Fig. 1

Fig. 2

Fig. 3

Fig. 4

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ATTORNEYS
DEVICE AND METHOD FOR TREATING A RUNNING ARTIFICIAL MULTIFILAMENTARY THREAD WITH A GAS JET

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18 Claims

ABSTRACT OF THE DISCLOSURE

The invention provides novel apparatus and method for treating running multifilamentary thread, and a resultant novel thread, said thread having little or no twist and its components and closely interlinked to one another, the thread being passed through spaced guides arranged with respect to a nozzle which delivers pressurized gas onto the guided thread and thereby into an opposing resonant chamber so that the line joining the guide center intersects the common axis of the nozzle and said chamber, the nozzle outlet port and the chamber inlet comprising two vertical slits, the height of the nozzle slit being between 5 mm's and 15 mm's, and its width being between 0.1 mm and 0.5 mm, the height of the chamber slit being between 5 and 15 mm's, its width being between 1 and 3 mm's, and the distance between said two opposing slits being between 3.1 mm's and 6 mm's.

This invention relates to an apparatus and a method for treating a running multifilamentary thread, having a little twist or no twist at all, with a gas jet so as to interlink the filaments, and also to the threads so treated and the textile articles obtained with the threads so treated.

As it is generally known, multifilamentary threads having little twist or no twist at all, can be subjected with difficulty to textile processing runs such as weaving and knitting since these threads have too loose a structure.

In order to do away with said loose structure, the multifilamentary artificial threads are twisted and, if necessary so demands, sized so as to improve the coalescence of the threads.

That twisting, however, is a burdensome task, both in term of waste of time and expenditures, many attempts having been made to find out other methods by which the structure of artificial multifilamentary threads having little or no twist could be made more coherent.

Conventional devices are known for treating a running artificial multifilamentary thread, said devices comprising a nozzle, through which a pressurized gas is fed, a resonant chamber, whose inlet has the same shape as the nozzle outlet, and two thread guides positioned, with respect to said nozzle and said resonant chamber, so that the line joining their centers meets at an angle the nozzle axis, the latter generally coinciding with the axis of the resonant chamber.

With the aid of said devices, a jet of pressurized air is directed from the nozzle so as to impinge on a thread running between said two thread guides, whereafter the gas jet enters a resonant chamber.

As a result of the action of the gas jet against the thread subjected to draw and running, in coaction with the action of the resonant chamber, the thread filaments are interlinked, and thus they coalesce. Since the thread is kept under tension, it remains smooth when undergoing treatment and does not acquire bulk, a fact which would have taken place if the thread feeding speed has exceeded the takeup speed and the threads had thus been fed without tension. A smooth thread obtained in this manner and whose filaments are coalesced will be indicated in the following as an "interlinked thread." The interlinked thread as hereinbefore defined can be treated on a weaving loom or a knitting machine without requiring any previous twisting.

In the conventional devices, the shape of the nozzle outlet and the inlet of the resonant chamber are generally indicated as being of circular shape. The possibility of having nozzle outlets and resonant chamber inlets, respectively, of a shape other than circular, has hardly been foreshadowed in the Italian patent specification No. 679,018, but nothing is disclosed therein as to the actual shape a non-circular outline should have, nor anything more is said, which is more important, as to the dimensions one should impart to a non-circular opening. Nothing is likewise disclosed about the depth of a resonant chamber having a non-circular opening, nor about the distance between the nozzle outlet and the resonant chamber inlet when non-circular peripheral outlines are involved. A shortcoming of the known devices having circular nozzle outlet ports is that the diameter of said port should be rather small, for example one or two millimeters so as to avoid an unduly high consumption of air which, in an industrial application of the method would have a negative bearing on the cost of the interlinked thread. On the other hand, should the diameter of the nozzle outlet port be in the order of 1 or 2 mm's, only a restricted area of the running thread would undergo the action of the air jet, coating with that of the resonant chamber, which latter should have an inlet port of circular shape, too. The result is that, in order that an adequate coalescence of the thread filament may be achieved, it is imperative that the running speed of the thread does not exceed a certain value.

A device and a method have now been advised, with whose aid an interlinked thread can be obtained, the component filaments of which are more closely interlinked to one another than it occurred with the prior art interlinked threads, the running speed of the thread being the same.

The inventive device for treating an artificial thread when running under tension and having little or no twist comprises a nozzle, through which a pressurized gas is fed, a resonant chamber opposite to the nozzle and whose inlet port has a non-circular outline similar to the outlet port of said nozzle, two thread-guides arranged, with respect to said nozzle and said resonant chamber, so that the line joining their centers intersects the common axis of said nozzle and said resonant chamber, and is characterized in that the nozzle outlet port and the resonant chamber inlet port are two vertical slits, the height of the nozzle port being comprised between 5 mm's and 15 mm's and its width being comprised between 0.1 mm and 0.5 mm, the height of the resonant chamber slit being comprised between 5 and 15 mm's, its width being comprised between 1 and 3 mm's, the distance between the two confronting ports of said nozzle and said resonant chamber being comprised between 3.1 mm's and 6 mm's.

In the inventive device, it is preferred that the axis of the nozzle and the axis of the resonant chamber be perpendicular to the line containing the centers of the two thread guides, that is, perpendicular to the running thread. It is also preferred that the axis of the nozzle and that of the resonant chamber be coincident.

In order that the device may operate in the best possible way it is important that the longitudinal axes of the outlet port of the nozzle and the inlet port of the resonant chamber, respectively, be coplanar.
The distance between the two thread guides is preferably adjusted to 20-55 mms.
The depth of the resonant chamber, that is, of the vertical slit formed in a block of metal or other suitable material, may vary between 0.5 and 5 mms.

In general, the area of the outlet port of the nozzle is made smaller than the area of the inlet port of the resonant chamber. The inventive device does not generate particularly troublesome noises, and this is doubtless an advantage over a few prior art devices which produced an unbearable whine. However, if desired, a complete silencing can be obtained if the nozzle and the resonant chamber are enclosed in a box of any desired shape which can also have, in its inside, a soundproof material such as flax, wool, glass-wool, foraminous panelboards and the like.

The inventive device can be applied, among the numerous applications which can be imagined of it: past a machine for the continuous production and after-treatment of artificial yarns or past the drawing frames of a drawing and twisting assembly.

The inventive method for treating a multifilamentary artificial thread when running under tension and having a little twist or no twist at all by means of the above described device, comprises the step of directing by means of the nozzle a jet of pressurized gas on a thread running between two thread-guides by which the gas enters a resonant chamber, and is characterized in that the yarn running between the nozzle and the resonant chamber intersects, according to a line perpendicular to the common axis of the nozzle and the resonant chamber, the plane on which lie the longitudinal axes of the nozzle outlet port and the resonant chamber inlet port, respectively.

The pressure of the gas jet is preferably comprised between 0.5 and 10 atmospheres. Any kind of gas can be used, such as air, carbon dioxide, nitrogen, or also vapours such as steam. For reason of economy, however, air is the preferred gas.

According to the invention, the tension of the thread being fed should be comprised between 0.05 and 0.3 gram per denier. Although under a tension of less than 0.05 gr./den., the interlinking of the filaments may still take place, the thread interlinked in this way will show loops on its surface. If, conversely, the tension is more than 0.3 gr./den., only a reduced interlinking will be the result. It is preferred, in any case, that the tension of the thread be comprised in the range of from 0.1 to 0.15 gr./den.

The thread being treated should have little or no twist. The term "little twist" is used to indicate a thread having a twist of not more than 40 twists per linear meter. If the twist is more than that, the filaments are not rumped up by the gas jet so that no filament interlinking is obtained.

Various kinds of artificial yarns can be treated with the inventive process. Among these, for example, for example, polyamides, polyesters, polyalkylenes, polyacrylonitriles, cellulose acetate, regenerated cellulose, glass and others. The denier count of the yarns can vary from low values (20) to a high value (2000 and over).

According to the inventive method, the distance between the thread guides is comprised between 20 mms. and 55 mms. As a general rule, the higher is the pressure at which the gas jet comes out of the nozzle, the higher the distance between the thread guides should be.

According to the inventive method, the depth of the resonant chamber is preferably comprised between 0.5 and 5 mms. For depths of less than 0.5 mm. or of more 5 mms. the coalescence of the filaments does not attain a satisfactory value any longer.

The mutual distance between the confronting ports of the nozzle and the resonant chamber is preferably adjusted to from 3.1 mms. to 6 mms. The sizes of the slits of the nozzle and the resonant chamber, respectively, according to the inventive method, have preferably the following dimensions: the height of the nozzle slit is preferably between 5 and 15 mms. and its width between 0.1 and 5 mms., whereas the width of the resonant chamber is between 5 and 15 mms. and its width is between 1 and 3 mms. The result is that according to the inventive method it is preferred that the area of the nozzle outlet is smaller that the area of the resonant chamber.

The inventive method is preferably carried out by enclosing the nozzle and the resonant chamber within a box having any desired shape so as to obtain a nearly total silencing of the device. To this end, the inner walls of the box can also be lined with an insulating material such as cotton wool, glass-wool, foraminous panelboards and the like.

The invention is now further illustrated with reference to the accompanying drawing which, however, is not to be construed as a limitation.

FIG. 1 shows a cross-sectional view of the device as viewed from below, the section being taken along a plane containing the common axis of the nozzle and the resonant chamber.

FIGS. 2 and 3 show a front view of the nozzle outlet slit and of the resonant chamber inlet slit, respectively.

FIG. 4 is a section in plane of the device taken along a plane passing through the axis common to the nozzle and the resonant chamber.

In FIG. 1, the numeral 1 indicated the nozzle and the numeral 2 the resonant chamber. The thread-guides 3 are positioned in such a way that a moving thread 4, running between said guides, is moved between the nozzle outlet slit 5 and the inlet slit 6 of the resonant chamber; these are vertically arranged slits. The gas jet 7 thus impinges on the thread and then penetrates into the resonant chamber.

In FIG. 2, the characters I—I indicate the longitudinal axis of the slit 6 of nozzle 1. In FIG. 3, the characters II—II connote the longitudinal axis of the slit 6 of the resonant chamber 2.

In FIG. 4 can be seen how the thread 4 is coplanar with the axes I—I and II—II. Said plane intersects at right angles the plane of the sheet of drawing along the line III—III.

Not to overcrowd the drawings too much, the thread guides 3 are shown with a diameter which is higher than that which would be appropriate for the filament vibrations of the thread outside the plane passing through the line III—III. It should also be noticed that the form of the thread guides could also be other than the eyebolt shape down in the drawings, without therefor falling outside the scope of this invention.

The invention will now be further explained with reference to a few practical examples.

The degree of mutual interlinking of the filaments is indicated herein as "coalescence factor" and is measured as follows:

A thread having the length of 100 cms. is suspended, with a clamp, in front of a scale which has a centimeter graduation. A clip is fastened to the free-falling end of the thread, said clip having a weight of 0.2 gr. per denier, but will not exceed in any case a total of 100 gms.

In correspondence with the zero of the graduated scale, immediately below the clamp, a steel needle, having a thickness of 0.4 mm. and which has been bent through 120°, is inserted into the thread, taking care that said needle is inserted as near as practicable to the center of the filament bundle. At least one-fourth, and preferably at least one-third of the filaments should be on a side of the hook.

The hook is lowered by hand with caution so as not to damage the filaments, at a speed of 2 cms. per second approx. The hook is continuously depressed until the
thread offers a considerable resistance, which is due to a close entanglement of the filaments. At this stage, the filaments would be broken if the lowering of the hook is further insisted upon. In correspondence with the point at which the hook has been stopped, the distance, expressed in cm., through which the hook has been brought down, is read out. The determination is repeated 10 times on additional samples of the same thread, whereafter the average descent distance of the hook is reckoned.

The said value is expressed as $x$. The factor of coalescence is thus defined:

$$\frac{100}{x}$$

**Example 1**

A device such as described in the foregoing, installed on a drawing and twisting assembly, past the drawing members and before the takeup members, is employed. The dimensions of the nozzle outlet port were: height 8 mm., width 0.15 mm. The dimensions of the inlet port of the resonant chambers were 8 mm. of height and 1.4 mm. width. The depth of the resonant chamber was 2.6 mm. The distance between the confronting ports of the nozzle and the resonant chamber, respectively, was 4 mm. The interval between the thread guides was 22 mm.

Both the nozzle and the resonant chamber were enclosed within a box having a swingable door in the front wall.

A nylon-6 thread, formed by 15 filaments and whose final count after drawing was 60 deniers, was passed through the interlinking device at a speed of 460 meters/minute. The twists of the thread as introduced in the device were not more than 20 twists per meter, the tension of the thread before the thread guide was 0.1 gr. per denier. The air pressure, at the outcome of the jet from the nozzle was 4 atmospheres.

Upon treatment, the thread had a coalescence factor of 81.

An identical thread was treated in similar manner with the device described in the Italian patent specification No. 679,018, in which the nozzle outlet port and the resonant chamber inlet port were circular. In spite of all attempts of trying all the conditions specified in the examples of the above mentioned Italian patent, that is by varying the distance between the nozzle outlet and the resonant chamber inlet, the distance between the thread-guides, the diameter of the circular inlet to the resonant chamber, the capacity, diameter and depth of the resonant chamber, the air pressure, it was not possible to obtain a value of the coalescence factor comparable with the one obtained with the inventive device. In point of fact, the maximum coalescence value obtained with the device disclosed in the Italian patent specification No. 679,018 was but 25. It should be noticed at this stage that the coalescence factor is a function of the running speed of the thread through the device, all the other conditions being the same, in the sense that said factor is decreased as the running speed is increased.

A comparison with a similar thread treated in similar manner was made also with apparatus described in the copending Italian patent application No. 1,099 of Feb. 9, 1965 in the name of the same applicant.

Also in this case, in the best conditions, the maximum value obtainable for the coalescence factor was 36.

**Example 2**

The procedure was the same as used in Example 1 with the inventive device, the only difference being that the running speed of the thread was 590 meters per minute. The thread so treated had a coalescence factor of 35.

Since a thread adapted to be processed on textile machinery in replacement for twisted thread, should have a coalescence factor of at least 30, the result is that a thread with the proper filament coalescence is obtained even with a high running speed.

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Air pressure, atmospheres</th>
<th>Resonant chamber depth, mm.</th>
<th>Distance between nozzle and chamber</th>
<th>Coalescence factor</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>2.6</td>
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<tr>
<td>11</td>
<td>2.6</td>
<td>2.6</td>
<td>4</td>
<td>41</td>
</tr>
</tbody>
</table>

**Example 3**

The same procedure indicated in Example 1 was followed in the inventive device, the difference being that in a few tests a few data were varied, such as the pressure of the air jet, in other tests the depth of the resonant chamber, in still further tests the distance between the confronting ports of the nozzle and the resonant chamber, respectively. The following table reports the respective results.

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Air pressure, atmospheres</th>
<th>Resonant chamber depth, mm.</th>
<th>Distance between nozzle and chamber</th>
<th>Coalescence factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
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<td>2.6</td>
<td>2.6</td>
<td>4</td>
<td>41</td>
</tr>
</tbody>
</table>

**Example 4**

The same procedure of Example 1 was followed, the only difference being that nylon-6 thread when running and subjected to the treatment with the inventive device had 40 filaments and a final count after drawing of 100 deniers. The coalescence factor of a thread so treated was 78.

What is claimed is:

1. A device for treating a multifilamentary artificial thread under tension having little or no twist, comprising: a nozzle having an elongated outlet port through which a pressurized gas is fed, a resonant chamber opposite to said nozzle, said chamber having an elongated inlet port spaced from and extending in the same direction as said nozzle outlet port, said nozzle and said chamber having a common axis, two thread guides arranged so that the line joining their centers crosses said common axis, characterized in that the longitudinal axes of the nozzle outlet port and the resonant chamber inlet port extend in the same direction as and are substantially coplanar with said line.

2. A device according to claim 1 characterized in that the nozzle outlet port and the resonant chamber inlet port are both slits, the height of the nozzle port being comprised between five mm. and fifteen mm. and its width being comprised between 0.1 mm. and 0.5 mm., the height of the resonant chamber slit being comprised between 5 and 15 mm., its width being comprised between 1 and 3 mm., the distance between the two confronting ports of said nozzle and said resonant chamber being comprised between 3.1 mm. and 6 mm.

3. A device according to claim 2, characterized in that the axis common to said nozzle and said resonant chamber is perpendicular to the line passing through the centers of the two thread-guides.

4. A device according to claim 2, characterized in that the distance between the two thread guides is between 20 and 55 mm.

5. A device according to claim 2, characterized in that the depth of the resonant chamber is comprised between 0.5 mm. and 5 mm.

6. A device according to claim 2 characterized in that the area of the nozzle outlet port is smaller than the area of the resonant chamber inlet port.

7. A device according to claim 2, characterized in that the nozzle and the resonant chamber are enclosed in a boxlike structure.

8. A method for treating a multifilamentary artificial thread running under tension and having little or no twist, the steps comprising: directing a jet of pressurized
gas from a nozzle having an elongated outlet port into a resonant chamber having an elongated inlet port spaced from and extending in the same direction as said nozzle outlet port, running a thread under tension through said jet along a line which crosses a common axis of the nozzle and the chamber and lies in the plane containing the longitudinal axes of said nozzle outlet port and said resonance chamber inlet port, respectively.

9. A method according to claim 8, characterized in that the thread is run between two thread guides spaced between 20 and 55 mms. apart.

10. A method according to claim 8, characterized in that the nozzle outlet port and the resonance chamber inlet port are both slits, and that the nozzle slit has a height comprised between 5 and 15 mms. and a width comprised between 0.1 and 0.5 mm., the slit of the resonant chamber having a height comprised between 5 and 15 mms. and a width comprised between 1 and 3 mms.

11. A method according to claim 8, characterized in that the gas jet has a relative pressure of from 0.5 to 10 atmospheres.

12. A method according to claim 11, characterized in that the thread has a twist not higher than 40 twists per meter.

13. A method according to claim 8, characterized in that the tension of the thread is comprised between 0.05 and 0.3 gram per denier, preferably from 0.1 to 0.125 gram per denier.

14. A method according to claim 8, characterized in that the depth of said resonant chamber is comprised between 0.5 and 5 mms.

15. A method according to claim 8, characterized in that the distance between the confronting ports of the nozzle and the resonant chamber is comprised between 3.1 and 6 mms.

16. A method according to claim 8, characterized in that the area of the nozzle outlet port is smaller than that of the resonant chamber inlet port.

17. A method according to claim 8, characterized in that said nozzle and said resonant chamber are enclosed in a boxlike enclosure.

18. An artificial thread treated according to the method of claim 8.

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JOHN PETRAKES, Primary Examiner.

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