United States Patent [19]

White

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[45] **Apr. 17, 1973**

[54] **MULTIFILAMENT YARN INTERLACING DEVICE**

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[52] **U.S. Cl.** **28/1.4**, 28/72.12

[51] **Int. Cl.** **D02g 1/16**

[58] **Field of Search** 28/1.4, 72.12

[56] **References Cited**

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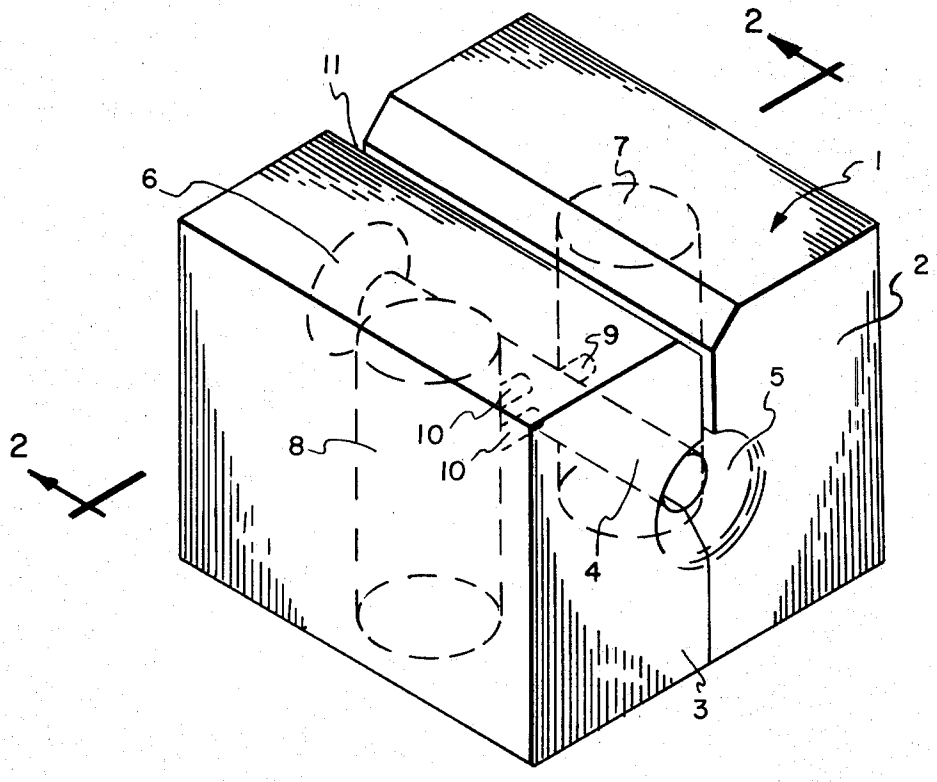
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[57] **ABSTRACT**

Apparatus and process for efficiently intermingling multifilament yarn by subjecting a yarn bundle to the simultaneous action of two parallel tangential fluid jets and one opposing radial fluid jet, all of the jets being in a common plane which substantially intersects the longitudinal axis of the yarn at right angles.

10 Claims, 4 Drawing Figures



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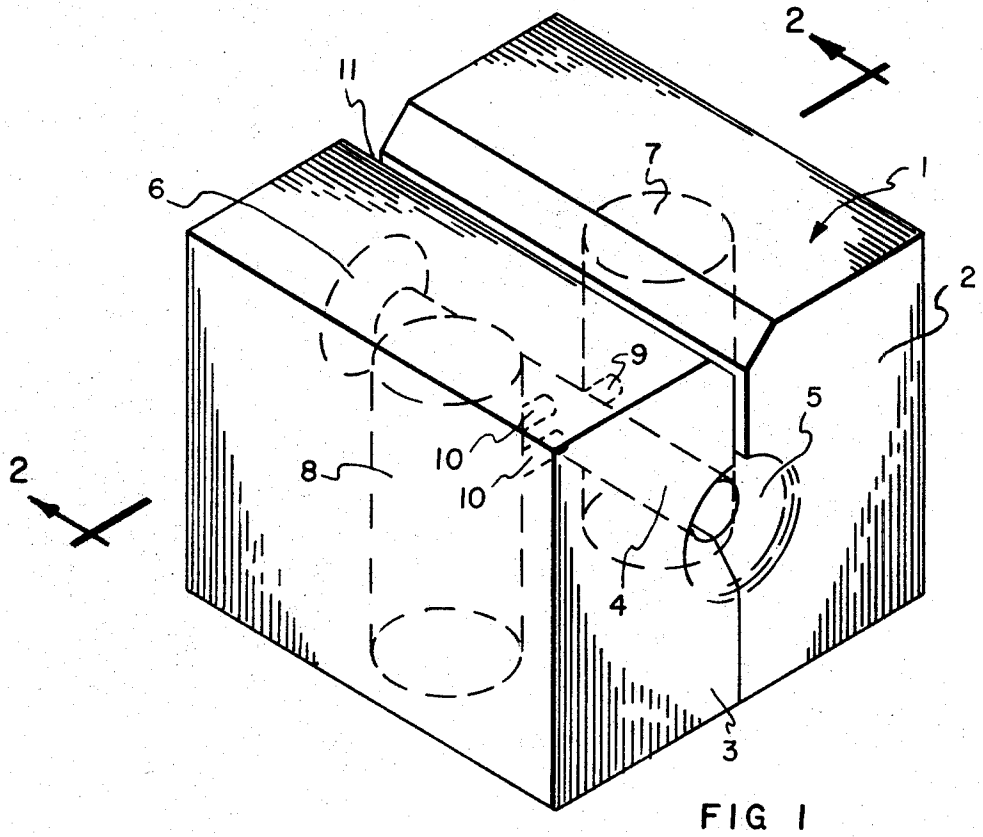


FIG 1

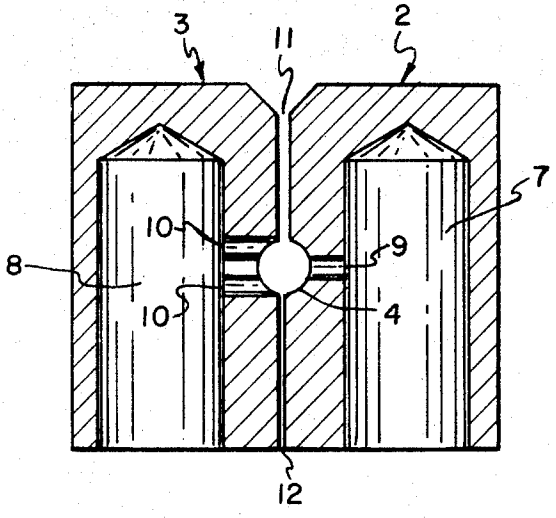
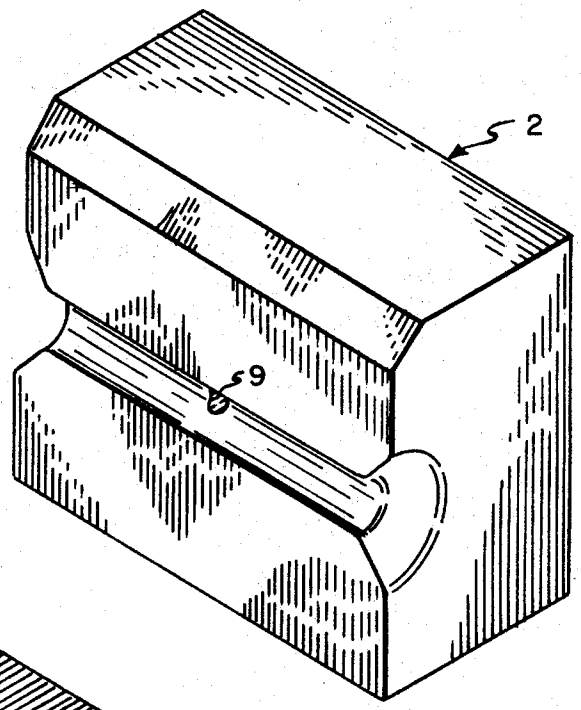


FIG. 2

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FIG. 3



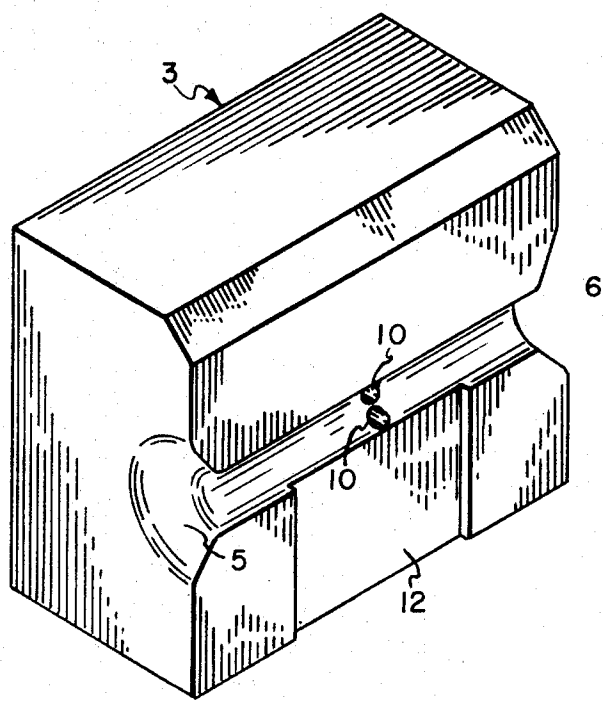


FIG. 4

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MULTIFILAMENT YARN INTERLACING DEVICE

This invention relates to intermingling jets for multifilament yarn, and more specifically, to intermingling jets for heavy denier multifilament yarns.

It is well known in the textile industry that continuous filament yarn bundles in their "as spun" or zero twist configurations perform poorly in many of the common textile operations such as winding, weaving, knitting and the like, primarily due to a looseness of structure that permits individual filaments to snag and break, thence forming fluff balls, slubs, ringers, wraps, strips backs or similar defects. Zero-twist yarns also have a tendency to run in the form of a ribbon over guides, rollers and so forth, whereby as a result of increased frictional contact, the yarns are more readily abraded and subject to breakage. As a result of these shortcomings, continuous filament producers usually carry out the additional step of twisting each continuous fllament yarn bundle to provide an acceptable starting product. The twisting operation serves to compact and unify the yarn bundle, thus resulting in a more cohesive structure which resists the pulling out of individual filaments. The twisting operation however, is expensive and time consuming and does not lend itself to the continuous operation which characterizes much of the manufacturing sequence in the preparation of the zero-twist continuous filament yarn bundle.

In order to overcome the expense of the twisting operation, and also to employ a twist substitute manufacturing operation, which is adaptable to the continuous manufacturing operating employed in the manufacture of continuous filament Yarn bundles, compact interlaced yarns have recently been introduced to the textile industry. Compact interlaced multifilament textile yarns of the type presently under discussion are set forth in U.S. Pat. No. 2,985,995. In brief, the compact interlaced multifilament textile yarns of the prior art are produced by subjecting an as spun substantially zero-twist continuous filament yarn bundle to the action of one or more fluid jets, whereby individual filaments are randomly intermIngled with adjacent filaments and groups of filaments along the length of the yarn to maintain the unity of the yarn by frictional constraint between the filaments. Yarns of this type have been found to be satisfactory for such textile operations as winding and beaming.

The primary reason for the acceptance of compaction techniques by the textile industry is one of economics, and therefore the crIteria for use of a particular type of apparatus For achieving multifilament yarn compaction is based on intermingling efficiency and fluid consumption rate. It can readily be seen that in order for a multifilament yarn to be satisfactory for those textile treating operations to which yarns are normally subjected, a satisfactory degree of intermingling or compaction must be achieved, efficiencies in yarn processing operations usually being directly correlatable to compaction levels. However, inasmuch as twist substitute techniQues are applied for economic reasons, the air or other compacting fluid consumption must be sufficiently low to produce a product, the cost of which iS substantially lower than twisted and/or slashed yarns.

It is therefore an object of this invention to provide a yarn intermingling apparatus which produces yarn having high coherency while minimizing fluid consumption.

It is another object of this invention to provide a process for producing highly compacted yarn while minimizing fluid consumption.

In accordance with this invention, it has now been discovered that a highly efficient yarn intermingling apparatus is achieved by a design wherein a bore adapted for passage of multifilament yarn therethrough has three fluid inlets, two of these inlets are parallel to each other and tangential to the bore, while another of the fluid inlets is radial to the bore and opposite to the parallel tangential fluid inlets, all of the fluid inlets being in a common plane, substantially perpendicular to the longitudinal axis of the bore. Preferably the apparatus is provided with a yarn string-up slot, substantially radial to the bore and intersecting the extensions of the fluid inlets at right angles thereto. Still more preferably, the apparatus is provided with chambers for supplying fluid to the three fluid inlets and is also provided with flared entry and exit portions on the yarn processing bore.

The highly efficient process of this inventIon employs fluid energy to vibrate and disperse filaments and swirl them together again with such momentum and confusion that they become intertWined and obtain coherency factors (hook drop) of from 5 to 100. The process comprises simultaneously subjecting a multifilament yarn bundle to two tangential fluid jets and one radial fluid jet, the tangential jets and the radial jet being positioned on opposite sides of the yarn bundle, the jets being operated at pressures of from 10 pounds per square inch gauge to 50 pounds per square inch gauge and velocities of from 75 feet per second to sonic velocity, yarn tensions on entry and exit are from 0.001 grams per denier to 0.5 grams per denier and running speeds of from 500 feet per minute to 20,000 feet per minute. Preferably the yarn has a total denIer of at least 20 and still more preferably from 500 to 20,000.

The phrase "coherency factor (hook drop)" as employed herein defines coherency factor as measured by the hook drop test. The hook drop test is conducted by clamping a sample of yarn in a vertical position under the tension provided by a weight in grams which is 0.20 times the yarn denier (but not greater than 100 grams). A weighted hook, having a total weight in grams numerically equal to the mean denier per filament of the yarn (but weighing not more than 10 grams) is inserted through the yarn bundle and lowered at a rate of 1 to 2 centimeters per second until the weight of the hook has travelled through the yarn characterizes the extent of filament entanglement. The result is expressed as a "CF or coherency factor" which is defined as **100** divided by the above distance in centimeters.

A better understanding of the inventiOn may be had from a description of the drawings wherein:

FIG. **1** is a projected partial phantom view, not to scale, of the interminGling apparatus of this invention;

FIG. **2** is a cross-sectional view of FIG. **1** taken along the line **2,2**;

FIG. **3** is projected Projected view of the right-hand section of FIG. **1**;

FIG. **4** is a projected view of the left-hand section of FIG. **1**.

Turning to FIG. 1, a segmented block 1 made up of right-hand segment 2 and left-hand segment 3 has a cylindrical bore 4 disposed therein, cylindrical bore 4 has flared entrance portions 5 and flared exit portions 6. Segment 2 and segment 3 are each provided with air chambers 7 and 8 respectively, chamber 7 feeding fluid entry port 9, while chamber 8 feeds fluid entry ports 10. Fluid entry port 9 is radial to yarn processing bore 4, while fluid entry ports 10 are substantially tangential to yarn processing bore 4. The geometry of the entry angles of the air entry ports to the yarn processing bore may be readily ascertained in FIG. 2, which is a cross-sectional view taken along the line 2,2 of FIG. 1. In FIG. 2, it can clearly be seen that fluid entry ports 9 and 10 all lie in a common plane which is substantially perpendicular to the longitudinal axis of the yarn processing bore 4. It can also be seen that fluid entry port 9 is radial to yarn processing bore 4 while fluid entry ports 10 are substantially tangential to yarn processing bore 4, and moreover, that fluid entry ports 10 are parallel to each other, and parallel to an extension of opposing radial fluid entry port 9.

Although not essential, it is preferred that the apparatus be provided with a yarn string-up slot which is longitudinal slot member 11 which runs the entire length of left-hand segment 3 into and substantially on a radius with yarn processing bore 4. All of string-up slot member 11 resides in component 3 which prevents slot member 11 from being truly radial. It is also preferred that the induction of air through yarn string-up slot 11 be compensated by air balance slot 12, air balance slot 12 being substantially radial to yarn processing bore 4, but extending along only a portion of left-hand segment 3. A better view of air balance slot 12 may be had by turning to FIG. 4 of the drawings which is a projected view of left-hand segment 3. As can be seen from FIG. 4, air balance slot 12 does not extend the length of segment 3, but rather terminates well prior to flared portions 5 and flared portions 6.

For ease of fabrication, the apparatus has been designed in two segments, segment 2 being best illustrated by FIG. 3 of the drawings, while segment 3 is best illustrated by FIG. 4 of the drawings. Segments 2 and 3 may be easily joined by use of a common clamping means (not illustrated), or by means of screw members (not illustrated) threaded through the base extremities of a right-hand segment 2 and left-hand segment 3.

In operation, a multifilament, substantially zero-twist bundle is passed through flared portion 5 into yarn processing bore 4 where the yarn bundle is contacted on its upper and lower periphery by fluid streams issuing from tangential entry ports 10. Simultaneous to peripheral contact, the yarn is subjected to the action of a fluid stream issuing from the opposite side of the bore from radial fluid entry port 9. While not wishing to be bound to the precise action which takes place within yarn processing bore 4, it appears that the filament bundle Is fixed within the yarn processing bore by the tangential jets where it is opened and simultaneously interleaved so as to produce a high degree of compaction with minimum consumption of air or other compacting fluid. The apparatus and process of this invention are suitable for use with any natural or synthetic filamentary material such as for instance, polyamides, e.g., poly(epsilon caproamide) and poly(hexamethylene adipamide); cellulose esters, e.g., cellulose acetate, polyesters, particularly polyesters of terephthalic acid or isophthalic acid and a lower glYcol, e.g., poly(ethylene terephthalate), poly(hexahydro-p-xylene terephthalate); polyalkylenes, e.g., polyethylene, linear Polypropylene, etc.; polyvinyls and polyacrylics, e.g., polyacrylonitrile, as well as copolymers of acrylonitrile and other copolymerizable monomers can be used.

A better understanding of the process of this invention may be had from the following specific examples. It should be understood however, that the examples are given for purposes of illustration, and are not considered to limit the spirit or scope of this invention.

EXAMPLE I

Polyethylene terephthalate is melt spun at a temperature of 300° C through a spinnerett containing 192 round holes. The material is found to have an intrinsic viscosity of 0.89. The yarn is then drawn so as to give a draw ratio of about 6 to 1 and the drawn 1,020 denier yarn passed into the apparatus as illustrated in FIG. 1 of the drawings, complete with an air balance slot. The apparatus has a yarn processing bore 0.1875 inches in diameter and air entry ports 0.0625 inches in diameter. Upstream and downstream yarn tensions are maintained at 75 to 85 grams. High coherencies at low air pressures are found to result when operated at pressures as given in the following table designated as Table I.

TABLE I

Air Pressure (p.s.i.g.)	Average CF(hook drop)
60	30
70	37
80	38
90	41

EXAMPLE II

The procedure of Example I is repeated except that the apparatus is devoid of an air balance slot, and employs air entry ports having a diameter of 0.052 inches. Coherencies slightly lower than those of Example I are found to result when pressures are employed as given in the following table designated as Table II.

TABLE II

Air Pressure (p.s.i.g.)	Average CF (hook drop)
60	15
70	26
80	
90	38

EXAMPLE III

The process of Example I is again repeated except that the apparatus as illustrated in FIG. 3 of U.S. Pat. No. 3,115,691 is employed. The apparatus employs air entry ports 0.0625 inches in diameter and a plate spacing of 0.060 inches from the air entry ports. The air entry ports have an aspirating angle of 15° with respect to the plate's surface and have an included angle α of 30°. The apparatus is operated so that the aspirating angle is turned upstream. Tensions upstream of the apparatus are 30 grams while downstream tensions are about 75 grams. Compaction values when operated at

varying air pressures are as given in the following table, designated as Table III.

TABLE III

Air Pressure (p.s.i.g.)	Average CF (hook drop)
60	nil
70	nil
80	nil
90	10
100	25
110	35

EXAMPLE IV

Polyhexamethylene adipamide is melt spun at a temperature of 190° C through a spinnerette containing 140 round holes. The material is found to have a relative viscosity of 47.0. The yarn is then drawn so as to give a draw ratio of about 5.2 to 1 and the drawn yarn is passed into the apparatus as illustrated in FIG. 1 of the drawings, complete with an air balance slot. The apparatus has the same dimensions as those set forth in ExamPle I. Upstream and downstream yarn tensions are maintained at about 80 grams and when operated under air pressures of about 80 pounds per square inch gauge, a coherency factor of about 35 is found to result.

As can be seen, the efficiency of the apparatus of the instant invention, on the basis of air pressure versus coherency factor, is much greater than that of U.S. Pat. No. 3,115,691 which is believed representatIve of high eFficiency compactors of the prior art. While higher compaction values at correspondingly greater air pressures can be obtained with both the apparatus of this invention and apparatus of the prior art, yarn Coherency Factors in excess of 40 (hook drop) are not as desirable in that loops and whorls are developed in the yarn bundle.

Having thus disclosed the invention, what is claimed is:

1. An intermingling jet containing a bore adapted for passage of multifilament yarn therethrough and three fluid inlets leading into said bore, two of said inlets being parallel to each other and substantially tangential to said bore and one of said fluid inlets being radial to said bore and opposite said tangential bores, all of said fluid inlets being in a common plane substantially perpendicular to the longitudinal axis of said bore whereby the multifilament yarn may be simultaneously subjected to substantially tangential fluid jets and one radial fluid jet.

2. The apparatus of claim 1 having a yarn string-up slot disposed in said bore.

3. The apparatus of claim 2 wherein said string-up slot is substantially radial to said bore and intersects the extensions of said fluid inletS at right angles.

4. The apparatus of claim 1 wherein plenum chambers are disposed on opposite sides of said bore, a first plenum chamber supplying fluid to said parallel fluid inlets and a second plenum chamber supplying fluid to said radial fluid inlet.

5. The apparatus of claim 1 wherein said bore has a diameter in excess of 0.060 inch.

6. The apparatus of claim 1 wherein said bore has a diameter in the range of from 0.060 to 0.5 inches.

7. The apparatus of claim 1 wherein said bore has flared entry and exit portions.

8. A process for intermingling continuous filament yarn, said process comprising simultaneously subjecting said yarn to substantially tangential fluid jets and one radial fluid jet, said tangential jets and said radial jet being positioned on opposite sides of said yarn, said jets being operated at pressures of from 10 to 250 pounds per square inch gauge and velocities of from 75 feet per second to sonIc velocity.

9. The process of claim 8 wherein yarn tensions upstream and downstream of said jets are from 0.001 to 0.5 grams per denier.

10. The process of claim 8 whereIn said yarn has a total denier of from 20 to 20,000.

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