March 24, 1964 C. J. GONSALVES 3,125,793

INTERLACED YARN BY MULTIPLE UTILIZATION OF PRESSURIZED GAS

Filed Aug. 20, 1962

FIG. 1

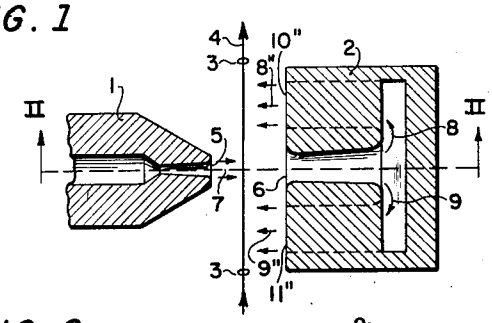


FIG. 2

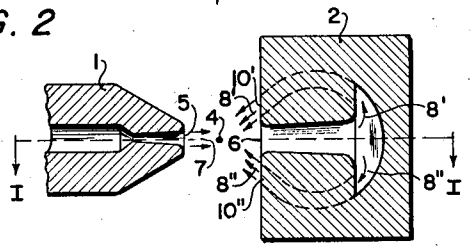


FIG. 3

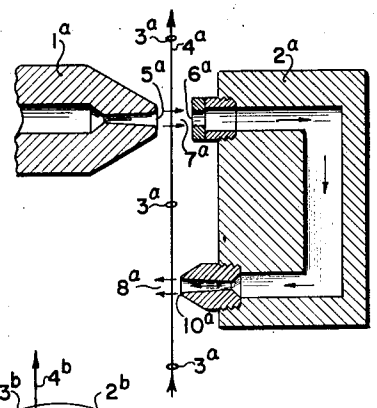
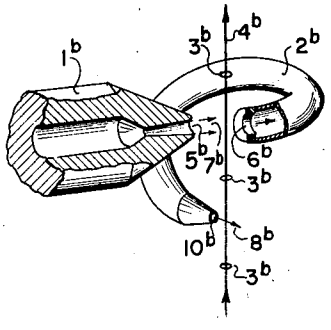


FIG. 4



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INTERLACED YARN BY MULTIPLE UTILIZATION OF PRESSURIZED GAS

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This invention relates generally to tangled yarn or thread and more particularly to a system for treating a moving, multi-filament artificial thread with a gas jet so that the filaments will be intertwined.

As is generally known, artificial multi-filament threads having little or no twist cannot practically be subjected to various textile treatments, such as weaving and knitting, since the structure of these threads is too loose. To prevent a loose structure, the artificial multi-filament threads are generally twisted after manufacture, thus requiring an additional operation. If necessary, the twisted threads are also sized, as a result of which the filaments exhibit even better coherence properties.

Since twisting is a time-consuming and costly operation, many attempts have been made to find other methods by which the structure of artificial multi-filament threads having little or no twist can be condensed. In one known method an artificial multi-filament thread having little or no twist is passed through an enclosed space in which a gas jet is directed onto the thread. See U.S. Patent No. 2,985,995, dated May 30, 1961. The thread is withdrawn from the enclosed space at a rate which is practically the same as the feed rate. As a result of the gas jet blowing against the tensioned thread, the filaments are separated and intertwined. In the thread thus treated, which has practically the same denier as the original thread, the filments are interlaced and consequently kept together. Since the thread is under tension during the treatment, the treated thread has a tense appearance and shows no loops on the surface.

A thread treated in the manner suggested above will hereinafter be referred to as tangled yarn. The tangled yarn is satisfactorily entwined and need not be twisted before being processed on weaving and knitting machines, although in some cases it may require sizing.

There is another known method for the manufacture of tangled yarn. See Canadian Patent No. 554,150. This second method comprises directing a high velocities gas jet having a small diameter onto an artificial multi-filament thread running between two thread guides, and guiding the gas jet past the thread into an enclosed space which is constructed as a resonance chamber. It has been found that an improved result can be obtained if this known system is modified so that at least one primary gas jet is directed onto the low or untwisted thread at a gauge pressure of from 0.5 to 10 atmospheres, while feeding the thread under a tension of from 0.03 to 0.3 gram per denier, the gas being discharged from the enclosed space and redirected onto the thread as a single or multiple secondary gas jet at some distance from the point at which the primary gas jet comes into contact with the thread.

An object of the present invention, therefore, is to provide a yarn tangling system functioning to provide more filament intertwining than heretofore possible.

Another object of this invention is to provide a yarn tangling system which provides the desired filament intertwining in a more economical manner than heretofore possible.

Still another object of the present invention is to provide a yarn entwining apparatus which may be easily fabricated and which requires little or no maintenance.

According to the present invention, a primary gas jet is utilized two or more times, which not only yields a better tangled yarn, as will be shown presently, but also affords an economy on the use of gas under presure.

The primary gas jet may be diverted past the thread and at some other point again be directed onto the thread. However, the primary gas jet also may be split up into two or more gas jets, which are directed onto the thread at different points. It is clear that the velocity of the secondary gas jet or jets should be such that the thread filaments are separated and then intermingled. The gauge pressure of the primary gas jet should be of from 0.5 to 10 atmospheres. Although at a gauge pressure less than 0.5 atmosphere the filaments may still be separated, it can hardly be said that they are intermingled. When using steam, good results are still obtained at a gauge pressure of 0.5 atmosphere. When air is used, however, a gauge pressure of at least 1.5 atmospheres must be maintained in order to effect satisfactory entanglement of the filaments.

Gases must not be used at a gauge pressure higher than 10 atmospheres. This not only would be costly, but also would blow the threads away. Moreover, a uniform entanglement of the filaments along the length of the yarn could not be obtained. Instead of one primary gas jet, use may be made of several primary gas jets which, after passing the thread, may at different points again be directed onto the thread as single or multiple secondary gas jets. In the method according to the invention, use may be made of all kinds of gas under pressure, for instance, carbon dioxide, nitrogen, unsaturated steam, etc. For economy, however, air will generally be chosen.

The artificial multi-filament threads to be treated must have little or no twist. By little twist, it is to be understood that the thread must not show more than 40 turns per meter. The threads to be treated may be of many different kinds, for instance, threads of polyamides, polyester, polyalkylenes, polyacrylonitrile, cellulose acetate, regenerated cellulose, etc. The cross section of the filaments of these threads may be circular or have a different shape.

The tension in the thread fed must be at least 0.03 gram per denier. Although the filaments will also entangle at a lower tension, the surface of the threads will then show filament loops. At a tension of more than 0.3 g./denier, the filaments do not become entangled. To obtain entanglement, the pressure of the gas would have to be chosen very high. At such a high pressure, however, the thread is blown away, as indicated earlier.

The angle at which the primary gas jet is directed onto the thread may be acute, right, or abtuse. This also applies to the angle at which the secondary gas jet or jets is (are) directed onto the thread. The primary gas jet is preferably directed perpendicular to the thread. In that case, it is recommended that the secondary gas jet or jets also be directed perpendicular to the thread, but in a direction opposite to that of the primary gas jet.

The velocity of the secondary gas jet should be such that it separates and subsequently interlaces the filaments. This can only be achieved if the gas pressure is sufficiently high before the gas leaves the enclosed space. If this should not be the case, then it is recommended that the gas pressure in the exit be increased.

When treating the artificial multi-filament threads, it is sometimes found that the threads have an electrostatic charge. To obtain a better entangled yarn, it is recommended that the electrostatic charge be removed from the withdrawn thread. This may be done in a simple manner, as by wetting the thread with material containing a wetting agent, or with water. If desirable for special purposes, a sizing agent may be added to the water.

Apparatus for carrying out the methods according to the

invention comprise a nozzle, a chamber provided with an opening opposite the exit of the nozzle, and thread guides which are so positioned that a line passing therethrough intersects the center line of the nozzle exit. This apparatus is constructed so that the distance between the exit of the nozzle and the line passing through the thread guides is 1 to 3 mm. and the chamber is provided with at least one outlet for discharging the gas from the chamber, which outlet discharges at a distance of from 0.5 to 2 mm. from the line passing through the thread guides, but displaced from the point of intersection of the line passing through the thread guides and the center line of the exit of the nozzle.

The bore of the nozzle may be round or oval, or any other shape found to be suitable. The cross sectional area of the bore may remain constant, but it is also possible for the bore to diverge towards the end of the nozzle. If the exit of the nozzle (primary gas jet) is positioned at less than 1 mm. or more than 3 mm. from the line passing through the thread guides, then the filaments of the thread are interlaced insufficiently. Moreover, if the outlet of the chamber (secondary gas jet) is positioned at less than 0.5 mm. or more than 2 mm. from the line passing through the thread guides, then the filaments also are not entangled satisfactorily. If the gas flowing from the chamber contacts the thread at the same point as does the primary gas jet, then the filaments are interlaced insufficiently.

In a favorable construction, the center line of the exit of the nozzle is perpendicular to a line passing through the thread guides. The apparatus operates even better if the center line of the outlet of the chamber is also perpendicular to the line passing through the thread guides, and if the direction of discharge of the nozzle is opposite to that of the chamber.

Very good results are obtained using one of the aforementioned apparatus if the inlet of the chamber has the same shape as and is from one to two times the size of the nozzle exit, and if the chamber outlet has a smaller diameter than the inlet thereof and discharges at a distance of from 0.5 to 2 mm. from the line passing through the thread guides. By preference, the outlet of the chamber in this apparatus is formed by a nozzle. To increase the degree of entanglement, it may be desirable in some cases to use a series of these apparatus, one after another, for treating a running thread.

The interlace density, hereinafter referred to as coherency factor, of the filaments is determined as follows. A thread of at least 60 centimeters long is suspended by a clamp in front of a vertical scale graduated in centimeters. Attached to the lower end of the thread is a clip, the weight of which is numerically equal to 0.2 times the denier of the thread and which should not be greater than 100 grams (as when the denier of the thread exceeds 500). Immediately below the suspension clamp a steel needle 0.4 mm. in thickness and bent through 120° is inserted into the yarn at a point as closely as possible to the center of the bundle of filaments. At least one-fourth of the number of filaments should be on one side of the hook, preferably, however, at least one-third of the number of filaments.

The hook is carefully lowered by hand (without damaging the filaments) at a rate of about 2 cm./second. The hook will be lowered, without causing damage and possibly while unravelling some slight entanglements of the filaments, until a point is reached where the filaments are heavily interlaced. Further lowering would only result in breakage of filaments. The hookdrop distance thereby traversed through the thread is then read. Hookdrop distances of more than 50 cm. are recorded as 100 cm. Since the needle is inserted rather inaccurately, 0.5 cm. is subtracted from the distance read. The determination is repeated ten times with additional samples of the same yarn, after which the average hookdrop distance (x) is calculated. The coherency factor is defined as

$100/x$. If a multi-filament thread is to be capable of being processed without being twisted, a coherency factor of at least 1.5 is required.

The present invention will be described more specifically hereinbelow with particular attention being directed to the drawings, wherein:

FIGURE 1 and 2 represent cross sectional views of the same apparatus through the axis of a gas jet or nozzle and at a relative angle of 90°, FIGURE 1 being in the direction of the arrows I—I in FIGURE 2, and FIGURE 2 being in the direction of the arrows II—II in FIGURE 1;

FIGURE 3 shows in section a different apparatus according to the invention in the plane through a line connecting the thread guides and also through the center line of the nozzle; and

FIGURE 4 is a view in perspective of another apparatus according to the invention, the center line of the nozzle and the center line of the outlet of the chamber crossing each other at an angle of 90°.

In FIGURES 1 and 2, the numeral **1** refers to the air nozzle and the numeral **2** to the air chamber. The thread guides **3** are so positioned that a moving thread **4** passing through these guides runs between the exit **5** of the nozzle **1** and the circular inlet **6** of the chamber. The exit **5** is circular and measures 1.2 mm. in diameter, whereas the inlet **6** measures 1.4 mm. in diameter.

Upon passage through the chamber, the primary gas jet **7** is split up into two gas jets **8** and **9**, which in turn are split up into the gas jets **8'**, **8''**, **9'** (not shown since it is not in the plane of the drawing), and **9''**. These jets discharge from the chamber by the slit-shaped outlets **10'**, **10''**, **11'** (not shown, since it is not in the plane of the drawing), and **11''**. The secondary jets **8'**, **8''**, **9'**, and **9''** blow against the thread at a point displaced from that against which the primary gas jet **7** blows.

In FIGURE 3, the numeral 1^a refers to the nozzle and the numeral 2^a to the chamber. The thread guides 3^a serve to pass a thread 4^a in front of the circular nozzle exit 5^a which measures 1.2 mm. in diameter. Opposite the exit 5^a there is the circular chamber inlet 6^a which measures 1.4 mm. in diameter. The chamber is provided with an outlet 10^a in the form of a nozzle having a circular exit which measures 1.2 mm. in diameter. The gas jet 7^a issuing from the nozzle 1^a flows past the thread 4^a into the chamber 2^a and leaves the chamber by the outlet 10^a. In FIGURE 4 numeral 1^b represents the nozzle and numeral 2^b represents a curved tubular chamber. Thread guides 3^b align thread 4^b with circular nozzle exit 5^b similar to that described above and with circular chamber inlet 6^b also similar to that described above. Gas jet 7^b issuing from the nozzle flows past the thread and discharges as a secondary jet 8^b from outlet 10^b. For even more details, attention is directed to the following specific examples.

EXAMPLE I

For these tests, use was made of the apparatus shown in FIGURE 3. The distance from the exit 5^a to the thread 4^a was 1 mm., and from the inlet 6^a and the outlet 10^a to the thread, 2 and 1 mm., respectively.

A 24-filament nylon thread having a denier of 70 and a twist of 20 turns per meter was passed through the thread guides **3** at a rate of 150 meters/minute. The tension in the thread before the first thread guide was 0.1 g./denier. The ratio of feed rate to draw off rate of the thread was 1. The thread was treated with air at 20° C. and a gauge pressure of 4 atmospheres. The treated thread showed a coherency factor of 12.1.

An identical thread was treated in an analogous manner with the aid of an apparatus according to the aforesaid Canadian Patent No. 554,150 and an apparatus according to FIGURE 4 of the said U.S. Patent No. 2,985,995, respectively. The yarns obtained showed coherency factors of 4.5 and 3.6, respectively. Under analogous conditions, the apparatus according to the in-

vention consequently yielded a yarn having a higher coherency factor.

EXAMPLE II

Use was made of the apparatus shown in FIGURE 3 for these experiments. Conditions were identical with those of Example I, with the following exceptions. In runs 4 and 5 (see Table I), the tension in the thread was 0.3 and 0.03 g./denier, respectively, instead of 0.1 g./denier, and the gauge pressure of the primary gas jet was 10 and 1.5 atmospheres, respectively. In run 6, steam of 120° C. and at 0.5 atmosphere gauge pressure was used instead of air about 20° C. The tension in the thread was 0.03 g./denier. In this run, the ratio of feed rate to draw off rate of the thread was 0.96, in order to allow the thread to shrink. The following table shows the test conditions and the results obtained.

Table I

Run	Thread tension in g./denier	Ratio of feed rate to draw off rate	Gauge pressure in atm.	Cohrency factor
4	0.3	1.0	air 10	3.1
5	0.03	1.0	air 1.5	2.6
6	0.03	0.96	steam 0.5, 120° C.	8.7

EXAMPLE III

The apparatus according to FIGURE 3 was again used for these further tests. Conditions were identical with those of Example I, with the following exceptions. In runs 7, 8, 9 (see Table II), the thread tension was 0.0, 0.04, and 0.1 g./denier, respectively, and the ratio of feed rate to draw off rate of the threads was 0.98, 0.99, 1.0, respectively. In run 10 the thread tension was 0.1 g./denier and the ratio of feed rate to draw off rate of the thread was 1.0. Also in this run, the thread was wetted with water immediately before winding. In run 11, the thread tension was 0.1 g./denier and the ratio of feed rate to draw off rate of the thread was 1.0. In contrast with run 9, no use was made of the nozzle **10**[a].

Test conditions and results are shown in Table II. The runs 7, 8, and 9 show that a certain tension is required in the thread to prevent the occurrence of loops on the thread surface. Run 10 clearly shows that wetting after the treatment has a favorable effect. Runs 9 and 11 show that the presence of a nozzle in the outlet of the chamber yields more favorable results.

Table II

Run	Thread tension in g./denier	Ratio of feed rate to draw off rate		Coherency factor
7	0.0	0.98	loops on thread surface	17.8
8	0.04	0.99		15.4
9	0.1	1.0		13.2
10	0.1	1.0	thread wetted after the treatment.	27.1
11	0.1	1.0	nozzle 10 not present	5.4

EXAMPLE IV

In run 12 (see Table III), use was made of the apparatus shown in FIGURE 4, and in run 13 the apparatus shown in FIGURE 1 was utilized. In the runs 14, 15, and 16, use was made of the apparatus shown in FIGURE 3. The other test conditions were identical with those in Example I, except that instead of a nylon thread in the run 15, use was made of a polyethylene terephthalate thread (75-denier, 36-filament, twist 40 turns/meter) and in the runs 16 and 17, a viscose rayon thread (75-denier, 30-filament, twist 0) was treated.

In run 17 the angle at which the primary and/or the secondary gas jet came into contact with the thread was varied from acute to obtuse. In all cases the coherency factor appeared to be relatively low when use was made of angles which deviated considerably from 90°. Test conditions and results are shown as follows:

Table III

Run	Type of thread	Turns/meter	Apparatus	Coherency factor
12	Nylon 70/24	20	Fig. 4	6.7
13	do	20	Figure 1	5.7
14	do	20	Figure 3	11.9
15	Polyethylene terephthalate, 75/36.	40	do	13.6
16	Viscose rayon	0	do	12.9
17	do	0		lower than 12.9

EXAMPLE V

In this test the apparatus shown in FIGURE 3 was used. Conditions were identical with those of Example I, except that the distances from nozzle to thread, from thread to chamber inlet, and from chamber outlet to thread were varied. Test conditions and results are shown in the following Table IV.

Table IV

Run	Type of thread	Turns/meter	Apparatus	Distance to thread in mm.	Distance chamber inlet to thread in mm.	Distance chamber outlet to thread in mm.	Coherency factor
18	Nylon 70/24.	20	Fig. 3	1	5	0.5	3.8
19	do	20	Fig. 3	3	2	2	2.9

It is believed that the foregoing data clearly demonstrates the improved filament intertwining or entanglement made possible by the system described. Inasmuch as modifications other than those included herein will become apparent to those skilled in this art, it is intended that the scope of this invention be limited only to the extent of the following claims.

What is claimed is:

1. A method for treating multifilament artificial threads having substantially no twist comprising the steps of feeding said thread along a rectilinear path under a tension of between 0.03 and 0.3 gram per denier, directing a high velocity primary gas jet having a small diameter and a gauge pressure of from 0.5 to 10 atmospheres against the traveling thread, collecting gas from the primary jet in an enclosed space on the opposite side of the traveling thread, discharging the collected gas from the enclosed space, and redirecting the same as at least one secondary gas jet onto the traveling thread at a point displaced from the primary jet contact zone.

2. A method as set forth in claim 1 wherein the primary gas jet is directed perpendicular to the rectilinear path of thread travel.

3. A method as set forth in claim 2 wherein the secondary gas jet is also directed perpendicular to the rectilinear path of thread travel.

4. A method as set forth in claim 3 wherein the secondary gas jet passes across the thread in a direction normal to that of the primary gas jet.

5. A method as set forth in claim 3 wherein the secondary gas jet passes across the thread in a direction opposite to that of the primary gas jet.

6. A method as set forth in claim 2 wherein the secondary gas jet is directed against the traveling thread at a point preceding thread contact with the primary gas jet.

7. A method as set forth in claim 2 wherein the secondary gas jet is directed against the traveling thread at a point following thread contact with the primary gas jet.

8. A method as set forth in claim 1 and comprising

the additional step of increasing gas pressure during passage of the same through the enclosed space.

9. A method as set forth in claim 1 and comprising the additional step of wetting the treated thread immediately after passage through the jet zone.

10. An apparatus for treating multifilament artificial threads having substantially no twist comprising means for guiding thread along a rectilinear path under a tension of between 0.03 and 0.3 gram per denier, a nozzle aligned with said rectilinear path for directing a high velocity primary gas jet against the traveling thread, means defining a chamber for collecting gas from the nozzle in an enclosed space on the opposite side of the traveling thread, and means for receiving gas from said enclosed space and redirecting the same onto the traveling thread at a point displaced from the nozzle.

11. An apparatus for treating multifilament artificial threads having substantially no twist comprising means for guiding thread along a rectilinear path, a primary nozzle aligned with said rectilinear path for directing a high velocity gas jet against the traveling thread, means defining a chamber provided with an opening on the opposite side of the traveling thread from said primary nozzle for collecting gas therefrom, the spacing between the exit of said primary nozzle and the traveling thread being between 1 and 3 mm., and a secondary nozzle for

receiving gas from the enclosed space and discharging the same onto the traveling thread at a point displaced from the primary nozzle, the exit of said secondary nozzle being spaced a distance of from 0.5 to 2 mm. from the traveling thread.

12. An apparatus as set forth in claim 11 wherein the primary nozzle is directed perpendicular to the rectilinear path of thread travel.

13. An apparatus as set forth in claim 12 wherein the secondary nozzle is also directed perpendicular to the rectilinear path of thread travel.

14. An apparatus as set forth in claim 13 wherein the secondary nozzle directs gas across the thread in a direction normal to that of the primary nozzle.

15. An apparatus as set forth in claim 11 wherein the exit of said secondary nozzle has a diameter smaller than that of the opening in said chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

2,985,995	Bunting et al.	May 30, 1961
3,069,836	Dahlstrom et al.	Dec. 25, 1962

FOREIGN PATENTS

554,149	Canada	Mar. 11, 1958
554,150	Canada	Mar. 11, 1958