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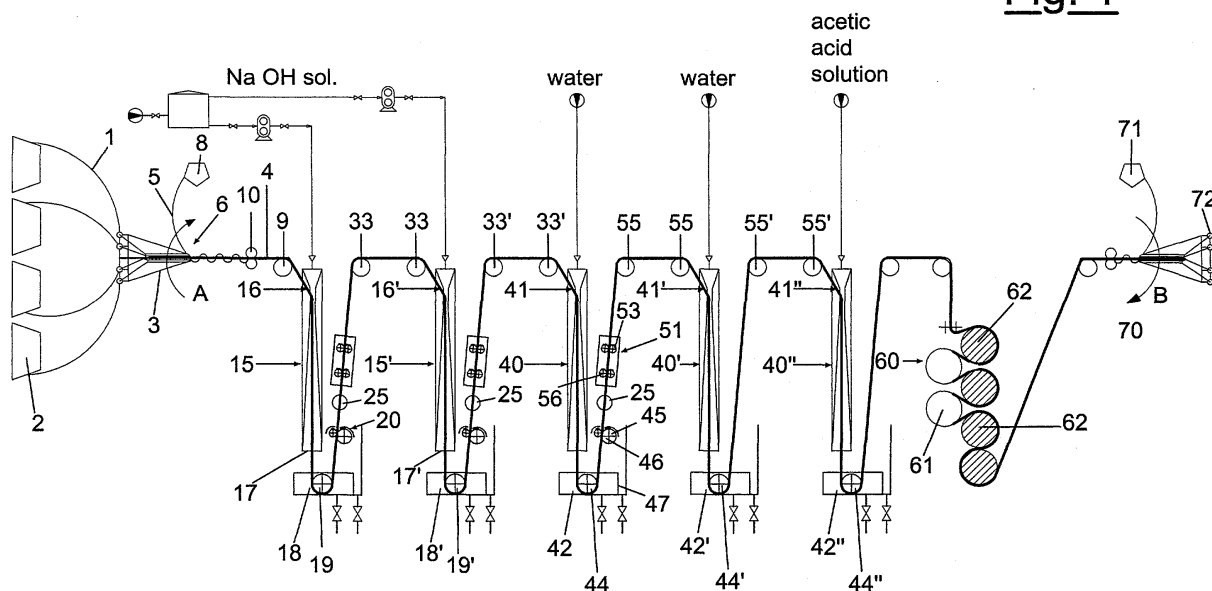
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(54) **Process and device for the continuous mercerizing of textile yarns**

(57) Continuous process for the mercerizing or yarns effected on the yarn (1) in the form of a bundle (4), introduced into one or more tubular reactors (15)

with an ejection nozzle (16) fed as driving fluid under pressure with the mercerizing solution and then drawn continuously through one or more drawing units.

Fig. 1



Description

[0001] The present invention relates to the treatment of yarns with process fluids to give them the desired characteristics for their final use for producing fabrics or other end-products. In textile technology, the treatment of yarn with reagent liquids is adopted for a wide variety of processings, for different types of fibres such as cotton, wool, silk, linen, etc., which give the yarn the desired characteristics or remove undesired components that reduce their value and the possibility of use. For cotton, for example, this type of treatment can relate to dyeing, mercerizing, bleaching, washing, sizing and so forth.

[0002] In highly prevalent industrial practice, these treatment operations are generally effected with batch operations on discrete lots of yarns, specifically prepared in bobbins or skeins which, after treatment, must be reeled off and re-prepared differently in the production line.

[0003] Batch processing on yarn is generally extremely onerous due to the considerable labour involved, the low performance of the process fluids, the high plant investments and finally as a result of the environmental implications caused by the reagents discharged with the waste water which consequently require further costs to bring the drain water within specification. Batch treatment also has the additional problem of the constancy of the product quality for each processing batch, depending on the variability of the parameters of each single batch processing such as temperatures, times, concentrations, etc.

[0004] The economy, efficiency and constancy of the quality of the yarn treated with continuous processing is therefore a decisive factor for the commercial success of the overall yarn production process.

[0005] To provide a better illustration of the characteristics of the continuous treatment system of yarn with process fluids, in the description of the present invention, reference is made to the mercerization technology - also called mercerizing - under tension of cotton, which represents a typical case of yarn treatment with process solutions; it should be explicitly specified, however, that the continuous treatment system of yarn according to the present invention can also be advantageously used for other types of treatment to be effected on yarns in textile technology.

[0006] Broadly speaking mercerizing consists in the treatment of yarn with alkaline solutions - typically caustic soda, but possibly also with other basic compounds - at a high concentration, followed by drawing. The mercerizing treatment of cellulose yarn improves its mechanical properties, it enhances its gloss and also its adsorption capacity and reactivity towards the finishing products and the affinity to dyes. This enhancement takes place on the single fibers of the yarn in a state of semi-plasticity induced by the concentrated alkalis with which they are soaked.

[0007] In the known technique, mercerizing is typical-

ly carried out on skeins of yarn, suitably prepared by means of a reeling step, which are subjected to batch mercerizing and are then washed, neutralized, dried, unwound and reformed in bobbins.

[0008] Proposals have also been made in the known art to treat yarns with mercerizing solutions by first preparing the single threads with winding onto beams, each having hundreds of threads. The threads are unwound from the beams in parallel, passed individually in a sequence of tanks at atmospheric pressure containing soda baths and other treatment fluids, drawn by pairs of rolls and rewound onto other beams or onto single spools.

[0009] The spools of mercerized yarn are then charged onto bobbin winders to be collected into bobbins. These technical solutions are extremely complicated, they have numerous disadvantages and for the moment have not been widely diffused on the market. Soda baths, for example, have large dimensions; this results in high costs for the plant and technical immobilizations and also a low efficiency of the soda baths. The large surfaces of the mercerizing baths are in contact with the air and their sodium hydrate is subject to rapid deterioration by carbonation due to contact with the carbon dioxide in the overlying air. If one of the threads being treated breaks, it would be difficult to detect and recover the skein ends, and in any case the processing must be interrupted.

[0010] The objective of the present invention is to provide a continuous treatment system of yarns with process fluids and, specifically mercerizing fluids, which allows the drawbacks of the systems available in the known art, to be overcome.

[0011] This objective is achieved, in accordance with the present invention, with the treatment system according to the most general definition of claim 1 and for preferred embodiments or possible variants defined in the dependant claims from 2 to 8. The present invention also provides a device for the continuous treatment of yarns, and in particular for mercerization, according to claim 9 and its dependant claims.

[0012] The characteristics and advantages of the present invention for the continuous mercerizing of yarns and, more in general, for their continuous treatment with process fluids, will appear more evident from the following illustrative but non-limiting description, referring to its application to the mercerizing of cotton, according to the plant scheme illustrated in figure 1.

[0013] Figure 1 illustrates the general scheme of the treatment system of yarns with process fluids. Figure 2 shows an embodiment variation of the mercerizing tubular reactor.

[0014] In the general scheme of figure 1, the yarn 1 to be treated is fed starting from a series of bobbins 2 arranged in parallel on specific unwinding creels, not shown in the figure for the sake of simplicity, which release a series of parallel threads which are concentrated in a cable laying funnel 3 forming a bundle 4 of threads

adhering to each other. In principle, the process and the device according to the invention can also operate on a single thread 1, but their industrial application is more interesting - for its productivity and efficiency - with numerous threads, preferably collected in a bundle 4 consisting of from 20 to 200 threads or more, depending on their number and characteristics.

[0015] In order to increase the solidarity of the threads contained in the bundle 4 of threads to be processed, according to a preferred embodiment of the invention, in section 6 for the preparation of the bundle of threads, at least one auxiliary thread 5 with long coils, indicatively having a shed of 200 to 1500 mm, is wound around them, accompanying the bundle during its processing, and is subsequently separated and recovered at the end of the processing line. This expedient, in the case of the breakage of one or more single threads 1, prevents them from not continuing their run through the overall machinery but, with continuous feeding, they accumulate in one of the continuous processing machines.

[0016] For example, as shown in figure 1, said winding is effected with one or more auxiliary threads 5 with a high chemical and mechanical resistance - for example made of Kevlar - which are released from one or more bobbins 8 held by a rotating reel, not shown in the figure for the sake of simplicity, around the bundle 4 and rotating according to the arrow A. An alternative for increasing the adherence between the threads of the bundle 4 can be to apply a slight twisting to the bundle itself, a few twists per meter, assembling the creel of the bobbins 2 on a rotating support, according to the rope-making technique.

[0017] The pulling of the threads 1 to form the bundle 4 is effected with the pair of guiding rolls 10, which rotate at a controlled rate and which determine the linear pulling-rate of the bundle 4 of threads being processed, generally at a rate in the order of hundreds of m/min, sending it to the mercerizing reactors.

[0018] An important characteristic of the present invention consists in the treatment operation and structure of the reactor in which the treatment of the bundle 4 of threads is effected with the process fluid which, in the illustrative present description, consists of an alkaline solution of sodium hydrate at a high concentration. This operation is carried out in a tubular reactor 15 with a vertical axis and equipped at the beginning with an ejector or a Venturi tube 16.

[0019] The ejector or Venturi tube 16 is fed with a pressurized driving fluid consisting of the mercerizing alkaline solution, for example sodium hydrate at 30° Be, which corresponds to about 297 g/l, the bundle of threads 4 is guided by a deviator roll 9 and introduced into the reactor 15, with an inlet hole in correspondence with the depression of the contracted vein of the Venturi 16 fluid. The fluid sucks and pulls the bundle of threads 4 from the bobbins 2 released at a controlled rate by the initial guiding rolls 10. The bundle of threads passes through the tubular reactor 15, along its axial direction,

and exits with the mercerizing fluid from its lower output 17. The inlet pressure of the treatment fluid is regulated so as to obtain, in correspondence with the contracted vein of the ejector 16, a driving fluid rate ranging from 12 to 40 m/sec, preferably from 15 to 20 m/sec. It has in fact been observed that, as a result of the high turbulence established in the tubular reactor, high exchange coefficients of material are obtained between the fibers and the fluid, in the intermicelle spaces, and that the contact time can be greatly reduced. The same exchange efficiency has also been observed in the washing and neutralization operations effected in the subsequent tubular reactors.

[0020] A collection tank 18 of the mercerizing solution is situated in correspondence with the lower output 17 of the tubular reactor 15 of the ejector type. The bundle of threads 4, on the other hand, is resent upwards by means of a diverting pulley 19 immersed in the liquid collected in the tank 18, it passes through a loose squeezing group 20 consisting of one or more couples of loose rolls 21 pressed against each other, which squeeze the solution in excess held by the thread bundle 4. The tank 18 has an overflow mouth 22 which maintains the liquid level inside; the alkaline mercerizing solution is collected from said tank, filtered, reconditioned with respect to concentration and temperature, and then recycled to mercerizing section according to known techniques.

[0021] It is known that a typical phenomenon of mercerizing is that the concentrated alkaline solution causes a considerable enlargement and shortening of the cotton thread and consequently of the bundle 4, with the result that the initial flow-rate in m/min of the bundle at the entrance is clearly reduced at the exit of the reactor. For example, 1000 meters of the bundle of threads 4 at the entrance can correspond to 600-700 meters of bundle at the exit.

[0022] The ascending bundle of threads 4, is subjected to the control and regulation of its tension value by means of the compensator 25, which is illustrated with reference to the subsequent figure 2, and is therefore pulled upwards by the drawing device 30, comprising the discharge rolls 31, which operates at a linear rate corresponding to the shortening induced in the treatment in the reactor 15, for example at 60-70% of the arrival rate of the bundle 4 at the Venturi 16. The discharge rolls 31 also act as gripping rolls for the drawing of the bundle 4 due to the effect of the drawing rolls 32, situated downstream of the gripping rolls and are rotated with a higher rate than the rolls 31, for example at 90% of the arrival rate of the bundle 4 at the Venturi 16, thus recovering most of the shortening induced in the thread fibers 1 and providing the tension necessary for fully receiving the benefits obtained from the mercerization. The yarn is then discharged from the mercerization unit by means of the directional deviator rolls 33.

[0023] The treatment in the mercerization unit can be repeated once or several times to graduate its effect on

the processed cotton. Again for illustrative purposes, figure 1 shows a second mercerizing reactor 15', completely analogous to the previous one. The same numerical references refer to similar components and having the same function.

[0024] Also in the second reaction step, the alkaline mercerizing solution again induces an enlargement and shortening of the threads which form the bundle 4, so that it is pulled with the discharge rolls 31' at a linear rate which corresponds to the new shortening obtained in the treatment in the reactor 15'. The discharge rolls 31' and the drawing rolls 32', for example, operate completely analogously to the previous ones and at a linear rate which obtains a tension and induces a drawing with the recovery of length of the bundle of up to 90% of the initial arrival value of the bundle 4 at the Venturi 16. The yarn is then discharged by means of directional deviator rolls 33'.

[0025] In the second reactor 15', the treatment is perfected and a new shortening of the yarn is obtained, which is again drawn in the intermediate section between the rolls 31' and 32' and, for example, brought back to the value of 90% of the initial length which it had in correspondence with the initial guiding rolls 10.

[0026] After passage in the mercerizing reactors 15 and 15', the bundle of threads 4 is fed to the washing with water. For example, the washing is effected in several steps, with water in countercurrent and at a decreasing temperature, so that the last washing is carried out with the purest and coldest water and thus using the resulting water, containing the removed soda, for the next-to-last washing, and so on. For the sake of economy, the water coming from the first washing, containing the soda removed in the series of countercurrent washings, can then be used to prepare the concentrated mercerizing solution for being reintegrated in the plant. The illustrative scheme of figure 1 shows, to simplify the drawing, two washing steps in countercurrent.

[0027] The mercerized bundle of threads 4, guided by the directional rolls 33', is introduced in the first washing step into the unit 40, by means of the Venturi nozzle 41 fed with a pressurized stream of washing water coming from the subsequent step. Analogously to the previous mercerizing reaction steps, the bundle 4 enters the Venturi 41 in correspondence with one of its side holes in correspondence with the depression of the contracted vein of the fluid which sucks the bundle of threads 4, creating close contact between the mercerized threads forming the bundle and the washing water. Analogously to the mercerization units previously illustrated, the bundle of threads 4 leaves the Venturi 41 together with the washing water which is collected in the collection tank 42 of the mercerization solution. The bundle of threads 4 is, on the contrary, resent upwards by means of a loose diverting roll 44, immersed in the water collected in the tank 42, it passes through a squeezing group 45 consisting of one or more pairs of loose rolls 46 pressed against each other, which squeeze the solution in ex-

cess held by the bundle of threads 4. Analogously, the tank 42 is provided with a overflow mouth 47, from which the washing water is recovered and re-used.

[0028] The bundle of threads 4, rising from the washing unit, is subjected to the control and regulation of its tension value by means of the compensator 50, analogous to the compensator 25, which is illustrated with reference to the following figure 2, and is therefore pulled upwards by the final drawing device 51, completely analogous to the drawing devices 30 and 30'. The final drawing unit 51, situated between the two washing steps, consists of a pair of gripping rolls 52, and a subsequent pair of drawing rolls 53, which operate so as to restore, for example, the initial length of the bundle of threads 4. The gripping rolls 52 operate at the linear rate with which the bundle 4 leaves the lower part of the Venturi 41. The subsequent drawing rolls 39, for example, are activated, on the other hand, at the same linear rate as that of the arrival of the bundle 4 at the first Venturi 16, thus completely recovering the entire shortening induced in the threads 1 and providing the definite mercerizing tension. The yarn is then discharged with the directional deviator rolls 55.

[0029] Again for illustrative purposes, figure 1 shows a second washing unit 40', completely analogous to the previous unit 40. The same reference numbers refer to similar components and having the same function. The Venturi nozzle 41' is fed with a pressurized stream of the purest washing water, whereas the water coming from the second unit 40' is used as feeding in the first unit 40.

[0030] The bundle of threads 4 washed in units 40 and 40', is then subjected to a neutralization step, for example, with a diluted solution of acetic acid. The neutralization unit 40" is completely analogous to the washing unit 40' and operates again with a Venturi nozzle 41", this time fed with a pressurized stream of a diluted solution of acetic acid to remove the alkaline residue from the threads of the bundle 4. The same reference numbers in unit 40" refer to similar components and having the same function as unit 41'. The neutralization solution is collected in the underlying tank 42" and is recycled; the pH of the resulting acetic solution is checked in the tank 42", and its composition is controlled, before being recycled, for any possible corrections to be made to its number and to verify the neutralization trend.

[0031] The bundle of threads 4 washed in units 40, 40' and neutralized in unit 40", is then subjected to a complete drying step, for example in the drying unit 60 with a winding path around the cylindrical surfaces of a series of squeezing cylinders 61 and drying cylinders 62 heated with diathermic oil. As an alternative, drying with hot air can be effected at about 100°C, after a passage through a Venturi with a depression of around 200 mbar to remove the liquid particles still separated.

[0032] The threads 1 forming the bundle of threads 4 thus mercerized are then separated in the separation unit 70 of the bundle 4, according to an inverse process

with respect to that previously effected.

[0033] The first step consists in unwinding one or more auxiliary threads 5 initially wound, which are re-wound onto one or more bobbins 71 held by a rotating reel, not shown in the figure for the sake of simplicity, around the bundle 4 and rotating according to the arrow B, in the opposite direction to the arrow A and with the same winding shed. The threads 1 become parallel again and are no longer constrained in the bundle and can be separated by passing them in their guide-threads 72 to be rewound onto separate bobbins of mercerized thread.

[0034] An important characteristic of the present invention is the way in which the thread is impregnated with the process fluid, and essentially in the specific case of the mercerization of cellulose fibers. The impregnation and reaction step is effected in very short times in the reactor 15, starting in the Venturi 16. In these devices, a high flow-rate is established with respect to the bundle of threads 4, and there is a vortical motion and brusque involvement also of the threads inside the bundle 4. As described, the mercerization treatment can be repeated once or several times in subsequent reaction steps, to graduate its effect and then complete the drawing action after the washing, until the desired result is obtained.

[0035] Figure 2 shows an embodiment variation of the reactor with the ejector 16 forming the first part of the tubular mercerization reactor 15. In this variation, the single Venturi nozzle 16 described above, in the mercerization reactor 85, is substituted by several, i.e. two or more Venturi tubes in series along the reactor, in which the bundle of threads 4 passes in sequence, from the first Venturi 86' to the subsequent Venturi tubes 86'', 86''', and so on. The Venturi driving fluid consists again of the treatment solution: in this particular case the mercerization alkaline solution. In the embodiment illustrated in figure 2, the inlet 87 of the pressurized driving fluid in the Venturi 86, are situated at the side, whereas the bundle of threads 4 follows, in a straight path, the axis of the sequence of the Venturi nozzles in the reactor 85. The stream of driving fluid under pressure can thus be subdivided and distributed among the inlets 87', 87'', . . . so as to gradually increase the volumetric ratio between the volume fed of mercerizing solution and the amount of thread operating in the axial direction, from the beginning to the end of the sequence. The bundle of yarn 4 being processed, again deviated by a deviator roll 9, enters in an axial direction from the first Venturi 86' and axially follows the whole sequence receiving, in correspondence with each narrowing and depression of the contracted vein of the fluid, the arrival of the partialized stream of driving fluid from their entrances 87. Along the path of the yarn 4 there is consequently a considerable pulsation of contact conditions, such as rate and pressures of the fluid which flows around the bundle of threads 4. A second further embodiment variation of the invention contemplates, in correspondence with the first

entrance 87 for the process fluid, an entrance 88 for service connection with compressed air, both for maintenance operations and for the activation of the reaction unit with the insertion of the bundle 4 in the sequence of Venturi tubes 86.

[0036] This embodiment variation of the reactor 85 with several Venturi nozzles 86 in series allows a more effective contact and sealing for the fluids and can be adopted both for mercerizing reactors and for the subsequent washing and neutralization operations of the yarn 4 after the treatment with alkaline solutions.

[0037] The enlarged detail of figure 2 shows an illustrative structure of the compensator 25, with which the tension of the bundle of threads 4 rising towards the drawing system, is regulated and controlled. The compensator comprises two end pulleys 91, 91' situated at the ends of a telescopic rod 92 whose extremes are maintained in extension by an internal spring 93 set under compression. The higher tension of the bundle of threads 4 tends to draw the end pulleys 91, 91' closer and compress the spring 93. The telescopic rod 92, for example, has the lower end fixed to the structure and the upper end free to be extended: the pulley 91 is therefore free to move away from the pulley 91', which remains still. Two reference points 94 and 94' are situated on the telescopic rod 92, which represent fixed and adjustable limits of the approaching and distancing run end, respectively, of the two pulleys, detected by two proximity sensors 95 and 95', connected to the driving unit of the device.

[0038] When the sensor 95 detects that the reference point 94 has reached the set approaching limit, or compression limit of the telescopic rod, the tension increases to the maximum value allowed and the driving unit of the treatment device operates an increase in the feeding rate of the thread bundle 4. When, on the contrary, the sensor 95' detects that the reference point 94' has reached the allowed extension limit of the telescopic rod and that the tension has been reduced to the minimum value allowed, the driving unit of the treatment device causes a decrease in the feeding rate of the thread bundle 4 until the telescopic rod has been extended to an intermediate value. When the extension of the telescopic rod remains within the set range, the driving unit of the device remains inactive in the regulation of the feeding rate of the bundle.

[0039] The process for the continuous treatment of yarns with process fluids, according to the present invention, and, in particular, the mercerizing process described above, allows remarkable advantages to be obtained with respect to the processes of the known art. Mention should be made in particular to the following characteristics.

[0040] According to the present invention, the treatment operations with process fluids are effected with continuous operations, and not on lots of yarn, without requiring previous preparation on bobbins or skeins followed by their unwinding and re-preparation.

[0041] According to the present invention, continuous yarn processing is more economical, due to the lesser amount of labour used, the high performance of the process fluids and washing water, the lower overall plant investments and, finally, fewer environmental implications as a result of the reduced quantity of reagents discharged with the waste water. The constancy of the product quality which is obtained with the continuous treatment system according to the present invention is considerably improved, due to the constancy of the parameters of each processing step which can be maintained at the desired temperature, time, concentration values. The amounts of treatment solutions are extremely limited and, as far as the mercerizing alkaline solutions are concerned, their carbonation is very moderate.

Claims

1. A mercerization process of yarns comprising one or more treatment steps of the yarn with an alkaline solution, one or more drawing steps of the yarn after the alkaline treatment, one or more aqueous washing and neutralization steps of the alkalinity residue still present in the yarn, **characterized in that**

- the process is carried out in continuous on the yarn collected in a bundle (4) prepared in a section (6) in which solidarity is conferred between the threads, and subsequently fed with a feeding device (10),
- the bundle of fibers (4) is introduced for mercerization treatment in the tubular reactor (15, 85) by suction with a Venturi nozzle (16, 86'), in which the alkaline mercerizing solution is fed as driving fluid under pressure, entraining with it the bundle of yarn (4) and reacts, in one or more reactors (15, 85), from which it exits from the lower part, pulled by discharge rolls (31,31'),
- the bundle (4) is subsequently drawn in continuous in one or more drawing units consisting of gripping and discharge rolls (31, 31') and drawing rolls (32, 32'), situated downstream, which are rotated at a higher rate than the rolls (31,31').

2. The mercerization process of yarns according to claim 1, **characterized in that** the further treatment steps of mercerized yarns after drawing with process fluids are carried out in continuous, by putting the bundle (4) in contact with said process fluids in Venturi nozzles (41,41',41''), each fed with the process fluid, as driving fluid, entraining with it the bundle of yarn (4).

3. The mercerization process of yarns according to

claim 1, **characterized in that**, in correspondence with the contracted vein of the ejector 16, the driving fluid rate is maintained at between 12 and 40 m/sec.

4. The mercerization process of yarns according to claim 3, **characterized in that**, in correspondence with the contracted vein of the ejector 16, the driving fluid rate is maintained at between 15 and 20 m/sec.

5. The mercerization process of yarns according to claim 1, **characterized in that**, in the mercerization reactor (85), the bundle of threads (4) passes in sequence through one or more Venturi tubes (86',86'', 86''') situated in series along the reactor itself.

6. The mercerization process of yarns according to claim 5, **characterized in that**, in the mercerization reactor (85), the pressurized driving fluid stream is subdivided and distributed among the inlets (87', 87'', ..)

to gradually increase the volumetric ratio between the volume of treatment fluid fed and the amount of thread being processed in the axial direction.

7. The mercerization process of yarns according to claim 1, **characterized in that** the threads to be treated are fed to a preparation unit (6) comprising winding devices onto the threads of the bundle (4), of one or more auxiliary threads (5) with long coils, with a shed of 300 to 1500 mm, to form a bundle (4) of threads adhering to each other.

8. The mercerization process of yarns according to claim 7, **characterized in that** the bundle of threads (4) consists of from 20 to 200 threads.

9. A device for the treatment in continuous of yarns with process fluids, particularly for the mercerization of yarns of cellulose fibers, **characterized in that** it comprises:

- preparation and feeding means (10) of the single thread or the bundle (4) of several threads (1),
- means for treating the yarns comprising one or more tubular reactors (15,85) having at the start a Venturi nozzle (16,86'), fed, as pressurized driving fluid, with the treatment fluid, which sucks and entrains with it the bundle of yarn (4), with output in the lower part, pulled by discharging rolls (31,31').

10. The device for the treatment in continuous of yarns with process fluids according to claim 9, **characterized in that** the reactor (85) comprises two or more Venturi tubes (86',86'',86''') situated in series along the axis of the reactor itself.

11. The device for the treatment in continuous of yarns with process fluids according to claim 10, **characterized in that** the inlets (87',87'',87''') of the pressurized driving fluid in the Venturi tubes (86',86'',86''') are situated at the side, whereas the bundle of yarn (4) follows, with a straight run, the axis of the sequence of the Venturi nozzles in the reactor (85). 5
12. The device for the treatment in continuous of yarns with process fluids according to claim 9, **characterized in that** the preparation and feeding means of the threads in the bundle (4) comprise a cable laying funnel (3) and winding devices onto the threads of the bundle (4), of one or more auxiliary threads (5) with long coils, with a shed of 300 to 1500 mm, to form a bundle (4) of threads adhering to each other. 10 15

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Fig. 1

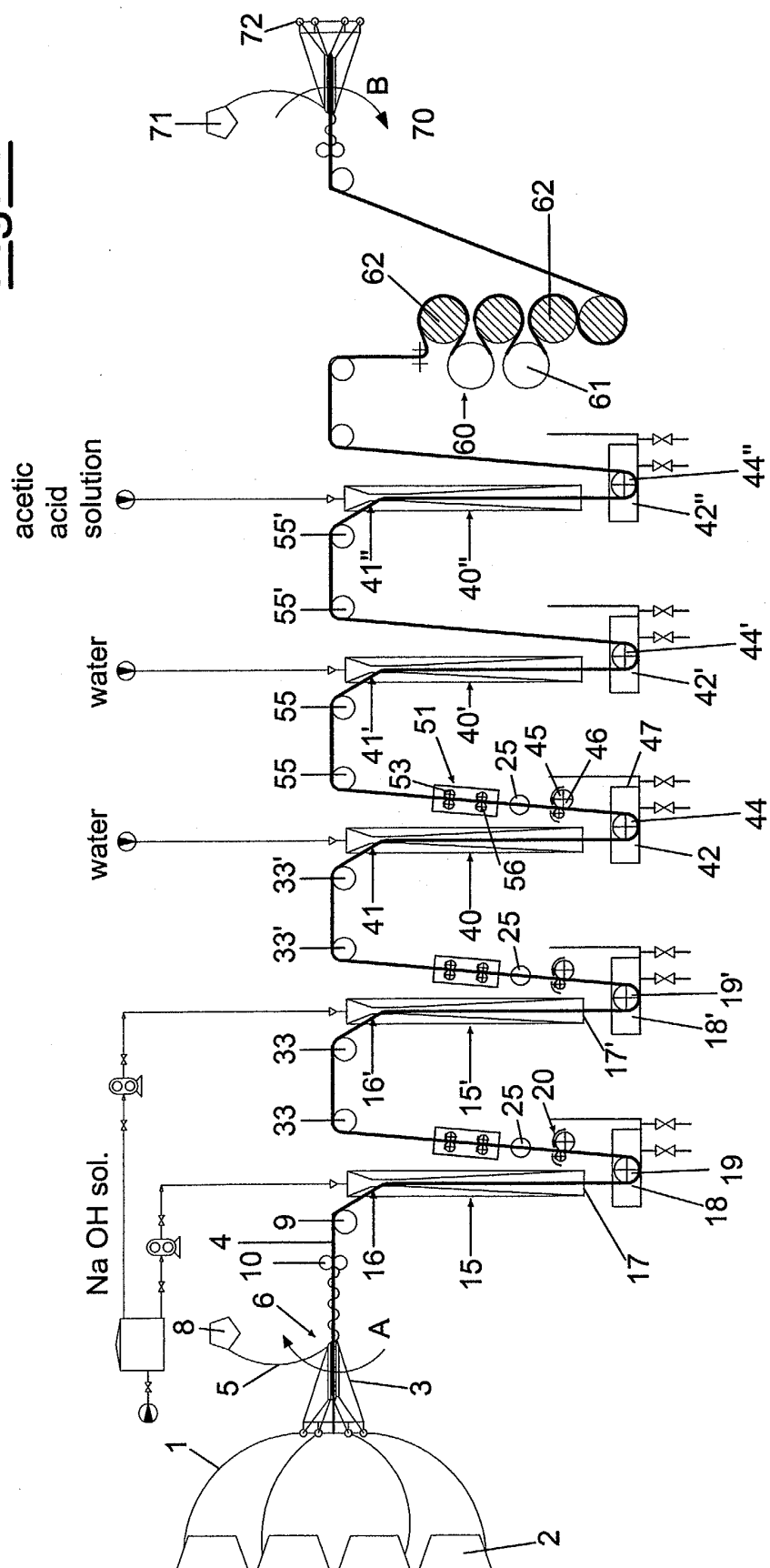


Fig. 2

