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METHOD FOR THE CONTINUOUS TREATMENT OF TEXTILE BUNDLES WITH PRESSURE STEAM

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Fig. 1

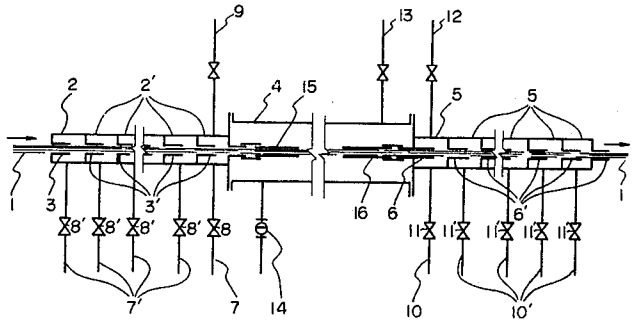


Fig. 2

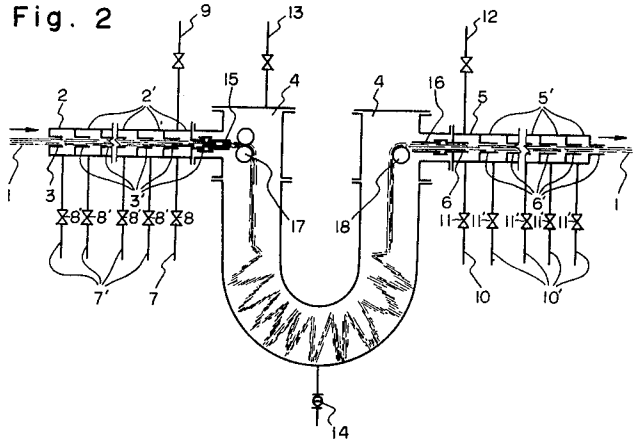
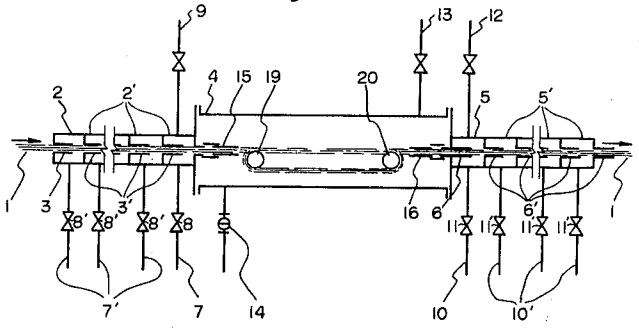


Fig. 3



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METHOD FOR THE CONTINUOUS TREATMENT OF TEXTILE BUNDLES WITH PRESSURE STEAM

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10 Claims. (Cl. 8—149.3)

The present invention relates to a method for the continuous treatment of textile-bundles with pressure steam. More particularly, the invention relates to the improvement in the method for treating tows of man-made fibers, yarn-bundles drawn from a number of bobbins on a warping creel in the preparatory step for weaving, or continuous short fiber bundles such as slivers in the spinning process, by continuously passing the same through a chamber for treatment with a pressure-heated steam at a temperature higher than 100° C., which improvement comprises that the chamber in which the textile bundles are treated has a plurality of pressure cells at the inlet and outlet ends, each of said pressure cells having a discharge pipe for leaking under steam pressure and condensate from the passing holes for the bundle, whereby a part of the steam which is passed to each cell from the adjacent pressure cell of higher pressure side through the bundle-passing hole is discharged through the discharge pipe and the remaining part of the steam is passed through the bundle-passing hole towards the next pressure cell of lower pressure-side, and thereby the bundle which is in the atmosphere at the inlet and of the treating chamber is passed through a number of pressure cells having stepwise elevated pressures toward the pressure steaming chamber, and, after being subjected to the treatment with a pressure steam, is drawn out through a number of pressure cells having stepwise lowered pressures to the atmosphere at the outlet end of the chamber.

One object of the invention is to provide a method for the continuous treatment of textile-bundle, in a chamber with pressure steam, which method makes the velocity of pressure steam leaking along with the bundle moderate by passing the bundle through a number of pressure cells having stepwise varied pressures, in the step of passing of the bundle into, or out of the steam-treating chamber having an elevated pressure through the small holes, thereby decreasing or eliminating injuries of the bundle caused by fluttering by the leaking steam, and decreasing the steam leaking to the atmosphere along with the bundle by discharging the leaking steam through a pipe other than the bundle-passing holes, and, thus, facilitating the continuous operation under a pressure. Another object of the invention is to provide apparatus having mechanism for carrying out the above-mentioned method.

It has been well known to heat-treat regenerated cellulosic fibers with saturated steam at an elevated temperature in the presence of moisture to remarkably increase the usefulness and i.e. the properties of the fibers, such as converting the fiber to hydrophobic, lowering and stabilizing the dyestuff absorption ratio, increasing the abrasion resistance, and lowering the plasticity, such as elongation, shrinkage, and deformation, of the fiber. Further, it is known to be a necessary step for remarkably improving the quality of wet-spun acrylonitrile synthetic fibers after stretching and drying, such as in lowering the thermoplasticity preventing the fibrilation, stabilizing the dyeability, and improving the strength to bending and abrasion, of the fiber, to subject the fiber, in the presence of moisture, to heat-treatment with saturated steam at a temperature near the softening point of the fiber, forming a polymer at optimum temperature of about 130° to about

160° C., varying depending generally upon the component of the polymer. Still further, any kind of textile-bundles of natural and man-made fibers are sometimes processed at a superatmospheric pressure when they are treated at an elevated temperature higher than 100° C. in the presence of water with processing agents such as scouring, bleaching, and dyeing. At any rate, an autoclave for batchwise operation has been mainly employed for such cases heretofore.

The present invention provides a method and apparatus for carrying out in continuous way the heat-treatment with pressurized saturated or unsaturated steam.

The textile-bundles to be treated in this invention may be a continuous bundle of textile of approximately uniform size, such as (1) tows of man-made fibers, (2) bundles of spun yarns and filament yarns, and (3) slivers in the spinning process.

The invention will be more fully understood with reference to the attached drawings, which set forth the method, and the apparatus for carrying out the same, of the invention schematically.

In the drawing:

FIGURE 1 diagrammatically illustrates an embodiment according to the invention where the required period of time for the processing is short and the treating chamber is a straight tube,

FIGURE 2 diagrammatically illustrates a second embodiment where the required period of time for the processing is longer, and the treating chamber is U-shape, and

FIGURE 3 shows an embodiment similar to that in FIGURE 1 but with rollers in the pressure-treating chamber, so that the bundle is subjected to tension for a definite period of time while being moved forward and backward on the rollers before being drawn out into the atmosphere.

In FIGURES 1 to 3, the textile-bundle, **1**, moving from the left in the direction shown by the arrow, is passed into the pressure cell, **2**, provided at the inlet end of the pressure treating chamber, **4**, through the bundle-passing hole, **3**, and subsequently into the adjacent pressure cell, **2'**, having a higher pressure, through the bundle-passing hole, **3'**, and finally into the pressure-treating chamber, **4**, where it is subjected to the steam-heat-treatment for a definite time at a definite temperature. Then, the textile-bundle, **1**, is passed to a plurality of pressure cells, **5**, and **5'**, provided at outlet end of the chamber by first passing, through the bundle-passing hole, **6**, and subsequently into adjacent cell **5'** at lower pressure, through the bundle-passing holes, **6'**, and finally into the atmosphere.

The steam leaking from the bundle-passing hole, **3'**, at the inlet end of the pressure-steaming chamber towards the pressurized cell passes countercurrently with the direction of travel of the bundle and is directly exhausted to the atmosphere or in water through the discharge pipes, **7** and **7'**, provided for each of the cells, by adjustment of the valves, **8** and **8'**. Thus the pressures in each of the cells is arranged to be higher stepwise concurrently with the passing direction of the bundle. The steam leaking from the bundle-passing holes, **6** and **6'**, at the outlet end of the pressure-steaming chamber into the pressure cells passes concurrently with the direction of travel of the bundle and is directly discharged to the atmosphere or in water through the discharge pipes, **10** and **10'**, provided for each of the cells, by adjustment of the valves, **11** and **11'**. Thus the pressures in each of the cells is so arranged as to be lower stepwise concurrently with the passing direction of the bundle. The steam leaking from the pressure-steaming chamber through the textile-bundle-passing hole along with the textile is partly discharged through the discharge pipe having a control valve installed at the first pressurized cell to the atmosphere,

thereby the pressure in the cell being decreased. While, the remainder of the steam leaks through the textile bundle-passing hole into the next pressurized cell, where a part of the steam is discharged through the discharge pipe having a control valve to the atmosphere, thereby the pressure in the second cell being further decreased. Accordingly, the farther the position of the pressurized cell from the pressure-steaming chamber is, the lower the pressure in the cell. If the pressurized cells are not kept warm, the steam is cooled by the walls of the cells to partly liquefy and be discharged through each of the discharge pipes along with a part of the steam.

When prevention of the leakage of the steam from the pressure-steaming chamber as far as possible is intended, a longer textile bundle-passing hole may be employed at the pressurized cell nearest to the steaming chamber, as seen from the figures. Namely, the fine tubes, **15** and **16**, in FIG. 1 may be provided, through which the textile-bundle is passed relatively tightly whereby, the resistance of the leaking steam along with the bundle lowers the steam pressure in the pressurized cell. Sometimes, compressed air having a pressure the same as, or somewhat lower than the steam pressure in the treating chamber may be introduced through the pipes **9** and **12** into the nearest pressurized cells, thereby preventing the leakage of the steam by the compressed air, and filling each of the pressurized cells mainly with the compressed air. Thus, this permits an easier operation, since the discharged flow is mainly composed of air, which contains less heat than the case where steam having a higher temperature is discharged. However, such introduction of compressed air for balance of the steam pressure is not essential in the present invention. At any rate, by providing a number of pressurized cells at the both ends of the pressure-steaming chamber, and by providing textile-bundle-passing holes and a discharge pipe equipped with an adjusting valve for steam at each of the pressurized cells and which is also used to discharge condensate, the pressure difference between the adjacent two small pressure cells can be suitably controlled, thus facilitating the continuous treatment of textile-bundles with pressure steam.

In the pressure-steaming chamber, steam having a definite temperature is introduced through the pipe **13**, and the moisture formed in the treating chamber during the operation is discharged through the steam trap **14** to the ouside of the chamber. When the apparatus is kept warm, however, the moisture is condensed onto the textile bundle which is sent out of the apparatus with a much higher moisture content, and less condensate is generated in the apparatus.

The greater the number of the pressurized cells at the inlet or outlet end of the pressure-steaming chamber, the smaller the pressure differences between adjacent pressure cells. Thus, the fluttering and trembling of the textile bundle are lessened, whereby the deterioration of the textile caused thereby is decreased and made negligible. The experimental results have shown, in cases where a textile bundle has a size that the sectional area of the filaments is about 30 to 40% of the sectional area of the bundle-passing hole through which the bundle is passed, the friction between the bundle and the wall of the hole has small adverse effect on the bundle even at the ordinary operation velocity, i.e. 10 to 80 m./min., but the pressured steam leaks through the inter-space of the textiles to the lower pressure side. It was recognized that, when the pressure difference between adjacent pressurized cells is 0.7 to 1.5 atm., the fluttering and trembling of the textile bundle caused by the current of leaking steam are not sufficient to injure the textile. In this condition, on the contrary, the fluttering and trembling make each textile in the bundle disperse, and the leaking steam melts increased surface frictional resistance. Thus, the operation is carried out smoothly by keeping the pressure differences between adjacent pressurized cells at 0.7 to 1.5 atms., as mentioned above. If the pressure difference is 5 to 10 atms., the fluttering of the textile bundle injures the textile, since the velocity of the leaking steam is too large. Accordingly, if the operating pressure in the pressure-steaming chamber is comparatively higher, the continuous operation for successful pressure steaming is difficult unless a greater number of the pressurized cells is provided.

If the textile-bundle is fully moistened by water or condensation, the textile fibers are adhered together by surface tension of water, and the dispersion or development of the fibers with the leaking steam current is reduced. Therefore, the frictional surface between the textile and the leaking steam current is decreased. As the result, the frictional resistance of the textile in the bundle-passing hole against the leaking steam is far less than the case where the textile composing the bundle is well dispersed. Thus, the pressure-sealing effect of the textile-bundle in the hole is lowered. By this reason, it is desirable for a high-pressure-sealing effect that cohesion of the textile fibers by surface tension of water be avoided, this means that mere moistening of the filaments is permissible while excess water is to be avoided. When the addition of a processing liquor to the textile bundle is required, as in scouring, bleaching, dyeing, etc., it is necessary that the bundle be squeezed as fully as possible for diminution of the added liquor, and for this reason the smaller diameter fine tubes, **15** and **16**, having a sufficiently longer length are used, alternatively, the number of the pressure cells is increased.

The shape of the hole, through which the textile-bundle is passed, is ordinarily circular, but the hole may conveniently have a flat section, especially when the bundle has been squeezed between nip rolls to form a flat section.

In FIG. 2, an example of comparatively longer treating period is shown, wherein the textile-bundle introduced in a pressure-steaming chamber of U-shape is prolonged for a definite period of time before it is discharged from the apparatus. The textile-bundle is forced to be sent in the treating chamber by means of the nip rolls, **17**, overcoming the inlet resistance, and from which the bundle is allowed to drop freely and accumulate naturally in the U-shape chamber without tension. After treatment for a definite period, the textile-bundle is guided through the nip rolls or guide roll, **18**, and then through a number of the pressure cells at the outlet end, to the atmosphere. FIG. 3 shows an example wherein rollers, **19** and **20**, are provided in the treating chamber, wherein the textile-bundle is treated for a comparatively long period while it is moved forward and backward on the rollers under tension.

As fully mentioned above, the present invention is adaptable to the treatment of textile-bundles with a saturated or unsaturated pressure steam having a suitable temperature of higher than 100° C., particularly above 120° C., which permits a continuous steam treatment at 10 to 15 atms. or the higher, which could not be obtained in the past.

We claim:

1. A method of continuously treating a textile bundle wherein the bundle is passed through a chamber for being treated with pressure steam at a temperature in excess of 100° C., the method comprising feeding the bundle successively through separate cells constituting zones of stepwise increasing pressure towards said chamber and wherein the pressure in said zones is controlled by successively allowing discharge of steam from said chamber and through said cells in stepwise decreasing pressure fashion such that the bundle is fed countercurrently with the steam.

2. A method of continuously treating a textile bundle wherein the bundle is passed through a chamber for being treated with pressure steam at a temperature in excess of 100° C., the method comprising feeding the bundle successively through separate cells constituting zones of

stepwise increasing pressure towards said chamber, treating said bundle in said chamber, removing the bundle from said chamber through separate cells constituting zones of stepwise decreasing pressure, and controlling the pressure in said zones by successively allowing discharge of steam from said chamber and through said cells in stepwise decreasing pressure fashion such that the bundle is fed countercurrently with the steam as the bundle advances otwards said chamber while the bundle is fed concurrently with the steam as the bundle is fed from said chamber.

3. A method of continuously treating a textile bundle comprising feeding the bundle through separate cells constituting inlet zones of stepwise increasing pressure to a chamber of maximum pressure, the pressure in said chamber being obtained by pressure steam at a temperature greater than 100° C., and withdrawing the bundle after treatment in said chamber through separate cells constituting outlet zones of stepwise decreasing pressure, said stepwise pressure zones being formed by bleeding off pressure steam from the chamber and through said cells respectively in countercurrent flow with the bundle in the inlet zones and in concurrent flow with the bundles in the outlet zones and wherein the steam in each cell is in turn bled off to the atmosphere in controlled quantities to regulate the pressure in said zones.

4. A method as claimed in claim **3** comprising forming the bundle from continuously spun man made fibres in the form of a tow.

5. A method as claimed in claim **4** comprising forming the bundle by drawing the fibres from a plurality of bobbins on a warping creel.

6. A method as claimed in claim **3** comprising forming the bundle from a sliver of textile fibres in a spinning process.

7. A method as claimed in claim 3 comprising supporting said bundle in substantially straight fashion as the same traverses said zones and chambers.

8. A method as claimed in claim **3** comprising exerting a tension on the bundle to maintain the same in stretched condition as the bundle traverses said zones and chamber.

9. A method of treating a textile bundle composed

of individual fibers comprising feeding the bundle through separate cells constituting zones of stepwise increasing pressure to a treating chamber wherein the pressure is a maximum and is obtained with pressure steam at a temperature greater than 100° C. and a pressure exceeding 10 atmospheres and withdrawing the bundle from the treating chamber through separate cells constituting zones of stepwise decreasing pressure, said stepwise zones being formed by discharging pressure steam from the treating chamber in opposite directions respectively in countercurrent with the direction of travel of the bundle being fed into said chamber and concurrently with the direction of travel of said bundle as the same is withdrawn from the chamber, the pressure steam successively flowing to cells more distant from the treating chamber along the same path of travel of the bundle to pass through the bundle and disperse the fibers thereof while the pressure steam is controllably discharged in part externally from each cell to regulate the difference in pressure between adjacent cells.

10. A method as claimed in claim **9** wherein said treatment in said chamber includes heat setting, annealing, scouring, bleaching and dyeing.

References Cited by the Examiner

UNITED STATES PATENTS

1,577,311	3/26	Dudley	68—5
1,577,315	3/26	Dudley	68—5
1,663,845	3/28	Jacoby	8—149.3
1,738,946	12/29	Chapin	8—149.3
2,276,394	3/42	Hill	68—54 X
2,427,054	9/47	Jacobson	68—54 X
2,468,081	4/49	Koster	8—149.3
2,622,961	12/52	Finlayson	8—149.3
2,989,026	6/61	Gardner.	
3,066,006	11/62	Sonnino	68—5 X

FOREIGN PATENTS

705,101	3/54	Great Britain.

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