

March 9, 1971

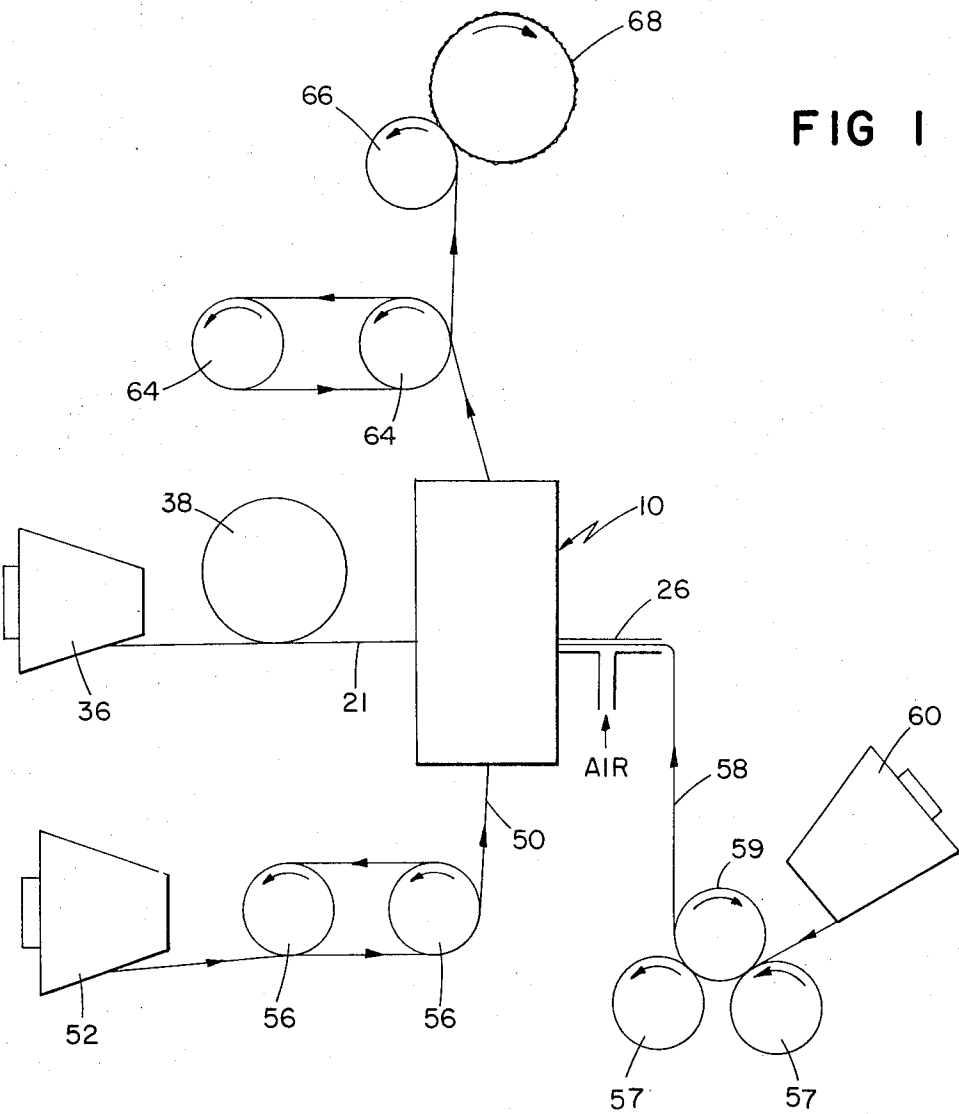
P. F. MARSHALL

3,568,424

PROCESS AND APPARATUS FOR PREPARING FLUID-TEXTURED YARN

Filed Sept. 9, 1968

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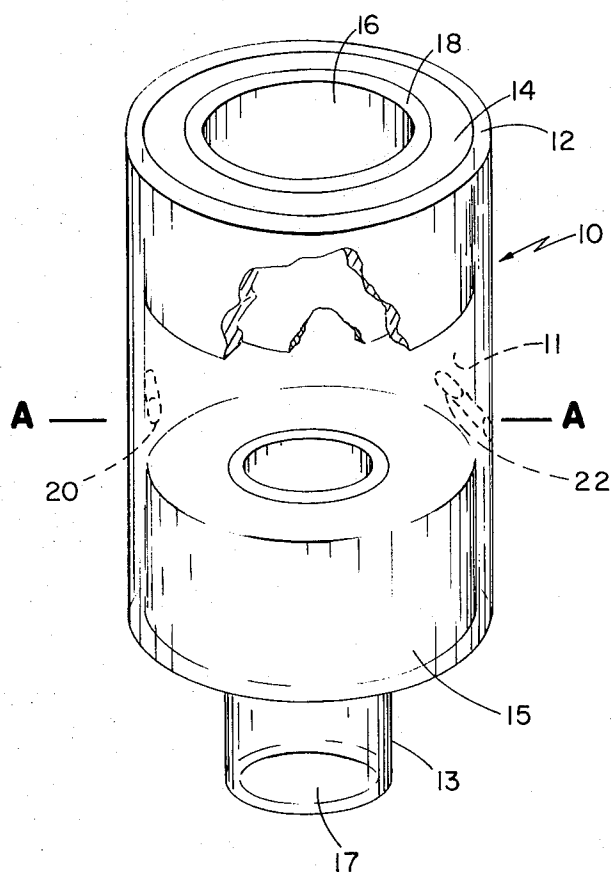
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PROCESS AND APPARATUS FOR PREPARING FLUID-TEXTURED YARN

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FIG 2



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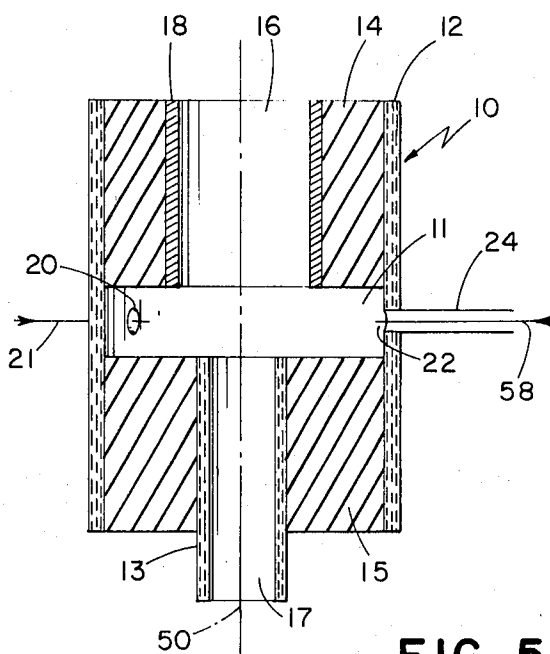
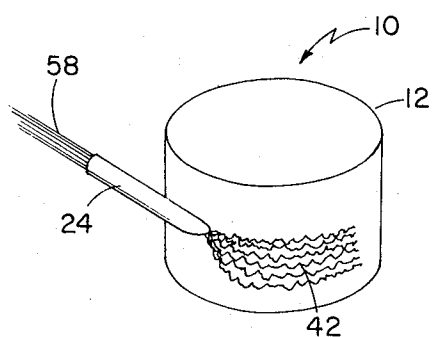
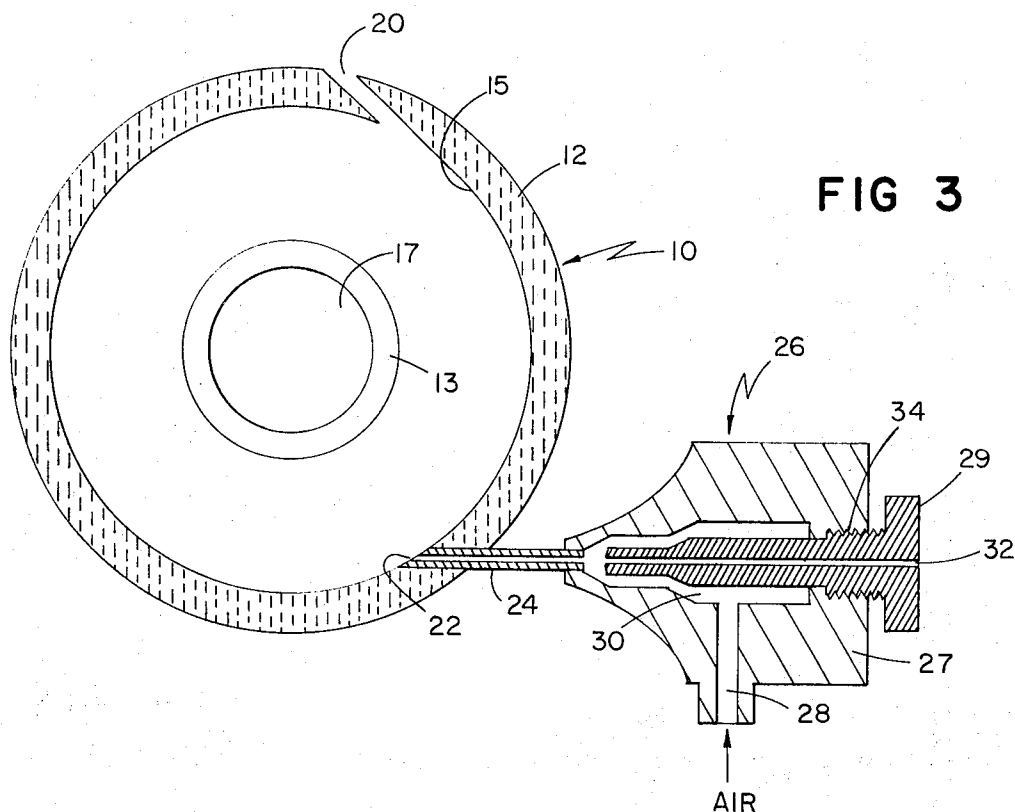
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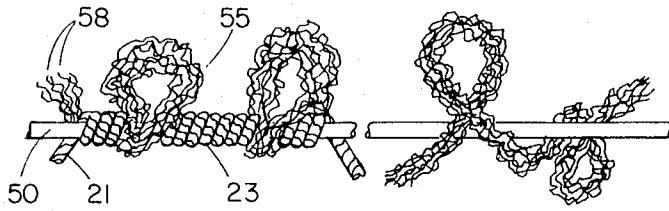


FIG 6

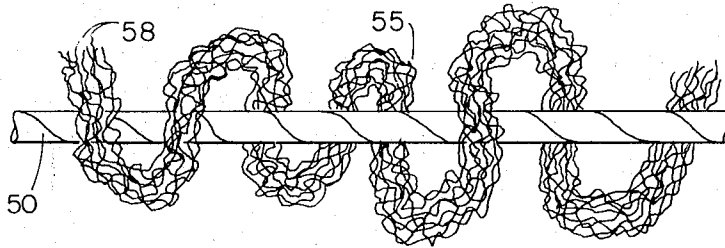


FIG 7

FIG 8

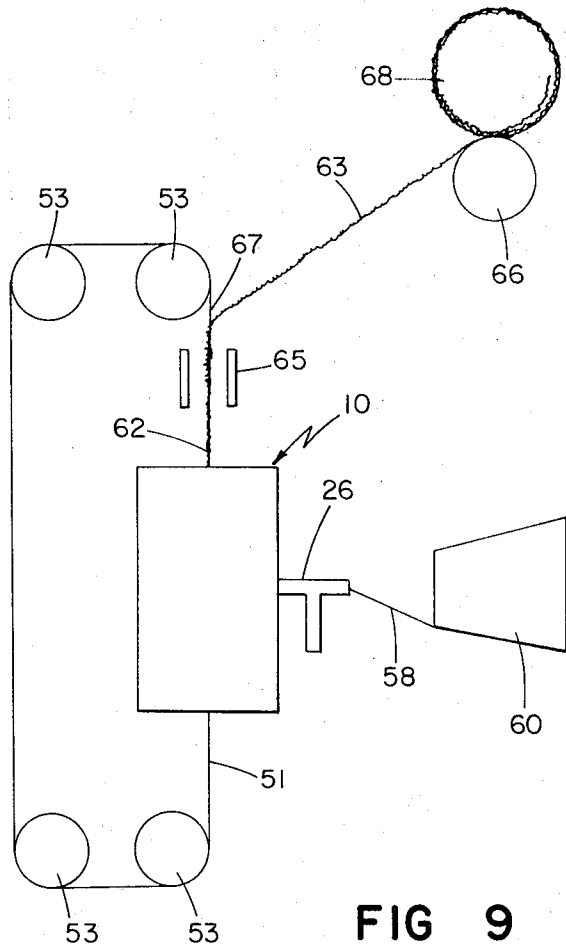
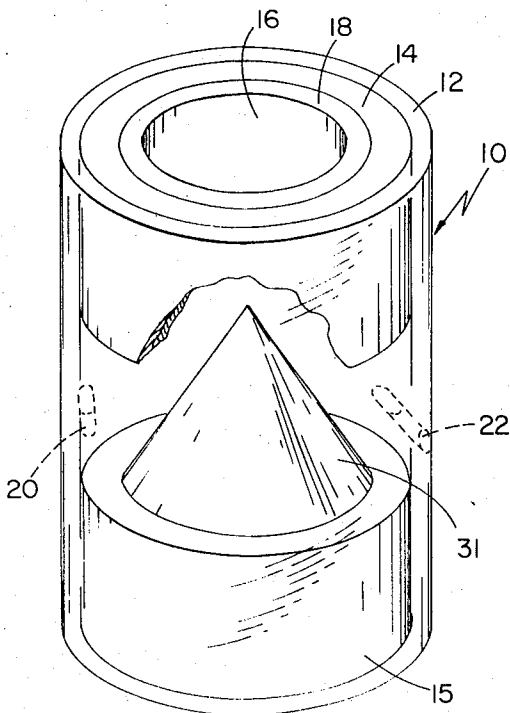


FIG 9

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3,568,424

PROCESS AND APPARATUS FOR PREPARING FLUID-TEXTURED YARN

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9 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus and process are described for the fluid-texturing of continuous filament strands. Such a strand is fed through a fluid jet at at least half-sonic velocity into a generally cylindrical chamber containing a whirling body of fluid, causing the strand to erupt turbulently into said chamber. The texturized strand may be false-wrapped around a core strand which simultaneously passes axially through the chamber.

This invention relates to a method and apparatus for the preparation of fluid-textured yarns. More particularly it relates to the bulking of continuous filament yarns by means of air, and to certain products obtained thereby.

One general method for producing air-textured yarns is illustrated by the inventions set forth in my U.S. Pats. 3,041,812, 3,078,654, and 3,082,591. In these systems a fluid stream such as air is caused to move in a generally circular path within a so-called vortex cell, and while there may be incidental turbulence, the flow of air may be described as steady. While these systems have been found useful in producing a variety of novelty yarns such as wrapped yarns, boucle yarns, nubbed and slubbed yarns, etc., yarns thus produced in general lack the surface softness or loft and bulk which are desirable for many apparel and decorative fabric applications. This has been ascribed to the fact that the generally steady state of air flow within the vortex cell does not exert a high degree of filament dispersion or filament perturbation on the continuous filament yarn. For the same reason, an effect strand thus disposed around a core strand is not anchored on the core strand with as much stability or resistance to slipping as it would have if the individual filaments were more highly dispersed.

Another well-known system for the fluid-texturing of yarns is exemplified in U.S. Pats. 2,783,609 and 2,852,906 to A. L. Breen. In this system a multifilament yarn has its filaments separated and distorted by a highly turbulent fluid stream, the action on the yarn generally taking place at or outside of the jet orifice, sometimes in the presence of a baffle to increase the turbulence. This system suffers from the disadvantage that the effect on the yarn tends to be random, with the result sometimes difficult to reproduce. Furthermore, it is not suited to the production of novelty wrapped yarns, such as those enumerated above, nor is it operable when a more or less unitary core strand is employed, as in the case of a monofilament core, a bonded multifilament such as a spandex core, or a wire strand.

It is a basic object of this invention to provide a process and apparatus for the production of bulked continuous filament yarns.

It is also an object of this invention to provide bulked novelty yarns of the wrapped, looped, nubbed, or slubbed type.

It is a further object of this invention to provide a falsely-wrapped composite yarn in which the individual filaments of the wrapping strand are convoluted, whereby the bulk of the wrapping strand is increased. Other objects of the invention will appear more fully from the following description and drawings, in which:

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FIG. 1 is a schematic view of a train of apparatus suitable for carrying out the generalized process of the invention.

FIG. 2 is a perspective view, partially broken away, of a vortex cell suitable for use in this invention.

FIG. 3 is a cross-sectional view of the vortex cell of FIG. 2 along the line A—A.

FIG. 4 is a schematic representation of the behavior of a continuous filament strand when introduced into the vortex cell 10 of FIG. 1.

FIG. 5 is an idealized vertical cross-sectional view of the vortex cell of FIG. 2.

FIG. 6 is a typical novelty yarn made by the process of this invention.

FIG. 7 represents another wrapped yarn of this invention.

FIG. 8 is a perspective view, partially broken away, of another vortex cell suitable for use in this invention.

FIG. 9 is a schematic representation of another apparatus suitable for producing a single-end bulked yarn.

Basically, the objects of this invention are achieved by combining the explosive, filament-dispersing action of a fluid jet, propelling a continuous filament yarn, with the generally circular wrapping action of a fluid-powered vortex cell.

FIG. 1 is a general schematic layout of a process for making various yarns according to this invention. A core strand 50, of suitable nature, is drawn from a conventional package 52, at a rate which is determined by the speed rates of feed rolls 56, 56, and the take-up rolls 64, 64. The core strand passes through a vortex cell 10, described more fully below. In the cell, a wrapping strand in bulked form is disposed in false-twist configuration around the core strand, said wrapping strand being drawn from a conventional package 60 by the roll-off device 59 driven by rolls 57, 57, and being fed into the cell by the yarn-forwarding jet 26. Upon emerging from the cell, the composite core strand and bulked wrapping strand are transported by the take-up wheels 64, 64 to the conventional winder 66-68.

In case a three-component yarn is desired, an auxiliary wrapping strand 21 may be fed to the vortex tube from a conventional package 36, its rate of feed being governed by the feed wheel 38.

FIGS. 2 and 3 represent views of one typical cell suitable for use in this invention. Referring to FIG. 2, there is shown a generally cylindrical cell 10 with sidewalls 12, the cell being provided with tangential sidewall openings 20 and 22 large enough to allow the entrance of a continuous filament strand or strands, and with a core strand entrance 17 defined by a glass tube 13 set in a rubber gasket or plug 15. The textured yarn is withdrawn from the cell through the upper opening 16, defined by a glass or metal section of tubing 18 set in the rubber plug or gasket 14. The bulking or texturing of the strand or strands takes place principally in the generally cylindrical chamber defined by the walls 12 of the tube 10 and by the rubber plugs 14 and 15.

FIG. 3 is a cross-sectional view of the vortex cell of FIG. 2 looking downward through the cell cut away along the line A—A. The cell 10 is defined by sidewalls 12, with a bottom core strand inlet passage 17 formed by a section of glass tubing 13 set in a rubber plug 15. The cell is also provided with a wrapping strand inlet 22 and an optional auxiliary wrapping strand inlet 20.

A generally cylindrical whirling body of fluid is established and maintained within the cell 10 by fluid, such as air, admitted under pressure through the inlet 22 in the cell wall. The air is supplied by the yarn-forwarding air-jet device 26, which may be of various types known in the production of bulked yarn. Shown is an air jet com-

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prising a block 27 fitted with an air inlet 28 leading to a plenum chamber 30, from which air under pressure is conducted through the passage 24 and into the cell through the opening 22. The yarn-forwarding device is also supplied with an adjustable plug 29, threaded as shown at 34 to mate with the forwarding device. This plug 29 is provided with a central passage 32, for feeding in a continuous filament strand to be bulked. The yarn passage through the plug 32 is substantially axially aligned with the air inlet passage 24.

In operation, air under pressure of 50 to 300 p.s.i.g. is supplied to the yarn-forwarding device through the air inlet 28, establishing an air stream in the inlet passage 24. A strand to be bulked is fed into the yarn inlet tube 32, whence it passes through the inlet tube 32 and is expelled into the vortex cell 10.

FIG. 4 represents schematically the behavior of a strand 58 being fed through the convergent air inlet passage tube 24 through the side wall 12 of the vortex cell 10, only the central portion of the cell being shown for clarity. Although the cell has inlet and outlet yarn openings, the cell acts at least momentarily as a closed system so far as immediate exhaust of air pressure is concerned. The circular wall of the cylindrical cell therefore acts as curved baffle of small radius. In accordance, therefore, with the well known law for uniform circular motion a centripetal acceleration is induced in the amount proportional to the square of the velocity of the stream and inversely proportional to the radius of curvature of the stream's path. As an example, an air stream flowing at 10³ feet per second around a radius of 10⁻² feet would have an induced force of approximately three times 10⁶ gravitational units. This tremendous induced "G" acts on the stream to flatten and fan the stream out into a ribbon-like shape and thus entrain the continuous filament yarn into a similar flat ribbon as shown in 42 of FIG. 4. Fluid streams operating at at least half-sonic velocity are preferred in the process of this invention.

Although the cell 10 is herein shown as circular, this is a matter of convenience. Cells of elliptical, oval, or other cross-section are also contemplated by the definition that the cell be "generally circular." The principal criterion is that the air stream not be degenerated into pure turbulence, but that a rotating, sweeping or wrapping action be maintained on the textured wrapping strand.

In my copending U.S. patent application Ser. No. 653,237, filed July 13, 1967, now U.S. Pat. No. 3,438,186, there is described a process for making a novelty looped yarn by feeding three strands at different rates into a vortex cell, the second fastest strand being fed at at least twice the speed of the slowest strand, and the fastest strand being fed at at least twice the speed of the second fastest strand. A process for utilizing the process of this invention to produce an improved version of such a looped yarn is shown schematically in FIG. 5, and the product thereof in FIG. 6. FIG. 5 is a cross-sectional view in elevation of the vortex cell of FIG. 2, with the detailed drawing of the yarn-impelling air jet being omitted. The cell 10 comprises an inner chamber 11 having a cylindrical side wall 12. Set into the upper and lower circular ends of the cell are plugs or gaskets, preferably of rubber, 14 and 15, which are lined with circular pieces of metal tubing or glass 18 and 13. In this fashion, an upper or exit opening 16 and a lower or entrance opening 17 are defined. The air inlet passage 24 for the yarn to be textured, conveniently a shortened size 18 hypodermic needle, is connected as shown in FIG. 3 to a source of fluid such as air under pressure, so that the strand to be textured is impelled through the inlet tube 24 and exploded into the whirling and generally cylindrical body of air formed within the chamber 11.

Simultaneously and continuously there are fed to the cell a core strand 50 and an auxiliary wrapping strand 21, the latter through an opening 20 tangential to the cell wall and positioned preferably about 120° away from

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the air inlet opening 22. The supply packages of all strands, and the feed rate control mechanisms, are conventional and are not illustrated.

The above process will be illustrated by the following example.

EXAMPLE I

As a core strand, an 8s cotton yarn 50 was fed to the cell to FIG. 5, at a rate of 229 feet per minute. A whirling body of fluid was maintained inside the cell by passing air at 110 p.s.i.g. through the air inlet tube 24. At the same time, as well as powering the vortex cell, the air stream entrained a strand 58 of 300 denier 76 filament acetate, at a rate 2.88 times the linear speed of the core strand. As the strand 58 was exploded into the chamber of the cell and became transported by the cylindrical body of fluid whirling around therein, the individual filaments were fanned out as in FIG. 4, and were convoluted into kinks, twists, and crunodal loops appearing irregularly along the length of each filament. The air forces in the cell disposed this bulked strand into a looped configuration falsely wrapped around the core strand.

The third strand, 21 was fed through the side opening 20 in the cell wall 12, as a 75 denier 19 filament polyester strand, at a rate of 2534 feet per minute, or 11 times the feed rate of the core strand.

The resulting product is shown in FIG. 6, in which the right hand portion of the composite yarn, for the sake of clarity, has been shown without the superimposition of the second wrapping strand 21.

In this composite yarn, the strand fed at the slowest rate (core strand 50) is the tensile-bearing element of the structure, extending in a substantially straight and unconvoluted configuration. The first wrapping strand 58 is disposed in the form of falsely-wrapped loops 55 around the core strand, the individual filaments of the loops being separated from each other by convolutions introduced within the air mass of the cell, thus softening and bulking the loops and increasing the over-all loft and softness of the yarn.

In order to anchor the loops securely to the core strand, the second wrapping strand 21 is disposed around both the core strand 50 and the loop strand 58 in a tight wrapping 23 which is bifilar in nature—that is, a loop is formed in strand 21 by entrainment in the generally cylindrical whirling body of fluid contained within the cell chamber. The successive loops thus formed impinge upon and wrap around the core strand and loop wrapping strand, so that there is no true net twist of either wrapping strand around the core.

If no second wrapping strand 21 is used in the above process, the product resembles the composite yarn of FIG. 7, wherein the bulked and looped wrapping strand 58 is only loosely associated with the core strand 50. The association is such, however, that the core strand acts as a carrier strand for the looped strand, allowing the composite yarn to be wound into a package without substantially decreasing the high loft and bulk which has been built into the loop strand. In this way, the yarn can be heat-set or otherwise treated in package form to render the convolutions in the looped wrapped yarn permanent. The yarn of FIG. 7 is utilizable per se in fabric constructions where there is minimal opportunity for the looped wrap to be displaced along the core strand. Otherwise, since the association between core strand and looped wrapping strand is a loose one, and based on false twist, the two strands may readily be separated after a heat-setting operation has been conducted on the package.

The general process of this invention may also be employed for the production of "single-end" air-textured yarns—that is, continuous filament yarns which by themselves are subjected to a bulking process without being disposed around a core strand or overwrapped with another strand. For this purpose, the general process scheme shown in FIG. 1 is modified by the complete omission of

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the core strand 50, and the vortex cell is modified as shown in FIG. 8. Since the single-end textured yarn has no core strand, the core strand opening 17 of FIG. 2 is replaced by a solid conical brass plug 31 set in the rubber gasket 15. Additionally, the auxiliary strand cell wall opening 20 of FIG. 4 may be omitted, although its presence or absence seems to have little or no effect on the process. The suitably modified cell as shown in FIG. 8 is generally similar in dimensions and configuration to the cell described in my copending U.S. patent application Ser. No. 672,821, filed Oct. 4, 1967, now U.S. Pat. No. 3,477,220.

The preparation of a single-end air-textured yarn will be illustrated by the following example.

EXAMPLE II

A 300 denier 76 filament polyester yarn was fed into the vortex cell of FIG. 8 through the side wall tangential opening 22, it being understood that the opening 22 was equipped with the yarn-forwarding air-jet device 26 of FIG. 3, omitted here for simplicity. The air pressure was 60 p.s.i.g., and the yarn feed rate was controlled at 107.5 feet per minute. Within the cell the individual filaments of the yarn were separated, fanned out, and convoluted into a crimped or looped configuration forming an air-textured yarn with more bulk and softness than the starting material. The wind-up speed was 92 feet per minute, indicating that the convoluting and bulking process had contracted the yarn by about 14%.

FIG. 9 is a representation of another process for producing a single-end bulked yarn directly from a vortex cell. As in FIG. 1, a low-twist continuous filament strand 58 is fed from a conventional supply package 60 to the vortex tube 10 by means of the yarn-forwarding air jet 26. The individual filaments of the strand 58 are blown apart and convoluted into a bulked and lofty yarn configuration by the aerodynamic effects discussed above. Instead of being falsely wrapped around a core strand which remains associated with the wrapping strand in the finished package, however, the bulked and textured wrapping strand 58 is falsely wrapped around a temporary or scaffolding core strand 51, which may be a fine flexible wire which travels continuously upward through the vortex cell around the pulleys 53, one of which is driven by conventional means not shown.

In this manner, a composite yarn 62 of core strand and textured wrapping strand is continuously formed in and withdrawn from the vortex cell 10. Thence it may pass in its upward travel through a heated tube or between a pair of heated plates, shown schematically at 65. As is well recognized, a heat-setting process will stabilize the convolutions previously induced into the bulked wrapping strand, insuring a retention of the bulked configuration against future manipulative stresses.

Since the bulked wrapping strand is associated with the endless core strand only by false twist, it may be removed therefrom as at 67 without any untwisting or unwinding operation, the heat-stabilized single-end bulked strand 63 being merely taken off the core strand at an angle and led to the conventional wind-up mechanism.

Since the process of this invention leads to a high degree of individual filament dispersion, it enhances the loft, softness, and apparent bulk of various prior art wrapped and novelty yarns, such as those described in U.S. Pats. 3,078,653; 3,280,546; and 3,357,171, as well

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as the yarns described in my copending U.S. patent application Ser. No. 672,821, filed Oct. 4, 1967.

Having thus described my invention, I claim:

1. Apparatus for the fluid-texturizing of yarn comprising:

a chamber which is of generally circular cross section perpendicular to the axis thereof,
an aperture in the side wall of said chamber, the axis of said aperture being generally tangential to the inner surface of said wall,
a fluid jet mounted in said aperture including nozzle means for converting fluid under pressure in said jet into a turbulent stream inside said chamber and including a channel for introducing yarn into said chamber,
means for supplying fluid under pressure to said jet, means for supplying at least one yarn to the channel of said jet,
and an aperture axially of said chamber for withdrawing the textured yarn.

2. An apparatus according to claim 1 in which the chamber is generally cylindrical.

3. An apparatus according to claim 1 in which the chamber has openings at each end of its axis.

4. A method according to claim 1 in which the side wall of said chamber has a second yarn entry aperture generally tangential to the inner surface of said wall and spaced approximately 120° from the first aperture.

5. A method of producing a special effect yarn which comprises:

continuously passing at least one multi-filament strand through a fluid jet into a chamber which is generally circular in cross section along an initial path generally tangential to the inner wall of said chamber and generally perpendicular to the axis thereof,
supplying through said jet a stream of fluid moving at at least half-sonic velocity as it erupts turbulently into said chamber, flattening said fluid stream and fanning it out into a ribbon-like shape, whereby the filaments of said strand are separated and distorted, and withdrawing the special effect yarn from said chamber.

6. A method according to claim 5 in which at least one other strand is continuously passed axially through said chamber and the strand introduced by the fluid-forwarding jet is wrapped around said other strand.

7. A method according to claim 6 in which at least one additional strand is introduced into a second strand entry aperture in the chamber wall.

8. A method according to claim 6 in which the other strand is elastic.

9. A method according to claim 6 in which the other strand is a wire.

References Cited

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JOHN PETRAKES, Primary Examiner

U.S. Cl. X.R.

28—1.4, 72.12; 57—34, 157