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R. P. BECHER
YARN TREATING APPARATUS

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FIG. 1

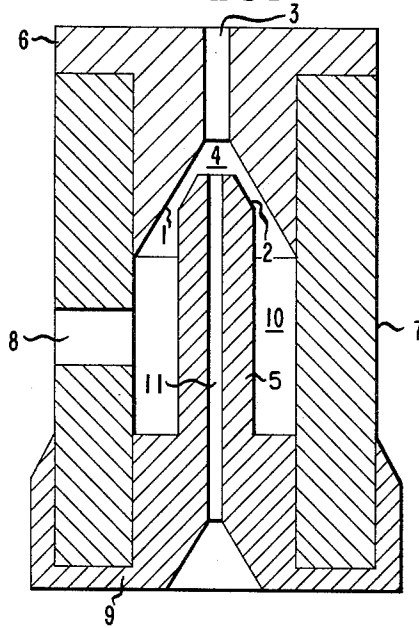
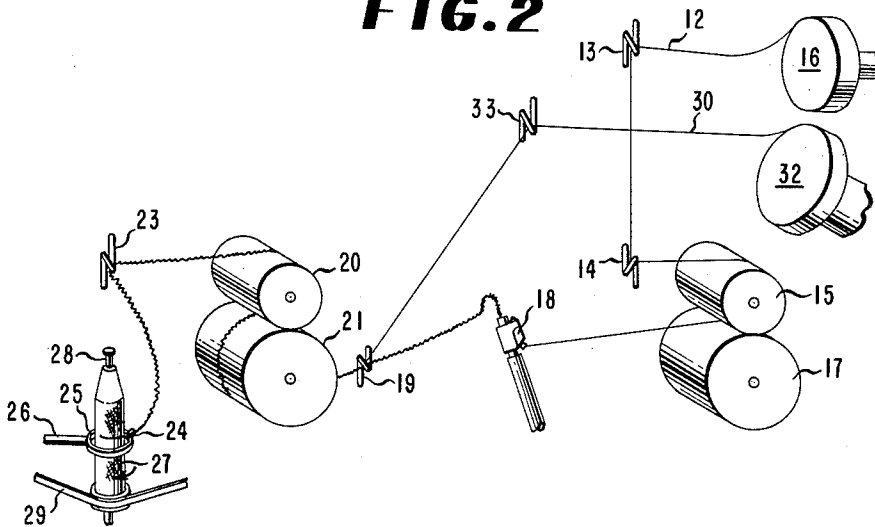


FIG. 2



INVENTOR
ROBERT PAUL BECHER

BY *Norman E. Rockman*
ATTORNEY

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YARN TREATING APPARATUS

Robert Paul Becher, Wilmington, Del., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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4 Claims. (Cl. 28—1)

This invention relates to an apparatus to be used in treating a bundle of filaments such as a yarn to produce a bulky strand composed of a plurality of individually convoluted filaments.

Artificial fibers are normally produced most easily as continuous filaments. Their extreme uniformity and lack of discontinuity makes conventional textile filament yarns much more dense than yarns made from staple fibers. The production of yarns from staple fibers, however, is time consuming and requires a complex series of operations. The occluded air spaces in staple fiber yarns gives them a lightness, covering power and warmth-giving bulk not normally possible with continuous filament yarns.

The bulk, covering power and recoverable elongation of continuous filament yarns have been greatly improved by a variety of mechanical and/or heat-setting processes. The most recently developed product in this area is described in U.S. Patent No. 2,783,609 to Breen. This latter technique involves exposing a filamentary material to a rapidly moving turbulent fluid thereby introducing a multitude of crunodal filament loops at random intervals along the individual filaments. These loops and snarls of entangled loops, together with the other convolutions increase the bulk of the continuous filament yarns considerably and result in fabrics of improved cover, bulk, handle, and the like. The essence of this new bulking tool of Breen is a turbulent fluid. A new apparatus or jet has now been discovered for utilizing the turbulent fluid technique of Breen's to produce improved yarn products with highly useful properties.

The object of this invention is to provide a jet which will uniformly combine multiple ends of yarn to a uniform bulky product. A particularly interesting variation of this process is the so-called core-texturing technique. In core texturing, one or more ends are fed to a jet at a relatively slow feed rate and to become the core of the yarn formed when other ends of "effect" yarn are overfed simultaneously to the same jet at a much greater rate of speed, i.e., 2-4 times the rate of the core yarn. The types of jets of this invention are also particularly useful in the blending and/or cotexturing of glass fiber yarns to get improved uniformity and stability of bulk.

FIG. 1 illustrates the jet used in practicing the invention.

FIG. 2 is an embodiment showing means for feeding core and effect yarns at different rates to a texturing jet.

The apparatus of which FIGURE 1 is a specific embodiment is made up of three basic components: a hollow cylindrical body 7; an orifice block 6; and a hollow yarn needle 5. The jet assembly combines the body which holds the component parts in the desired spatial relationship and provides a plenum chamber for air or other compressed fluid which is admitted through a suitable opening 8. The orifice block 6 has a tapered orifice throat 1 and an exit conduit 3 which may be cylindrical or tapered. The hollow needle 5 has a tapered needle tip 2 through which the yarn enters the bulking chamber. The orifice throat 1 and the needle tip 2 must be conical sections of substantially the same included angle. The combination of the orifice throat and the needle tip provides a conical annular nozzle which directs a stream of compressed air or other suitable fluid to the center of the conduit 3.

The yarn needle 5 discharges the yarn preferably concentrically into the bulking zone 4 where it is immediately

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penetrated by the fluid streams that impinge upon the yarn. The zone of turbulence so created exerts an opening action on the yarn components, so that the filaments are formed into loops and whorls by the action of the fluid.

The geometry of the air chamber 4 formed by the position of the needle tip 2 in relation to the orifice throat 1 is generally important for proper operation of the jet. The taper of these two conical sections may be varied from 45°-135°. The actual angle may be important for specific fibers, but generally speaking, any taper within these two extremes is highly useful.

Contrary to the teaching of the prior art, e.g., British Patent No. 793,044, of April 9, 1958, and U.S. Patent No. 2,884,756, of May 5, 1959, the two mating conical sections must have substantially the same included angle. This angle may be varied between wide limits as described in the preceding paragraph, but the conical sections must match almost precisely. The reason why this is necessary is not understood. However, intimate blending of the two or more component yarns cannot be achieved unless this condition is met. The velocity of the texturing fluid as it passes through the annulus surrounding the needle approaches sonic velocity and precise control of the conical sections is needed to accurately meter the air and control the turbulence.

The other important parameter of the jets of this invention is the relative length of the two mating conical sections, i.e., needle tip 2 vs. orifice throat 1. The specific embodiment shown in FIGURE 1 is the same as that used in the examples wherein the length ratio of needle tip 2 to throat 1 is 1:4. Obviously a wide range of ratios with either and above infinity will operate to texture yarns to a greater or lesser degree. For the specific embodiment of this invention, which is directed to core-texturing and cotexturing and aimed in part, at least, towards the special processing characteristics of fiber glass, this ratio must be within the limit of 1:2 to 1:6.

The jet can be made to be adjustable or non-adjustable. As shown in FIGURE 1 it is non-adjustable and would be the type used for multiple installments for production runs to process a few very closely related materials needing essentially equivalent conditions for optimum production. A more versatile variation can be made by threading the cap portion 9 of needle 5 where it fits around the body portion 7. The rotation of the needle 5 will vary the spatial relationship of throat 1 and needle tip 2, changing the amount and velocity of fluid impinging on the yarn. Such an apparatus variation will allow the processing of a great variety of yarns through the same jet, since yarns of dissimilar characteristics frequently need different texturing conditions for optimum operability. Since there is only a single simple adjustment to be made in operating the apparatus, uniformity of processing from one machine or one plant location to another and from one operator to another can be maintained within very close limits permitting the production of uniform yarn products with a very minimum of control and without the need for highly skilled operators.

In operation, air is forced into annular chamber 10 within body 7 by way of lateral conduit 8. Then the air passes through the tapered annulus between throat 1 and needle tip 2 to the turbulent zone 4 adjacent to the needle tip. The zone of turbulence 4 is created between the flat end of the needle 5 and inner end of the outlet conduit 3 as the fluid rushes into this area from all sections of the annulus. Yarn is fed into the zone of turbulence 4 through yarn passageway 11 in needle 5, where it is agitated violently and whipped about and exits through conduit 3 along with the high velocity air. The yarn is removed from the air stream immediately upon issuing from conduit 3 by withdrawing it to one side. It

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is important that the apparatus have dimensions such that the air or other suitable compressible fluid utilized will have a velocity equal to at least $\frac{1}{2}$ sonic velocity and preferably approaches sonic velocity where it first strikes the yarn in the zone of turbulence 4, and that the cross-sectional area of the outlet conduit 3 be of sufficient size to maintain backpressure in the yarn inlet at a minimum without substantially decreasing yarn velocity in the zone of turbulence.

The absolute and relative dimensions of the yarn inlet tube 5 and the outlet conduit 3 may be varied fairly widely but conduit 3 must be the larger one. One advantage of this apparatus is the effectiveness in processing a great variety of yarn counts without necessity of a change in the dimensions. For example, with a yarn inlet passageway 11 having a diameter of 0.028 inch, yarns varying in denier from about 80 to 1100 or more may be readily processed using an outlet conduit diameter of 0.056 inch. An inlet passageway diameter of 0.040 inch with an outlet conduit diameter of 0.070 inch is suitable for processing yarns varying in denier from about 500 to 2300 and is especially good for processing glass fiber yarns or mixing two or more synthetic organic filament yarns. The specific dimensions of the orifice throat or the yarn inlet may be varied widely. An optimum dimension depends upon the yarn being processed and the degree of texturing desired. Typical diameters for the outlet conduit run from 0.056 inch and lower to 0.070 inch and higher. The yarn inlet diameters are preferably considerably smaller and can be varied from below 0.020 up to 0.052 and higher. A particularly useful combination for textured glass fiber yarns is one wherein the yarn inlet diameter is 0.040, while the outlet conduit diameter is 0.070. Both dimensions, of course, can be increased considerably if it is desired to texture very heavy denier yarns of the order of 2300-5,000 denier or higher.

For maximum operability, the cross-sectional area of the outlet conduit 3 should be at least 50% greater than the cross-sectional area of the yarn inlet passageway 11 just prior to the entry into the bulking chamber 4. The ratio of these two cross-sectional areas can be varied between 1:1.5 up to 1:6.

While this jet has been described as being particularly useful for cotexturing multiple ends of glass fiber yarns, it can also be used to texture and bulk any natural or synthetic filamentary material. Single ends of multiple filament yarns can be bulked in a given jet, but this particular apparatus is peculiarly suitable for bulking multiple ends of yarn. Suitable synthetic filamentary yarns include polyamides, e.g., poly(epsilon caproamide), poly(hexamethylene adipamide); cellulose esters; polyesters, e.g., polyethylene terephthalate, poly(hexahydro-p-xylylene terephthalate), etc.; polyvinyls and polyacrylics, e.g., polyethylene and polyacrylonitrile, as well as copolymers thereof, are particularly suitable for producing the uniformly bulked products described herein. While the preferred form of material is continuous filaments, the process and resultant improvements occur with staple yarns as well. Both types of materials can be made into bulky yarns and fabrics having improved bulk, covering power (opacity) and hand.

This apparatus and process are useful for both multifilament yarns in textile deniers as well as the heavier carpet and industrial yarn sizes either singly or combined in the form of a heavy tow. Fine count and heavy count staple yarns can be processed both as singles and plied. Cruciform, Y-shaped, delta-shaped, ribbon, and dumbbell and other such filamentary cross sections can be processed at least as well as round filaments and usually contribute still more bulk than is obtained with round filaments. By proper design of the jet and process, multiple ends of yarn may be handled either in the form of warp sheets, ribbons, or tows.

The over-feed rate of the yarns will depend upon the

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character of the feed yarn as well as the particular characteristics desired in the product. When the apparatus is used to combine and bulk two or more yarns, one or both may be overfed to the jet and the overfeed of the yarns may be the same or different. Overfeeds as high as 1200% or higher have been used effectively.

Air is particularly preferred as a treating fluid because of its cheapness and convenience. However, steam or any other suitable compressible fluid or vapor may be utilized.

The efficient bulking action of this apparatus apparently results from the action of high velocity fluid on the individual yarn filaments as the yarn passes through the zone of turbulence at the tip of the yarn inlet needle. It appears that the yarn is opened up due to the action of the fluid in the zone of turbulence and that the individual filaments within the yarn bundle are separately whipped about and randomly twisted so that they become intimately entangled and interlocked with adjacent filaments while at the same time being formed into loops and whorls uniformly through the yarn bundle to provide the desired bulking action. Apparently also, a fluid vortex is formed so that in addition to the loopy characteristics in the yarn product and the individual twist, intermingling and interlocking of fibers within the yarn bundle, the yarn bundle itself assumes an alternate twist configuration which remains in the yarn after it is removed from the apparatus.

Quite possibly it is the interlocking and intermingling of the yarn fibers within the bundle which make this apparatus particularly suitable for bulking fiber glass yarns because processing such a fiber glass yarn produces a compact yarn bundle which is coherent and further processable in the same manner as a unitary strand. Prior art fluid treating apparatuses for bulking yarns have been less effective for the texturing of multiple ends and especially for core-texturing of fiber glass yarns since the resulting product was usually neither coherent nor unitary. Because of the unifying results produced by the apparatus of this invention, the feed yarn may be twisted or untwisted and the product may be twisted or not, as desired. Where a zero twist yarn is fed to the apparatus, the product is a bulked yarn in which the filaments are intermingled and interlocked with one another besides being uniformly loopy throughout and there is no need to twist this product for further processing.

The following example utilizes the apparatus of FIGURE 2 and the jet of FIGURE 1. This jet provides superior blending of fibers and colors as compared to prior art jets. The yarns are much more symmetrical together with better anchoring of effect yarn to core and at higher productivity rates. The relative conditions and feed yarns are as indicated in the table.

EXAMPLE

A simple embodiment which shows means for feeding core and effect yarns at different rates to the texturing jet is shown in FIGURE 2. Yarn 12 to be treated according to this invention may be supplied from package 16 through pigtail guides 13 and 14, to pass about cork cot 15 rotating in contact with drive roll 17 and into the nip of this feed-roll arrangement. The yarn then enters jet or nozzle 18; from the jet outlet the yarn is drawn through pigtail 19 about drive roll 21 and into the nip of it with cot 20, about which the yarn passes on its way to the twister. The yarn goes through center guide 23 and through traveler 24 moving about ring 25 mounted on rail 26, then onto bobbin 27, rotated on spindle 28 by belt 29. Core yarn 30, which is supplied from package 32 through pigtail guide 33, also passes through guide 19, the forwarding rolls, center guide, the traveler, and onto bobbin 27, along with the yarn treated by the jet. Typical operating conditions for producing different types of yarns are set forth in the table.

Table

Ex.	Feed yarn		Feed rate y.p.m.		Jet ¹	Air pres., p.s.i.g.	Windup, y.p.m.	Product
	Core	Effect	Core	Effect				
1.---	2 ends 66-nylon, 70/34/1/2Z-----	2 ends cellulose acetate, 300/80/0..	105	230	1	75	100	Moderate size chenille type yarn.
2.---	1 end 66-nylon, 140/68/1/2Z-----	2 ends cellulose acetate, 300/80/25..	16	225	1	75	15	Very heavy chenille.
3.---	1 end 66-nylon, 70/34/1/2Z-----	1 end polyethyleneterphthalate, 70/34/7Z.	60	190	2	55	57	Finely looped boucle yarn.
4.---	3 ends glass fiber, 150-1/0-1Z-----	1 end glass fiber, 150-1/0-1Z-----	43.5	90	3	60	40	Uniform novelty boucle yarn.

¹ See the following table:

Jets	Conical section length ratio needle/orifice	Cross-sectional area ratio needle/orifice throat
1.-----	1:4.1	1:3.9
2.-----	1:2	1:7.8
3.-----	1:6	1:3

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific illustrations except to the extent defined in the following claims.

I claim:

1. Yarn treating apparatus comprising a hollow cylindrical body, an orifice block closing one end of the body including a conical orifice throat and a cylindrical exit conduit with the axes along the cylindrical axis of the body, a yarn needle positioned in and concentric with the body having a longitudinal yarn passageway of smaller diameter than the exit conduit aligned with the axis of the exit conduit, the needle having a cap portion closing the end of the body opposite the orifice block to form a chamber surrounding the needle, the needle having a tip in the form of an conical section the apex angle of which is from 45° to 135°, said conical orifice throat having a precisely matching angle and a length from 2 to 6 times the length of the corresponding conical section of the needle, the conical needle tip being completely spaced from the orifice throat to provide a yarn treating zone between the tip of the needle and the exit conduit

and to provide an annular passageway around the needle tip from the chamber to the treating zone, and an inlet conduit for introducing air into said chamber from outside the body.

2. The yarn treating apparatus defined in claim 1 wherein said yarn passageway has a diameter of about 0.04 inch and said exit conduit has a diameter of about 0.07 inch.

3. The yarn treating apparatus defined in claim 1 wherein said conical orifice throat has a length of about 4 times the length of the conical section forming the needle tip.

4. The yarn treating apparatus defined in claim 1 wherein said exit conduit has a cross-sectional area which is from 1.5 to 6 times the cross-sectional area of said yarn passageway.

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