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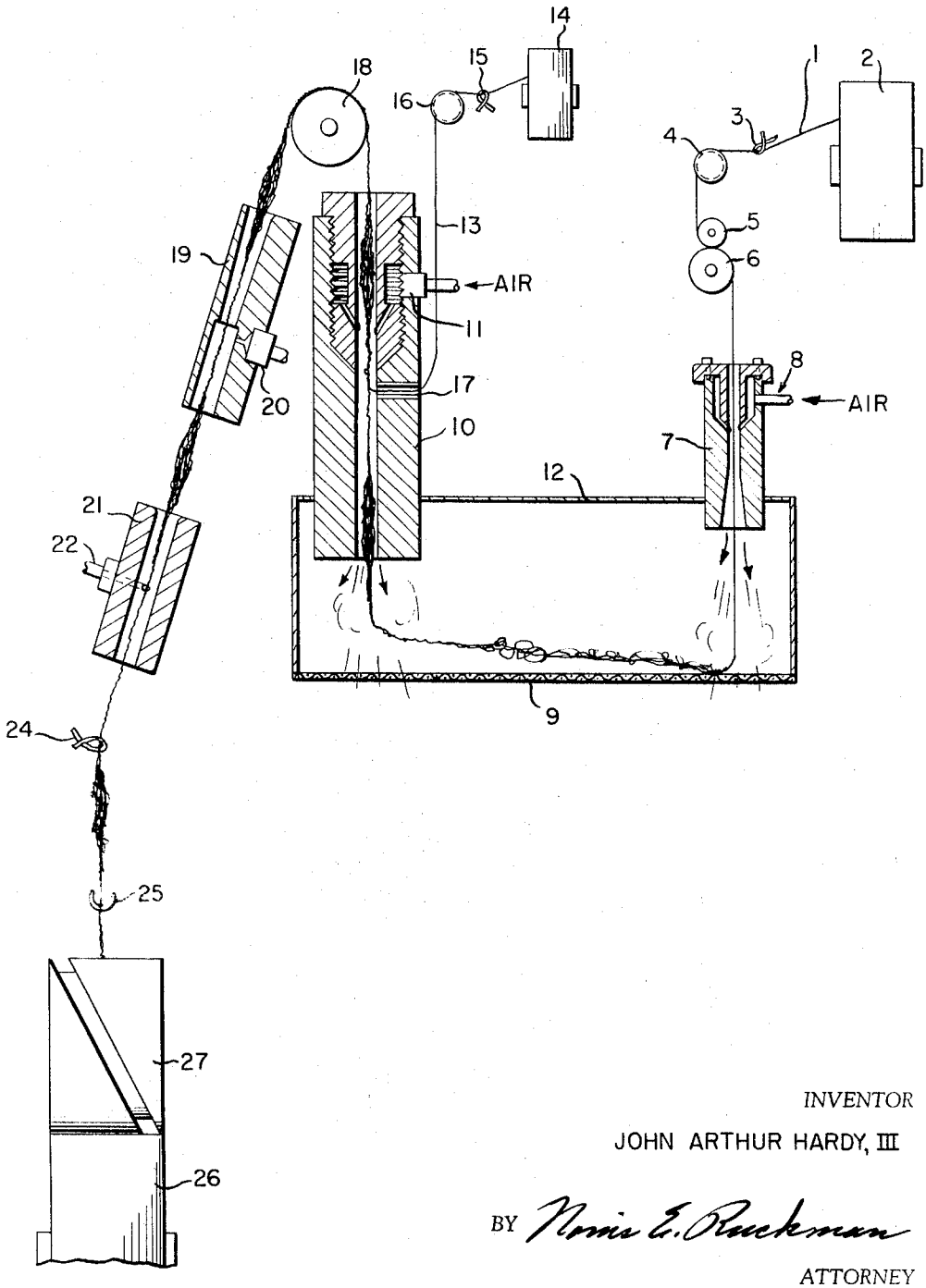

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PRODUCTION OF INTERLACED PLIED YARN FROM SLUB YARN AND CARRIER YARN BY MEANS OF FLUID JETS

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This invention relates to fluid treatment of yarns, and is more particularly concerned with a process for producing a slub yarn plied with a carrier yarn and with suitable apparatus for the process.

A process for the fluid treatment of yarn to prepare a continuous-filament, slub yarn is described in Edwards et al. U.S. Patent No. 3,116,589, dated January 7, 1964. In this process, interlacing jets of the type shown in Bunting et al. U.S. Patent No. 2,985,995, dated May 30, 1961, and torque jets of the type shown in Breen et al. U.S. Patents No. 2,997,837, dated August 29, 1961, and No. 3,009,309, dated November 21, 1961, are disclosed as being suitable for use in the preparation of slub yarns. The Edwards et al. patent also discloses the desirability of using a torque jet to ply the slub yarn with an unslubbed carrier yarn to overcome weak spots in the yarn within the slub regions. While such plied yarns are useful in imparting a decorative effect to fabrics, the weaving performance during the conversion of yarn to fabric is not completely satisfactory with respect to modern, high-speed, mass-production operations.

The utilization of slub yarns in a weaving operation is more difficult than for conventional, continuous-filament yarns. For example, it is exceedingly difficult to control the running tension, under high-speed conditions, of a slub yarn because of the continuously varying yarn diameter. Further, the yarn is more susceptible to damage in that the thicker slub portions may hang up when the yarn contacts various surfaces, causing the slub to strip back and result in yarn breakage. Consequently, slub yarns are frequently combined with a carrier yarn, or support yarn, for improved strength. Maximum processability is obtained when the slub yarn and the carrier yarn are plied together in such a fashion that they function, as nearly as possible, as a unitary structure. The plied yarns which are produced by the improved process and apparatus of the present invention are highly desirable for the purpose indicated since their use results in significantly improved weaving performance.

The process of the present invention involves the following steps:

(1) Forming slubs in a multifilament yarn by directing two high velocity streams of compressible fluid against a screen to form a turbulent zone between the streams adjacent to the screen, continuously feeding the yarn onto the screen at a controlled rate in one stream, and withdrawing the yarn from the screen at a lower controlled rate through the other stream. These streams are formed by a feed jet and a slub jet, the yarn being fed through the feed jet to be forwarded by the stream and the yarn being withdrawn through the slub jet in a direction counter-current to the stream. The feed jet is designed to open up the yarn and distribute the filaments in random fashion on the screen, a jet of the texturing type being suitable. The turbulent zone between the two streams then causes loops and folds to form in the yarn. The slub jet is designed to consolidate these loops and folds into slubs, a suitable jet being one of the interlacing type in which opposed pairs of streams are directed into the yarn passageway to form vortices.

(2) Adding a carrier yarn to the slub yarn as the yarn is withdrawn from the screen. The carrier yarn is preferably introduced at a controlled rate through a side opening itno the yarn passageway of the slub jet, so that the combined yarns exit from the jet.

(3) False twisting the combined yarns by passing the yarns through a torque jet which provides a high velocity single vortex stream of compressible fluid in the yarn passageway, and

(4) Interlacing the yarn plies with a plural vortex stream of compressible fluid by passing the combined yarns through an interlacing jet. A preferred form of interlacing jet is that of jet **19** of the figure. Plural vortices are formed by impingement of a fluid stream against the wall of the round yarn passageway opposite the fluid opening.

It has been found that the false twist, temporarily introduced into the combined yarns by the torque jet, does not interfere with interlacing and that these two jets can be located quite close together. Furthermore, either jet can precede the other, although it is usually preferable to have the torque jet last in the series.

The torque jet wraps protruding loops and ends about the yarn to provide a better product. It also performs another important function. The withdrawal rate is preferably controlled by the windup speed at which the product is packaged. The torque jet provides a braking action which improves the process and creates sufficient tension for satisfactory operation of conventional surface driven packaging devices. The withdrawal rate can readily be controlled relative to the feed rate to give a percent overfeed, i.e., (100) (feed rate/withdrawal rate)—100, of 5 to 200. An overfeed in the range of 6 to 70% is generally used and a preferred range for some of the most interesting products is from 8 to 50%.

The drawing is a diagrammatic representation of apparatus suitable for practing the invention, the jet devices being shown in cross-section taken through the yarn passageways.

The drawing shows a substantially O-twist, multifilament yarn **1** being withdrawn from supply package **2** through pigtail guide **3** and over snub guide **4** to feed rolls **5** and **6**. Passage of the yarn through the nip of rubber-covered idler roll **5** and driven feed roll **6** provides positive control of the feed rate. The yarn then passes through feed jet **7** and is forwarded by air introduced into the jet through fitting **8** to form a high-velocity stream. The yarn is forwarded to strike against a screen **9**, positioned across the path of the air stream at an angle of about 90°, so that the yarn is deposited on the screen and the air passes through the screen. A slub jet **10** of the interlacing type for consolidating slubs in the yarn is supplied with air under pressure through fitting **11** to form a high velocity stream which is also directed perpendicularly against the screen **9** to impinge on the screen adjacent to the stream from the feed jet. The turbulent zone created between the two streams causes the yarn to twist, loop, and entangle on itself. Preferably the screen **9** is completely enclosed at the sides and top to form a basket **12** which guides the yarn through the turbulent zone during slub formation. The sides and top may be of any material which will retain the yarn, either perforated or solid, such as screening, plastic or sheet metal, the feed and slub jet being mounted in the top of the box-like enclosure. The yarn passes from the screen through slub jet **10** in a direction counter to the high velocity stream passing through this jet. A carrier yarn **13**, from package **14**, passes through pigtail guide **15** and over snub guide **16**, and enters the side of jet **10** through an opening **17**. The slub yarn and carrier yarn pass from the jet **10** around roller guide **18** to a ply-interlacing jet **19**, supplied with air under pressure through fitting **20**, and is false twisted by passing

through torque jet **21** supplied with air under pressure through fitting **22**. The plied yarn then passes through a pigtail guide **24** and U guide **25** to a conventional windup such as a package **26** surface driven by self-traversing drive roll **27**.

The use of a torque jet, to consolidate the slubs in the yarn by wrapping the slub loops around the yarn bundle, results in an improved process. It has been found that the process is improved as a consequence of yarn tensioning and that this is a distinct aid in building a stable package. Further, when a self-traversing drive roll is used at the windup, a preferred embodiment, the tension control imposed by the torque jet prevents the yarn from jumping out of the traverse groove of drive roll **27**. As indicated previously, yarns prepared with only a torque jet are not completely satisfactory when used in high-speed, mass-production, weaving operations. A more suitable product, from the standpoint of the weaving operation, is obtained when the slub and carrier yarn are interlaced to provide a more unitary structure. If an interlace jet is merely substituted for the torque jet, the desired degree of interlace is obtained but the process becomes inoperable because of lack of tension control and, in addition, the slubs are not sufficiently consolidated into the yarn. When two similar torque jets are used, little, if any interlacing results. If two opposing torque jets are used, filament intermingling results; but the yarns are not as effectively plied as with the addition of an interlace jet. Consequently, it has been found necessary to use the interlacing jet in addition to, and in conjunction with, the torque jet. It is indeed surprising that a significant degree of interlace between the slub and carrier yarn can be achieved while the yarns are under the influence of a torque jet. As will be obvious to one skilled in the art, the torque imposed on the yarn in the torque jet will twist the yarn upstream and downstream of the point of fluid impingement but, nevertheless, the interlace jet effectively interlaces the carrier yarn and the base portion of the slub yarn. Because of the tangled and consolidated structure of the slub, comparatively little interlace between the slub and the carrier yarn occurs, although sufficient interlacing is accomplished to improve the unitary structure of the plied yarn. The majority of the interlace occurs between the base portion of the yarn and the carrier yarn.

Applicant's process is a complicated and highly compacted operation, with the many components assembled in near proximity to their neighbors to permit a multiplicity of such positions on the machine face. Because of the limited space available, it is desirable to position the interlace jet within one inch of the torque jet. Since there are no yarn contact points between the interlace jet and the torque jet, the jet sequence of the third and fourth jets in the process is not critical, i.e., in the process depicted in the drawing, the positions of torque jet **21** and interlace jet **19** may be reversed. The use of a torque jet to tension the yarn is a unique application of a torque jet. As will be readily apparent to those skilled in the art, the tensioning of a slub yarn is not readily achieved by mechanical contrivances. For example, if an attempt is made to tension a slub yarn with a tension-gate type of device, setting the tension in relation to the thicker slub portions will permit passage of the base portion in a relatively untensioned state, while setting the device to tension the base portion will result in excessively high tensions or even yarn breakage during the passage of a slub through the tensioner.

It will now be apparent that applicant was faced with the problem of tensioning a plied slub yarn, consolidating the slubs in the slub yarn and joining the carrier yarn to the slub yarn in a unitary manner, all in a relatively short distance of yarn passage, and that the solution to this difficult set of conditions was obtained with the highly unexpected discovery that the yarns could be interlaced while false twisted under the influence of a torque jet.

In the examples which follow, the coherency factor is determined by a modification of the hook-drop test described in Bunting et al. U.S. Patent No. 2,985,995, the test being modified to measure the degree of interlace between the base portion of the slub yarn and the carrier yarn rather than the degree of interlace of the composite structure. A section of yarn is chosen wherein the base portion of the slub yarn is distinguishable from the carrier yarn. A supporting pin and a hook weighing 2 grams are inserted in the yarn between the base portion and the carrier yarn. The hook is moved at the rate of 1 to 2 centimeters per second until supported by the yarn. The distance in centimeters between the pin and the hook is determined and the value found divided into 100. The result is expressed as the coherency factor.

Apparatus similar to that shown in FIGURE 1 is used to prepare a slub yarn and ply it with a carrier yarn. The slub yarn is prepared from 100-denier, 68-filament, O-twist yarn of a copolyester prepared from ethylene glycol and a mixture of terephthalic/5-(sodium sulfo)-isophthalic acids (98/2). The yarn is fed to the feed jet at 900 yards per minute and is wound up at 750 yards per minute. Air pressures for the feed and slub jets are 8 and 40 p.s.i.g., respectively. The carrier yarn is of the same copolyester used for the feed yarn and enters the slub jet at about 750 yards per minute. The 40-denier, 27-filament carrier yarn of the examples has been previously interlaced, while the 70-denier, 50-filament carrier yarn is essentially O-twist. After passing through the slub jet, the yarn preferably passes to the interlace jet prior to passing through the torque jet. However, the positions of the interlace jet and torque jet may be readily reversed as indicated by the various examples. The air pressure is 60 p.s.i.g. for the interlace and torque jets. In all of the examples, the distance between the exit of the third jet and the entrance of the fourth jet does not exceed 0.75 inch. The processing conditions used in the examples and the results obtained are given in Table 1. The column labeled "Operability" refers to the performance of the yarn at the windup and represents a qualitative evaluation with respect to a control process, e.g., a period of poor operability is indicated when the yarn jumps out of the traverse groove of roll **27** about once in every two minutes. As indicated in the table, the control example wherein no interlace jet is used shows good operability but poor interlace. In Example V, the substitution of an interlace jet for the torque jet results in good interlace but the operability is poor. The introduction of an interlace jet either immediately prior to, or immediately following, the torque jet results in good operability and a high level of interlace.

TABLE I

Example	Carrier Yarn	3rd Jet	4th Jet	Operability	Coherency Factor
I	70-50	Interlace	Torque	Good	28.6
II	40-27	do	do	do	18.2
III	70-50	Torque	Interlace	do	12.3
IV	40-27	do	do	do	28.6
V	40-27	Interlace	None	Poor	29.4
Control	40-27	Torque	do	Good	3.1

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. The process for producing a slub yarn plied with a carrier yarn which comprises continuously feeding a multifilament yarn to a supply jet and forwarding the yarn in a high velocity stream of compressible fluid onto a screen surface; directing a second high velocity stream of compressible fluid from a slub jet against the screen surface to provide a turbulent zone between the two streams adjacent to the screen surface; interlacing slubs

in the yarn by continuously withdrawing the yarn from the screen surface through the turbulent zone and through the slub jet in a direction counter-current to the stream; continuously feeding a carrier yarn to the slub jet and combining the two yarns; then false twisting the combined yarns with a high velocity single vortex stream of compressible fluid, by passing the yarns through a torque jet, and interlacing the yarn plies with a high velocity, plural vortex stream of compressible fluid, by passing the combined yarns through an interlacing jet, to form a plied yarn of slub yarn and carrier yarn.

2. A process as defined in claim 1 wherein the combined yarns are interlaced while false twisted by passing the yarns through closely adjacent interlacing and torque jets.

3. A process as defined in claim 1 wherein the plied slub yarn is wound up into a package and tension is applied to the yarn by the torque jet to provide effective winding conditions.

4. Yarn treating apparatus comprising means for supplying yarn at a controlled rate, a feed jet for forwarding the yarn in a high velocity stream of compressible fluid, screen means positioned across the path of the high velocity stream so that the yarn is deposited on the screen and the fluid passes through the screen, a slub jet for forming slubs in the yarn positioned to direct a high velocity stream of compressible fluid against the screen adjacent to the stream from said feed jet to provide a turbulent zone, means for withdrawing the yarn from the screen through said slub jet in a direction counter-current to the high velocity stream, means for feeding a carrier yarn to said slub jet to be combined with the yarn from the screen, an interlacing jet for interlacing the combined yarns to form a unitary plied yarn, and a torque jet for false twisting the combined yarns.

5. An apparatus as defined in claim 4 wherein the yarn is withdrawn from the screen through said slub, interlacing and torque jets by wind-up means for packaging the plied yarn under tension.

6. An apparatus as defined in claim 5 wherein the tension is controlled by the torque jet.

7. An apparatus as defined in claim 4 wherein the interlace jet is positioned within one inch of the torque jet.

8. An apparatus as defined in claim 4 wherein the jets are positioned so that the combined yarns from the slub jet pass through the interlace jet and then through the torque jet.

9. An apparatus as defined in claim 4 wherein the jets are positioned so that the combined yarns from the slub jet pass through the torque jet and then through the interlace jet.

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