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METHOD OF PRODUCING VOLUMIZED YARN

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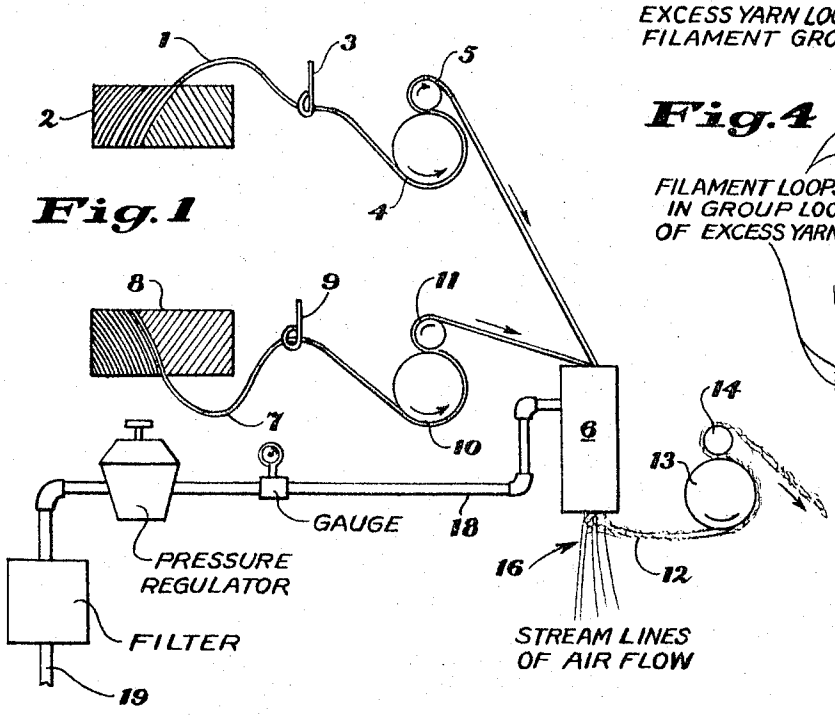


Fig. 1

Fig. 4

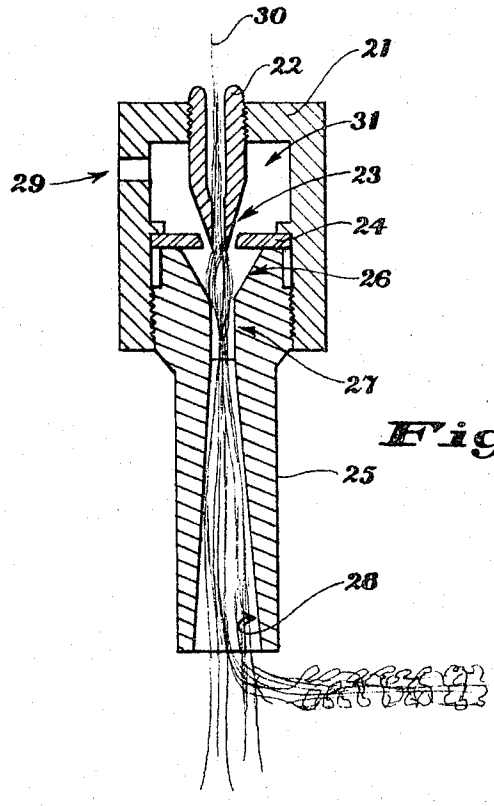


Fig. 2



Fig. 3

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METHOD OF PRODUCING VOLUMIZED YARN

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U.S. Cl. 28—72 17 Claims

ABSTRACT OF THE DISCLOSURE

A process for manufacturing a volumized yarn comprises feeding two multifilament yarns into an air jet where they are combined, and withdrawing them together therefrom as a composite volumized yarn. One of the yarns, the effect yarn is fed into the jet at a rate much greater than the composite yarn is removed, and the second yarn, the core yarn, is fed into the jet at a rate much slower than the effect yarn but sufficiently faster than the withdrawal rate of the composite yarn by an amount sufficient to cause the filaments of the core yarn to open and separate to permit penetration by the looping excess yarn and filaments thereof. The excess or effect yarn thus is caused to interweave back and forth through the core yarn and extend through the core yarn at random points, and to extend from the core yarn in the form of loops. The core yarn acts as a stress-bearing member and stabilizes the resulting composite yarn.

This invention relates to a new and novel yarn product and the method of producing it. More particularly, this invention concerns volumized yarn products of relatively large deniers.

There are many instances in the textile trade such as for drapery and upholstery fabrics where a rough textured yarn of bulky, voluminous nature and of a large denier is desired for use. However, prior to the present invention, such type of yarn material has not been readily and economically obtainable but has required the use of expensive and complicated novelty yarn twisters.

It has been proposed in the art to produce a volumized yarn of low denier material by blowing low denier yarn with air. However, for production purposes such prior art procedure on low denier yarn has permitted the increase of not more than about 30% denier due to the contraction of such yarn in the volumized or bulking procedures. Furthermore, in the prior type of treatment on low denier yarn, usually it has been required that twist be inserted in the yarn either before or after the bulking or volumizing operation to insure good performance of the yarn in subsequent processing into fabrics.

It is, therefore, apparent that the development of a method whereby a large denier volumized yarn suitable for drapery and upholstery fabrics and the like may be simply and economically produced represents a highly desirable result. I have found a method involving the use of multiple yarn feed as will be described in detail hereinafter whereby a volumized product of substantial size may be obtained.

This invention has for an object to provide procedure for producing extra volume in continuous filament yarn and an increase of denier substantially greater than has been heretofore considered possible, excepting by using complicated twisting equipment. Still another object is to provide procedure whereby heavy denier/filament fibers may be incorporated into yarns having a texture similar to spun staple fiber yarn. Still a further object is to provide procedures as just mentioned wherein the need for twist in the voluminous or bulky yarn is eliminated either completely or partially without reduction in processing speed.

Still another object is to produce new and novel voluminous yarn products from continuous filament yarn, which new products have size and volume which render the yarn particularly suitable for the production of unusual and heretofore unobtainable fabric textures and appearances.

I have found that certain new and unusual results may be obtained by feeding a number of continuous yarn filament bundles into a high velocity air jet in a certain manner as will be described in detail hereinafter. For convenience of description certain of this filament bundle feed will be referred to as excess yarn and others will be termed core yarn. My air jet is characterized by its minimum of air turbulence and its high efficiency of conversion of static into velocity pressure. The excess yarn treated in the jet is removed from the jet at a substantially slower rate than it is fed in, say, for example, one-half as fast as it is fed in. At the same time the excess yarn is being supplied, another continuous filament yarn from another source comprising a bundle of filaments which I term the core yarn is fed simultaneously to the jet. This core yarn is of a total denier not substantially greater and usually substantially smaller in total denier than the excess yarn. The rate of feed of the core yarn is only slightly faster than the rate at which the excess yarn is removed.

By this procedure just generally outlined, the passage of the core yarn and excess yarn through the jet blooms out and intermingles the individual filaments of both the core and excess yarn with each other and with the air stream. As the intermingled fibers of both yarns exit from the jet and are removed from the air stream preferably somewhat abruptly and at an angle to the direction of flow of the air stream, certain novel effects occur. That is, the excess yarn filaments tend to continue in the line of the air stream but are restrained by their intermingled state with the core yarn. As a result, there is formed a multitude of filament and yarn loops. The excess yarn filaments as disorganized groups tend to weave back and forth in the structure of the core yarn filaments.

By my process, wherein the rate of feed of the core yarn is controlled in a certain manner, there is a slight contraction of the core yarn which allows the core yarn filaments to be opened up or bloomed out. This facilitates the penetration of the excess yarn filaments in and out and around the core yarn filaments to achieve an intimate interweaving of the individual filaments of both yarns. Since in my process, there is an excess of filament length in the excess yarn, the filaments loop and stand out in the core yarn in a novel and attractive manner. Also, because of this interweaving, the need of twist to hold the filament loops of the excess yarn locked in place is eliminated.

For better understanding of my invention, reference is made to the attached drawing forming a part of the present disclosure. In the attached drawing,

FIG. 1 is a diagrammatic side elevation illustration of a combination of parts which may be used for carrying out my process.

FIG. 2 is a cross-sectional view showing in detail the construction of the air jet such as may be used, which jet gives a minimum of turbulence and a high conversion of static to velocity pressure.

FIG. 3 is a graphic illustration of a heavy denier yarn product such as may be produced by the present invention.

FIG. 4 is a graphic illustration of another effect which may be obtained in yarn produced by the present invention.

Referring now to FIG. 1, excess yarn is indicated at 1 This yarn is fed from a zero twist package 2. Such package would, of course, be held on a suitable support for permitting feed from the package. Since such feed ar-

rangements are conventional, they are not shown in the instant drawings. The excess yarn is passed through a yarn guide **3** to feed roll **4**. An idler roll **5** is positioned in close proximity to roll **4** for assisting in controlling the feeding of the yarn and preventing yarn slippage. The yarn from the aforementioned feed rollers is fed to the jet **6**. The air jet construction will be described in detail hereinafter in connection with FIG. 2.

Turning now to the core yarn designated **7**, this is fed from a zero twist package **8**. As indicated above, these packages would be suitably positioned and equipped in accordance with any conventional procedure to feed the yarn. The core yarn is threaded through yarn guide **9** around feed roller **10** and idler roller **11**. These rollers **10** or **11** are comparable to rollers **4** and **5** just described and function to readily feed the yarn and prevent slippage thereof. The core yarn is likewise fed into jet **6**.

Jet **6** is connected through conduit **18** and through the gauges, pressure regulators, and filter to a source of air at **19** or other suitable and comparable fluid. That is, nitrogen, carbon dioxide, steam or the like gases may be used but air is usually the most convenient and economical. By this arrangement, the jet **6** is furnished with suitable, clean, controlled gas supply of a suitable velocity as will be described hereinafter.

The core yarn **7** and the excess yarn **1**, after combining in jet **6**, exit from the jet gas stream at **16** to give the interwoven and looped volumized yarn now designated **12**. As diagrammatically indicated, the volumized yarn **12** is removed angularly from the direction of flow of the gas stream and then passed around feed roll **13**. The feed roll is provided with idler roll **14** for preventing yarn slippage. From rolls **13** and **14**, the volumized yarn is conducted to any desired winding and/or packaging equipment. Since any type of take-up and packaging equipment may be used, such as package winders or ring would bobbins, no parts corresponding thereto are shown on the drawing.

Reference will now be made to FIG. 2 which shows the details of the jet construction used for entangling the filaments in the process of this invention.

A body member **21** has threaded into its upper end a tube **22** terminating in a nozzle **23** at its lower end. Closely adjacent and concentric to the nozzle is an orifice plate **24** as shown. Just below and abutting the orifice plate is a venturi tube **25** also threaded into the body **21** and having an entrance throat **26** and a straight portion **27** about equal in diameter to the orifice plate opening and an exit throat **28** with a taper of about 10° included angle. Compressed gas may be admitted through the opening **29** to the annular chamber **31** in the body. The gas flows at very high velocity through the orifice plate opening, loses velocity in the venturi entrance throat but regains it in the straight portion **27**. Thereafter it expands evenly and loses velocity in the exist taper. My jet is designed so that in the area of the orifice and venturi throat the air velocity is sonic or supersonic. The several yarns **30** enter the intake tube **22** and are mixed with the gas stream at the orifice plate. Mixing continues until the yarn reaches the exit taper of the venturi, here the expansion of the air also expands the bundle of filaments until the filaments are separated and spaced apart. The yarn leaves the jet with an angular bend, say a right angle bend, and the turbulence of gas and loosened filament structure at this point results in a tangling of the filaments.

The gas pressure used is variable depending on the degree of entanglement or loopiness desired and on the filament size. Larger filaments and heavier denier yarns and faster processing speeds usually require higher gas pressures. Clean, dry, oil-free gas is preferred and, as shown in FIG. 1, the gas is well cleaned by a filter in the gas line. As also shown in FIG. 1, a pressure regulator and a gauge are provided to control the gas pressure.

The functioning of my apparatus is apparent to a substantial extent from the description alreardy set forth. However, the following additional description will illustrate in further detail the operation. Air at moderate pressures, say of 5 to 25 p.s.i., is supplied to jet **6**, through line **18** and **19**. This air supply is filtered and controlled by means of suitable filters and pressure regulators inserted in the line **18–19**. The core yarn **7** and the excess yarn **1**, by means of the several rollers **4**, **5** and **10** and **11**, described above, permit the feeding of the two sources of the yarn to the jet **6** in a controlled and special manner, the specific details of which will be apparent from the examples which follow. That is, the excess yarn feed is at a considerably higher rate than the core yarn feed. The correlation of speed of the yarn feeds is an important feature of the present invention. That is, by controlling the core yarn feed in a certain manner, it is caused to slightly open up thereby permitting the excess yarn to penetrate in and out of the core and achieve interweaving. By the overall control of speed of yarn feed and other correlations which will be apparent from the description in the specific examples which follow, it is possible to obtain by the present invention a volumized yarn of appreciably greater total denier, say 50 to 500%, than the yarn entering the jet and which has been volumized to an extent not heretofore obtainable in such a simple, inexpensive manner.

In the preceding description, I have referred to the use of zero twist yarn. If desired, the supply packages **2** and **8** can be substituted with yarn containing from .00+ to 1 t.p.i. or more. The finished, highly volumized, heavy denier yarn **12** can pass to ring twister apparatus, if desired. However, as pointed out above, twist is not required in my yarn of the present invention to lock the filament loops in place, since they are already locked in place by the interweaving of the excess yarn with the core yarn, and the yarn can be wound on a zero twist package type winder.

A still further understanding of my invention will be had by a consideration of the following examples which are set forth for illustrating certain preferred embodiments.

Example I

In accordance with this example the apparatus used was the same as that discussed in FIG. 1 of the drawing. Yarn from two separate sources was fed into an air jet. For convenience of consideration the process conditions followed are tabulated below:

Excess yarn	150 denier, 38 filaments, .3 t.p.i. dull white acetate.
Core yarn	150 denier, 38 filaments, .3 t.p.i. bright black acetate.
Excess yarn speed	100 y.p.m.
Core yarn speed	53 y.p.m.
Air pressure	7½ p.s.i. gauge.
Output roll speed	50 y.p.m.
Volumized yarn denier	440 measured, 460 theoretical.
Volumized yarn twist	0.00 t.p.i. in the ply.

The finished volumized yarn produced was compared and tested with other products:

Yarn type	Specific volume, cu. ins./lb.	Percent bulk, 100%= solid acetate
Volumized yarn	136	650
Normal bulk yarn	78	318
Spun staple yarn	56	266
Acetate filament yarn, regular cross-section	33	158

Example II

In accordance with this example the same type of ap-

paratus arrangement as shown in FIG. 1 was used. However, in this example different denier yarn was used and other conditions varied. For convenience of reference the data respecting this example is tabulated as follows:

Excess yarn	1100 denier, 75 filaments, zero twist bright cellulose acetate yarn.
Core yarn	300 denier, 75 filaments, .3 t.p.i. brown cellulose acetate yarn.
Excess yarn speed	80 y.p.m.
Core yarn speed	46 y.p.m.
Air pressure	20 p.s.i.
Output roll speed	40 y.p.m.
Volumized yarn denier	2200 measured, 2250 theoretical.
Volumized yarn twist	0.8 t.p.i.

Example III

In accordance with this example 1200 denier core yarn was used and a 2850 denier excess yarn. Processing conditions were as follows:

Excess yarn speed	y.p.m.	61
Core yarn speed	y.p.m.	13.7
Air pressure	p.s.i.	20
Output roll speed	y.p.m.	12.5
Volumized yarn twist	t.p.i.	0.0

This 4050 denier input was volumized 370% to give a 15,097 finished denier.

Example IV

In accordance with this example 1200/300/0 denier core yarn was used and a 2100/525/0 denier excess yarn. Processing conditions were as follows:

Excess yarn speed	y.p.m.	52
Core yarn speed	y.p.m.	13.7
Air pressure	p.s.i.	25
Output roll speed	y.p.m.	12.5
Volumized yarn twist	t.p.i.	0.0

This 3300 denier input was volumized 300% to give a 10,000 denier finished product.

Example V

In accordance with this example 300/14/STZ denier core yarn was used and a 150/7/STZ denier excess yarn. Processing conditions were as follows:

Excess yarn speed	y.p.m.	50
Core yarn speed	y.p.m.	13.7
Air pressure	p.s.i.	15
Output roll speed	y.p.m.	12.5
Volumized yarn twist	t.p.i.	1.7

This 450 denier input was volumized 100% to yield a 900 denier finished product.

In the above examples the y.p.m. reference means yards per minute of speed of passage of the yarn through the gas jet. P.s.i. means pounds of pressure per square inch, and t.p.i. means twist per inch. STZ means spun twist in Z direction.

In the above examples the yarn prior to volumizing was preferably treated with a treating agent for facilitating the processing operations. The particular treating agent used was comprised of mineral oil from about 40–85%, petroleum sulfonate from 5–40% and small amounts of one or more of the ingredients from the group consisting of glycol ethers and fatty acids and amino alcohols. This treating agent, which is characterized by high scroop and static properties, functions to aid in producing a finished yarn wherein the first yarn is interwoven into the second yarn in a manner that the interwoven filaments will not readily pull out of the core.

While in the above examples contraction has in some instances been given as 50%, my process is not limited in this respect. Greater contractions of the excess yarn may be accomplished by increasing the speed of feed and increasing the air pressure. Such greater contractions tend to produce a novel product in which the excess yarn filaments weave through the core yarn filaments and reunite into loop bundles of excess yarn, the filaments of which are individually entangled and looped as in FIG. 4.

By varying the speed of the yarn rolls 4 and 5 frequently and at random, thick and thin like volumized yarn can be produced. If contrasting colors of about equal denier core and excess yarn are used in both, input roll speeds are varied frequently and at random in such a manner that the core yarn becomes the excess yarn and vice versa, still further color and size effects are produced.

Although in the above examples I have described mainly the processing of cellulose ester yarn, it is possible to process yarn of other chemical composition. That is, my process may be applied to multi-filament yarns of viscose, polyamides (nylon), acrylonitrile yarns, polyester yarns and the like. It is possible to employ a polyamide or polyester type core yarn and use excess yarn of acetate or viscose in order to provide a volumized yarn which has gerater strength than if the core yarn were of acetate or viscose.

It is apparent from the foregoing that by the present process it is possible to produce a new volumized yarn product of various appearances. It is to be noted that the volumized product of the present invention differs considerably from prior art type of yarn such as boucle. That is, in boucle yarn the excess yarn surrounds the core yarn as a bundle of filaments. Also, boucle yarn usually requires a third binder yarn twisted about it to hold the surrounding yarn in place. In contrast to such boucle yarn it will be noted that in the new yarn of the present invention the excess yarn is interwoven into the core yarn as individual filaments or disorganized groups of filaments thereby not needing twist or a third yarn to hold the excess yarn in place. Likewise the yarn of the present invention substantially distinguishes from a type of yarn known as differential shrinkage yarn in that such yarn also does not have interweaving of filaments and requires twist to hold the fluffiness in place under tension.

The new yarn produced by the present invention, in addition to its greatly increased bulk, exhibits adequate strength, particularly if certain types of yarn are used as the core, and many novelty appearance effects may be produced.

I claim:

1. The process for manufacturing a volumized yarn of large denier which yarn is useful for drapery and upholstery fabrics which comprises feeding a first yarn into a device wherein the yarn may be subjected to streamlined gas flow, also substantially simultaneously feeding a second yarn into said device at a substantially slower feed rate than that of the first yarn and into close association with the first yarn, said first yarn being of a continuous multi-filament type, said second yarn likewise being of a continuous multi-filament type, controlling the rate of feed and passage of the yarn through said device so that the first yarn exists from the gas stream at a speed at least one-third less than its speed of entrance into said device, feeding the second yarn at a speed faster than the first yarn is removed but slower than the first yarn is fed, and removing the second yarn at a speed less than its speed of feed by an amount such as to cause the second yarn to open up to achieve penetration and interweaving of the first yarn into and through the second yarn, supplying gas flow to said process so that the gas flow in the device moves in the direction of the movement of both yarns, and removing the formed yarn from the effluent gas flow, whereby the filaments of the first and second yarn are caused to interweave and a volumized yarn is produced having numerous loops on its surface and a denier increase relative to the total starting denier of at least 50%.

2. The process for manufacturing a volumized yarn of large denier which comprises feeding a first yarn into a device wherein the yarn may be subjected to streamline air flow, also substantially simultaneously feeding a second yarn into said device and into close association with the first yarn, said first yarn being of a continuous 38-filament cellulose ester type of a denier of about 150, said second yarn likewise being of a continuous multi-filament type but of a denier not substantially greater than the denier of the first yarn, controlling the rate of feed and passage of the yarn through said device so that the first yarn enters at about 100 y.p.m. and exits from the air stream at a speed of about 50 y.p.m., feeding the second yarn at a speed of about 53 y.p.m. and removing it at the exit speed of the first yarn to cause the second yarn to open up for penetration by the first yarn, supplying air flow at 5–15 p.s.i. gauge to said process so that the air flow in the device moves in the direction of the yarn movement, and removing the yarn angularly from the effluent air flow, whereby the filaments of the first and second yarn are caused to interweave and a volumized yarn is produced having numerous loops on its surface and a denier increase relative to the starting denier of at least about 50% and an increase in specific volume over the starting yarn of at least 300%.

3. The process for manufacturing a volumized yarn of large denier which yarn is useful for drapery and upholstery fabrics which comprises feeding a first yarn into a device wherein the yarn may be subjected to streamlined air flow, also substantially simultaneously feeding a second yarn into said device at a substantially slower feed rate than that of the first yarn and into close association with the first yarn, said first yarn being of a continuous multi-filament type, said second yarn likewise being of a continuous multi-filament type, controlling the rate of feed and passage of both yarns through said device so that the first yarn exits from the gas stream at a substantially lower speed than its speed of entrance into said device, and the second yarn exits at a speed less than its speed of entrance by an amount sufficient to cause the filaments of the second yarn to open up and separate for penetration by the filaments of the first yarn, supplying air flow to said process so that the air flow in the device moves in the direction of the yarn movement, and removing the yarn from the effluent air flow, whereby the filaments of the first and second yarn are caused to interweave and a volumized yarn produced having numerous loops on its surface, the entrance speeds of said first and second yarns relative to their exit speds being such that the denier of the volumized yarn is increased at least 50% over the combined deniers of said first and second yarns.

4. A process for the manufacture of volumized yarn of large denier useful for manufacture of drapery and upholstery fabrics which comprises passing at least two separate continuous multi-filament yarns through an air jet supplied with pressurized air, said air flowing through the jet in the same direction as the direction of yarn passage, controlling the rate of feed and rate of withdrawal of the yarn so that at least one of the yarns is fed into the jet at a substantially higher rate than the other and is withdrawn at a rate at least one-third less than its rate of feed and the other of said yarns is withdrawn at least 3% less than its rate of feed, such that the filaments of the yarns are caused to interweave and a volumized yarn having numerous loops on its surface is produced which yarn is increased in denier at least 50% over the combined deniers of the aforesaid two separate yarns supplied to the process.

5. The process for manufacturing volumized yarn from two separate multi-filament starting yarns designated as excess yarn and core yarn respectively whereby there is obtained an increase in total denier of greater than 50% over the sum of the deniers of the two starting yarns, which comprises feeding the excess yarn into a blowing device wherein the yarn is subjected to air flow, also substantially simultaneously feeding the core yarn into the same device and into close association with the excess yarn, the speed of feed of the excess yarn being at least 100% greater than the speed of removal of the excess yarn and substantially greater than the speed of feed of the core yarn, taking up the volumized yarn on take-up means positioned on the exit side of said device, the speed of take-up of both yarns being sufficiently less than the speed of feed of the core yarn such that the core yarn is opened up in the device permitting excess yarn to form loops through the core yarn thereby increasing the total denier greater than 50% as aforesaid.

6. The process in accordance with claim 5 wherein the core and excess yarn are fed into the device at an angle and the volumized yarn is withdrawn at an angle.

7. The process in accordance with claim 5 wherein the excess yarn is fed at a speed of the order of at least two times the speed of feed of the core yarn.

8. The process in accordance with claim 5 wherein the speed of the take-up of the volumized yarn is from 3 to 30% slower than the speed of feed of the core yarn.

9. The process in accordance with claim 5 wherein the core yarn is of a denier smaller in total denier than the denier of the excess yarn.

10. The process in accordance with claim 5 wherein the speed of feed of the core yarn is within 13–75 y.p.m. and the speed of feed of the excess yarn is within 43–153 y.p.m.

11. The method of manufacturing a bulk yarn which comprises feeding at least two multi-filament yarns simultaneously into and through a jet venturi having a throat in which jet there is a zone of high velocity air flow, and withdrawing the air-treated yarn from the zone at an angle, the process being characterized in that one of the ends of yarn is fed at a rate of feed at least 100% greater than its speed of withdrawal, and the other end of yarn is fed at a rate substantially less than the rate of feed of the one yarn but sufficiently greater than the rate of withdrawal of the air-treated yarn as to cause the filaments of said other end of yarn to open up in the area of said zone to receive filaments of said one end of yarn and interweave the two yarns.

12. A method of manufacturing a bulk yarn which comprises feeding two multi-filament yarns simultaneously into and through a zone of high velocity air flow, one of said yarns comprising core yarn and the other comprising excess yarn, withdrawing the air-treated core and excess yarn from the zone in the form of a combined yarn wherein the excess yarn has intermingled with the core yarn, the process being characterized in that the excess yarn is fed through said zone at a rate at least about 100% greater than its speed of withdrawal, and the core yarn is fed at a rate substantially less than the rate of feed of the excess yarn but sufficiently greater than the rate of withdrawal of the air-treated yarn as to cause the filaments of said core yarn to open up in the area of said zone to receive filaments of said excess yarn and interweave the two yarns.

13. A method of manufacturing a bulky novelty yarn which comprises feeding two multi-filament yarns simultaneously into and through a zone of high velocity air flow one of said yarns comprising a core yarn and the other comprising an excess yarn, withdrawing the air treated core and excess yarn from the zone in the form of a combined yarn wherein the excess yarn has interwoven back and forth in said core yarn and at a number of random points extends through said core yarn, the process being characterized in that the excess yarn is fed to the zone of treatment about 100% faster than it is withdrawn, the core yarn is fed to the zone of treatment at least 3% faster than it is withdrawn so as to cause the core yarn filaments to open up to permit penetration by the excess yarn, the rate of feed of the excess yarn being substantially greater than the rate of feed of

the core yarn, the final denier of the treated yarn being at least about 50% greater than the combined denier of the starting yarns and the specific volume measured in terms of units of volume per unit of weight is increased at least 300%.

14. The method of producing a bulk yarn comprising feeding two multi-filament yarns simultaneously into and through a zone of high velocity air flow, one of said yarns being fed through said zone at a rate which is of the order of about 100% greater than the rate at which the other yarn is fed through said zone, and the two yarns being withdrawn from said zone at a rate less than the rates at which the two yarns are fed into the zone by an amount such as to cause the slower fed yarn to open up to achieve penetration and interweaving by the faster fed yarn whereby said two multi-filament yarns are integrated.

15. A method for the preparation of a volumized yarn, which comprises feeding at least two bundles of continuous filaments into a zone of turbulent gaseous fluid and withdrawing all said bundles from said zone as a single assembly, at least one of the bundles being fed in at a linear rate substantially greater than the feed rate of a slower fed one of the remaining bundles and at least 50% greater than the withdrawal rate of the assembly, and said slower fed one of said bundles being fed in at a linear rate which is only slightly greater than the withdrawal rate of the assembly by an amount such as to cause the slower fed bundle to open up and achieve penetration and interweaving of looping portions of the faster fed bundle into and through the slower fed bundle, whereby the filaments of the faster fed bundle are convoluted into elongated loops extending outwardly from the body of the yarn.

16. A method according to claim **15**, wherein the relative rate of feed of the two bundles of filaments is periodically varied whereby a volumized yarn having neps at intervals along its length is produced.

17. A process for forming a bulky yarn comprising feeding a plurality of filamentary structures at considerably different rates into a zone of fluid turbulence and withdrawing them together therefrom as a composite yarn at a rate lower than the lower feed rate by an amount such as to cause the slower fed yarn to open for penetration and interweaving by looping portions of the faster fed yarn, the yarn having the higher feed rate being fed at a rate at least 100% greater than its speed of withdrawal, whereupon the individual filaments of the structure having the higher feed rate are convoluted into elongated loops extending outwardly from the body of the yarn, which includes the other structure in unconvoluted form as a stress-bearing member thereof.

References Cited

UNITED STATES PATENTS

2,098,981	11/1937	Sowter	57—140
2,504,523	4/1950	Harris	57—140
1,949,604	3/1934	Dreyfus et al.	57—34
2,477,909	8/1949	Stockly	57—34
2,026,736	1/1936	Gruber	57—157
2,667,964	2/1954	Miller	57—34
2,731,789	1/1956	Holder	57—91 X
2,807,862	10/1957	Griset	57—34
2,852,906	9/1958	Breen	57—34
2,825,118	3/1958	Soussloff et al.	57—34
2,874,445	2/1959	Griset	57—34

FOREIGN PATENTS

161,076	2/1955	Australia.
510,779	10/1930	Germany.

MERVIN STEIN, Primary Examiner

U.S. Cl. X.R.

57—34, 143, 157

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,462,813 August 26, 1969

Richard F. Dyer

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, in the heading, Serial No. "544,888" should read -- 544,886 --. Column 3, line 37, "would" should read -- wound --; line 55, "exist" should read -- exit --. Column 4, line 15, "speed" should read -- speeds --. Column 6, line 60, "exists" should read -- exits --. Column 7, line 3, "streamline" should read -- streamlined --; line 49, "speds" should read -- speeds --.

Signed and sealed this 5th day of May 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents