzle stages **7**, **7***a*; for some textile material, however, it may only be necessary to utilize a single injection stage, or a plurality of series-arranged injection nozzles coupled to the outlet of the vessel. The number of injection nozzles, as well as their adjustment, the pressure to be used and the amount of liquid to be supplied will depend on the nature of the treatment of the textile material.

Vessels **1** may be located to lie flat, or may be arranged vertically. It is preferred to utilize supervisory equipment to check proper movement of the textile material in the transport path; in one form, transparent pipe sections within the transport pipes can be used, for visual inspection by the operators, or for electronic supervision by otherwise known electrical equipment. Rollers contacting the textile material can sense motion thereof, or edgemarkings or other indicators may be used to check movement of the textile material as intended. The speed of the textile material passing through the transport path can likewise be measured, and a speed signal obtained from speed transducers can be utilized to control the temperature, quantity, pressure or speed of liquid injected in the injection stages, or the entire system can be connected into a closed servo control loop to maintain the speed of transport constant.

Various modifications and changes may be made in the apparatus, and in the treatment method within the inventive concept described.

We claim:

1. Method for wet treatment of elongated textile material in a closed fluid circuit having a material transport path and an enlarged vessel with a material inlet and a material outlet, the transport path being connected to the inlet and the outlet of the vessel, said method comprising the steps of;

entirely filling said closed fluid circuit, including said vessel and said transport path, with treatment liquid;

creating a stream of liquid flow in said fluid circuit in the direction of transport of said textile material in the transport path by injecting fluid beyond the outlet of said vessel in the transport direction;

introducing textile material into the closed fluid circuit, said stream of liquid flow in said fluid circuit moving said material through said fluid crcuit to treat the material in the completely filled vessel while maintaining the material wholly immersed in the liquid at all times, and guiding said material in said fluid circuit by said stream, while wholly immersed in the liquid;

injecting a stream of treatment liquid adjacent the region of the material outlet of the vessel in a direction counter to the direction of movement of said material through said vessel to bunch said material, counter the direction of movement within said vessel between the material inlet and the material outlet and to assist in directing the material to said outlet;

circulating the material within the closed fluid circuit by the stream of liquid flow in the transport direction;

and removing the material from the vessel.

2. Method according to claim **1**, wherein said method includes the step of maintaining a stream of treatment liquid in said transport path flowing in the direction from the material outlet of the vessel to the material inlet of the vessel.

3. Method according to claim **1**, including the step of periodically changing the sense of liquid flow in a direction transverse to said transport direction by removing a portion of the liquid, alternately, from said vessel at locations adjacent the point where the textile maerial is introduced to the vessel.

4. Method according to claim **3**, wherein the step of removing a portion of the liquid is carried out by suction.

5. Method according to claim **3**, including the step of injecting at least part of the portion of liquid removed into the stream of treatment liquid in the region of the outlet of the vessel, said injection being in the transport direcion of he textile material in the transport path.

6. Method according to claim **3**, wherein the step of removing a portion of the liquid in any time period is accompanied by the step of re-introducing, in said same time period, an equal amount of liquid into the system formed of the vessel and the transport path.

7. Method according to claim **3**, including the step of additionally, alternately, removing a portion of the liquid from the vessel at locations transverse to said material in the vessel, and in a region where the material is already bunched.

8. Method according to claim **7**, wherein the step of alternately removing a portion of the liquid from the vessel is carried out by suction.

9. Method according to claim **1**, wherein the step of injecting liquid in a direction counter the direction of movement of material through the vessel comprises injecting at least a part of the portion of liquid removed from the vessel into a vessel in the region adjacent the outlet of the vessel.

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