FLUID JET TWISTER

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FIG. 1

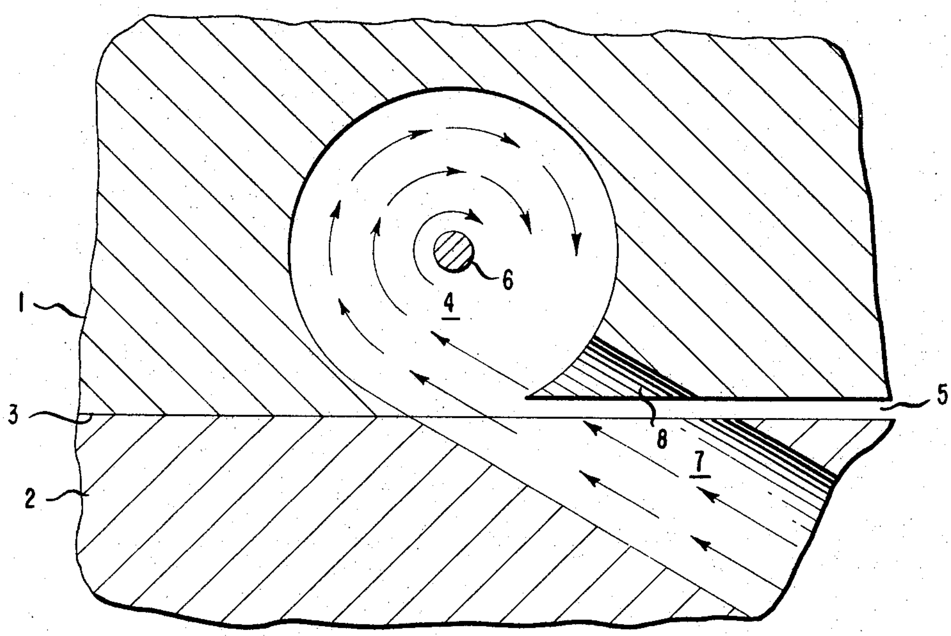
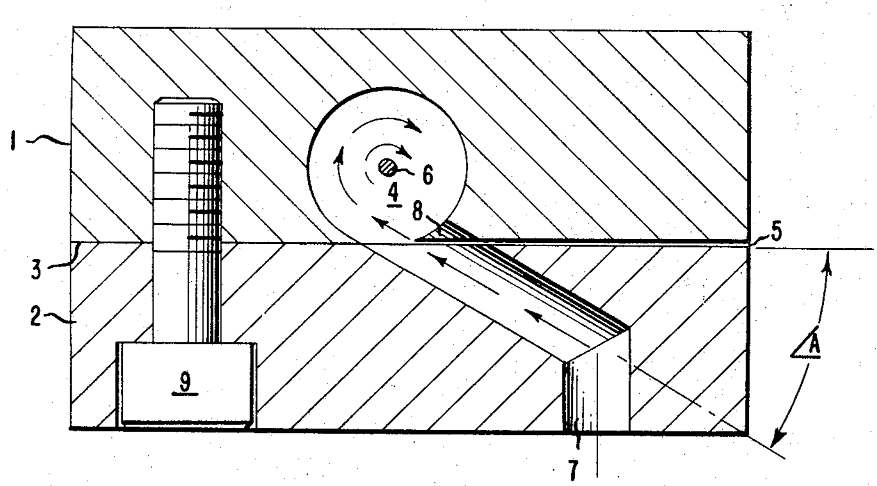


FIG. 2



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Nov. 21, 1967 F. J. CLENDENING, JR 3,353,344

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FIG. 3

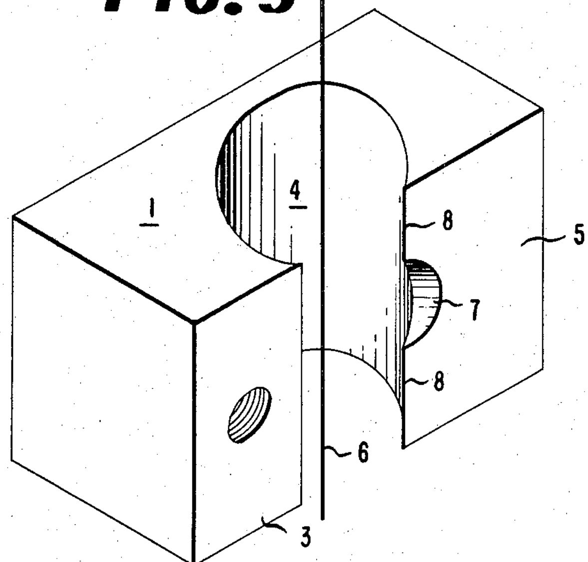

FIG. 4

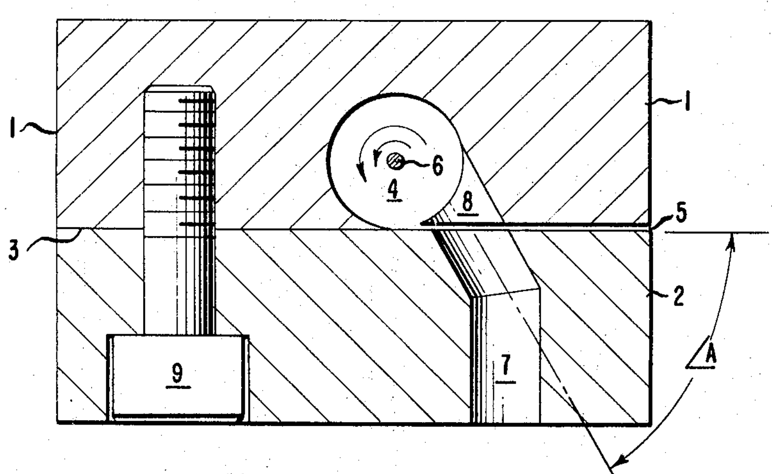

FIG. 5

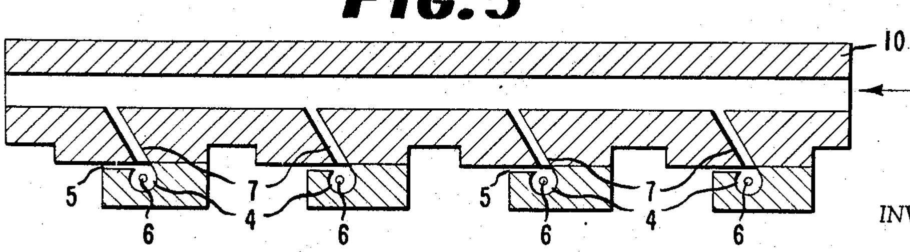

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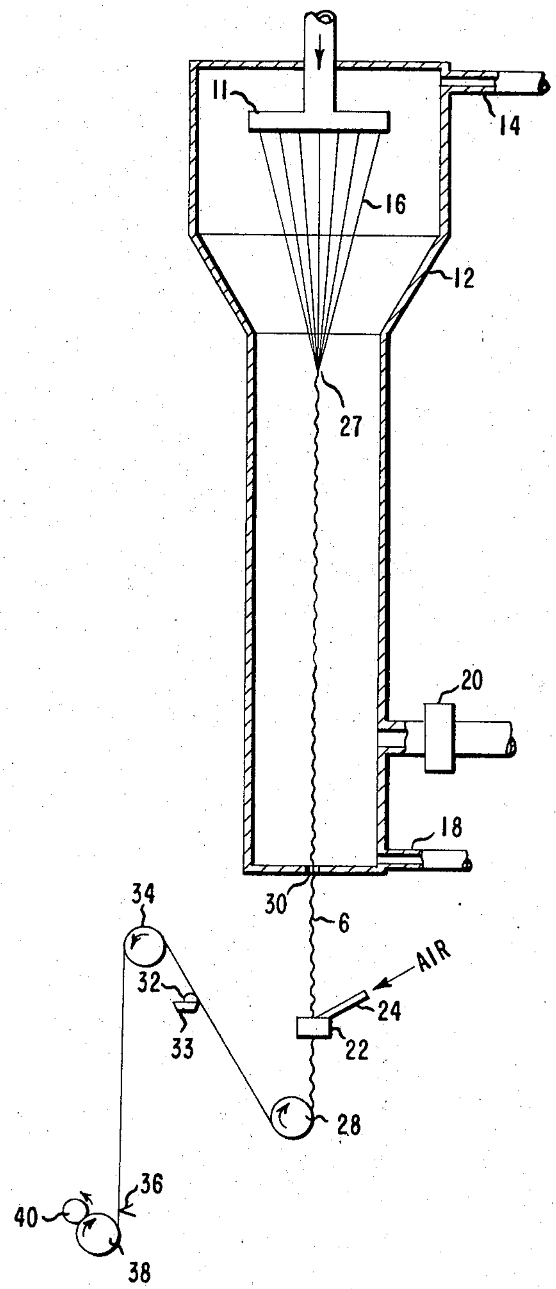
FIG. 6



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FLUID JET TWISTER

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This invention relates to apparatus for twisting yarns continuously. More particularly, it relates to an improved jet twister having an open stringup slot.

Jet twisters, in which a vortex of air or other fluid is used to exert a torque on a moving yarn or threadline, are known. For example, Foster and Battin, U.S. 2,515,299, and Smith, U.S. 3,094,374, describe two jet twisters of this type. The twisters shown in these patents are threaded with yarn by passing the end of the yarn through the yarn passageway of the twister. Although jet twisters can be designed so that the flowing air stream assists in the threading operation, it is more convenient to have a longitudinal stringup slot, as described in Breen and Sussman, U.S. 3,079,745. However, when jet twisters of the latter type are used under conditions of low yarn tension, as in the coalescence and windup of multifilament spandex, it has heretofore been found that the yarn will frequently tend to slip out of the stringup slot of the jet twister and thereby create non-uniformities along the yarn.

This invention provides a simple but effective and reliable textile yarn twister of low cost. This invention also provides a highly efficient jet twister which operates at low pressures and low flow rates and may be strung up rapidly. This invention further provides a jet twister of such construction that the flow of gaseous fluid serves to create a barrier whereby the yarn line is maintained in a stable position within the yarn passageway. This invention also provides a jet twister which has no moving parts and which may be constructed in very small size so that a series thereof may be used on multiple threads directly below a single spinning cell.

The advantages of this invention are attained in a jet twisting apparatus comprising (a) a single yarn passageway defined by a smooth curved concave inner peripheral wall surface, (b) a fluid conduit intercepting the yarn passageway and positioned to direct fluid substantially tangentially to its inner peripheral wall surface, and (c) a stringup slot intercepting the yarn passageway and running the length thereof to enable access of a yarn thereto. As an essential feature of the apparatus of the invention, the fluid conduit is positioned to intercept the slot at an angle of about 15 to about 90° and in the proximity of the yarn passageway. The interception of the slot by the fluid conduit in this manner causes fluid flowing through the latter to create an effective barrier which serves to eliminate, or at least greatly diminish, the tendency of the yarn to inadvertently slip out of the slot.

The jet twister of this invention may have a unitary construction, or it may be made of a plurality of parts held rigidly together. One embodiment of this invention is a jet twister comprising a flat plate cover and a mating body fixedly attached to the cover. The body is modified by an open, right circular cylindrical chamber serving as a yarn passageway, the longitudinal axis of which is parallel to the interface of the cover and body such that the chamber wall is tangential to the interface. A narrow, elongated stringup slot lies in the plane of the interface and intersects the chamber from one side throughout its full length. A fluid conduit directs a jet of fluid into the chamber so as to exert a torque upon a yarn passing therethrough. The fluid conduit forms a passage extending through the cover and across the stringup slot adjacent to the chamber and intercepting the chamber tangentially so as to direct a jet of fluid across the slot before entry into the chamber and thereby establish a fluid barrier for constraining the yarn in the chamber. As is well known in the jet twister art, the axis of fluid flow (entering the yarn passageway) must not intersect the axis of the yarn passageway. It will preferably lie in a plane substantially perpendicular to the longitudinal axis of the concave surface. For most purposes, this plane should not be inclined more than about 30° from said perpendicular.

In the drawings, which illustrate specific embodiments of this invention, like numbers appearing in the various figures represent similar structures. In these drawings,

FIGURE 1 is a partial section view of a jet twister of this invention;

FIGURE 2 is a full section of the embodiment of FIGURE 1;

FIGURE 3 is an isometric view of one part of the apparatus of FIGURE 2;

FIGURE 4 is a section view of another embodiment of the invention having alternate vortex action; and

FIGURE 5 is a view of an embodiment having multiple yarn passageways in a unitary construction for use in quadruple-thread spinning.

FIGURE 6 is a diagramatic representation of spinning apparatus for preparing coalesced spandex multifilament strands, including an improved jet twiste rof this invention.

The jet twister of FIGURE 1 contains a yarn passageway 4 which in this embodiment is substantially cylindrical in form throughout its length. A conduit for fluid 7 intercepts the yarn passageway at a right angle to the axis thereof and is positioned so that the longitudinal axis of the fluid conduit 7 does not intersect the longitudinal axis of yarn passageway 4 as shown. The fluid conduit 7 is tangent to the yarn passageway 4. When the gas under sufficient pressure is passed through conduit 7, torque upon yarn 6 is created to produce twisting of the yarn. Fluid may be supplied to conduit 7 by any convenient means, not shown. For example, a fitting may be fastened over the exterior port of the fluid conduit 7 and threaded for attachment to a fluid supply pipe. Preferably, the yarn passageway 4 will have rounded edges at both ends to minimize tearing of the yarn bundle. The yarn passageway may be widened by bevels at the yarn entrance and exit ports.

The jet twister is designed to provide for ease in stringing-up a thread by virtue of the stringup slot 5 running the entire length of the yarn passageway 4. Since a portion of the conduit 7 crosses and thereby intercepts the yarn stringup slot 5 in the proximity of the yarn passageway 4, yarn 6 is held in the passageway and will not tend to be inadvertently blown out of the slot 5.

In FIGURE 2 the jet twister is shown as comprising a generally flat body portion 1 made of suitable material, preferably a stainless steel alloy, and a cover portion 2 of like material, parts 1 and 2 being fixedly attached together by a threaded fastener 9. The mating surfaces of body 1 and cover 2 are ground flat and fit flush along the interface 3.

As further shown in FIGURES 2 and 3 yarn passageway 4, which is open at both ends, extends through the body 1 and is tangent at one point to interface 3. Stringup slot 5 lies in the plane of interface 3 and forms a gap separating body 1 from cover 2 through which a moving yarn 6 is manipulated into chamber 4 during stringup. It is preferred that the gap height of slot 5 be small enough to minimize leakage of the fluid supplied to the twister, but sufficient to permit stringup of a thread without snagging or breaking. A gap height of about 0.0015 to 0.0035 inch (0.037 to 0.089 millimeter) has been found satisfactory for yarn having a denier not greater than about 2500. However, it is understood that in processing yarn of different denier, the gap height is proportioned accordingly.

A critical feature of the jet twister of this invention resides in the placement of fluid conduit **7** relative to the chamber **4** and stringup slot **5**. In FIGURE 2 it will be seen that conduit **7** which has a diameter of one-half the diameter of chamber **4** extends through the cover **2** and intersects stringup slot **5** just before reaching the periphery wall of chamber **4**. Conduit **7** intersects stringup slot **5** at an acute angle which is designated in FIGURE 2 as angle A. Angle A may vary from about 15° to about 90°. In the preferred embodiment, i.e. to provide a most effective barrier, angle A is an acute angle on the order of 30°. Conduit **7** which enters chamber **4** tangent to the walls of said chamber thus provides a stream of fluid, advantageously compressed air, which is directed across the gap of stringup slot **5**. This discrete stream not only provides a vortex within chamber **4** for twisting yarn **6**, but also forms the barrier that prevents yarn **6** from being blown laterally out of slot **5**.

The fluid conduit **7** and stringup slot **5** are both tangent to the periphery of chamber **4**. For the purpose of this invention, these passages are considered "substantially tangent" to the chamber if the perpendicular distance from one wall to a point of true tangency does not exceed 20% of the radius of chamber **4**. In the preferred embodiment, one side of conduit **7** is tangent to chamber **4**, whereas the opposite side lies on a line intersecting the center of chamber **4**. For satisfactory operation, the jet twister should be so constructed that each side of conduit **7** deviates from the preferred design by not more than 20% of the radius of chamber **4**.

Essential to a stable fluid-vortex action are small extensions or wings **8** which are actually continuations of the walls of chamber **4** on either side of the aperture for conduit **7**. These wings serve to preserve the circular cross-section of chamber **4** and promote a more stable vortex action, thereby enabling the yarn **6** to be maintained at the axial center of chamber **4**. Preferably, the fluid conduit **7** is positioned equidistant from the ends of the chamber **4**.

Compressed air at room temperature is preferred for twisting yarn in the jet device of this invention, but the air may be heated or refrigerated if desired. Steam or solvogenic gases may also be used, provided that the plasticizing action, if any, is not harmful. For certain twisting applications, it may be desirable to utilize a fluid with a plasticizing effect. Other gases, such as carbon dioxide, nitrogen, and the like, may be used if desired. Non-gaseous fluids, because of their higher densities, need not be supplied at as high a velocity as gaseous fluids.

The size of chamber **4** may be proportioned to suit yarns of varying denier. For most yarn-twisting operations the diameter of chamber **4** may range from 1/64-inch (0.4 millimeter) to about 1/4-inch (6.3 millimeters). A diameter of 1/32-inch (0.8 millimeter) for chamber **4** and a diameter of 1/64-inch (0.4 millimeter) for conduit **7** gives good results in processing spandex yarns having deniers from about 5 to about 600. A jet having a diameter 1/16-inch (1.6 millimeters) for chamber **4** is suitable for a thicker yarn line, for example, up to about 2500 denier.

Operating pressures for the air used in the jet twister of this invention may range from about 1 to about 15 pounds per square inch gauge (p.s.i.g.) (70.3 to 1055 grams per square centimeter). In operation beneath a spandex spinning cell, the jet twisted performs well at relatively low air pressures, ranging from about 1 to about 6 p.s.i.g. (70.3 to 420 grams per square centimeter).

The air flow rate is generally set between 0.5 and 10 cubic feet per hour (0.014 and 0.28 cubic meters per hour.)

In FIGURE 4 an alternate vortex flow is obtained by positioning fluid conduit **7** so that it directs the fluid flow toward the opposite side of chamber **4**. It is to be noted, however, that conduit **7** intersects open slot **5** at a point prior but adjacent to the intersection of conduit **7** with chamber **4**. In operation, a moving yarn may be manipulated through the open slot **5** into chamber **4** without the aid of hooks or auxiliary devices. Once in chamber **4**, the yarn line **6** is held at the axial center by the action of the vortex and the fluid barrier positioned across slot **5**. It should be noted that the fluid supplied to conduit **7** need not be turned off during stringup operations. This is particularly advantageous in avoiding the delay in warming up the jet to a steady state thermal condition when using a heated fluid.

In the embodiment shown in FIGURE 5, the twister contains a plurality of non-connecting yarn passageways **4** and a plurality of fluid conduits **7**, each directed to serve an individual yarn passageway. In such cases it is convenient to design the apparatus in such a way as to provide a manifold **10** to facilitate maintenance of air or other fluid at constant pressure to all of the fluid conduits in the apparatus.

The jet twister of this invention is useful for treating any natural or synthetic filamentary material, particularly nylon, polyester, acrylonitrile polymer, and spandex fibers. Other materials, such as the natural fibers, wool, silk, cotton, regenerated cellulose and the like, may also be used with this invention. The apparatus is useful for treating both staple and continuous-filament yarns of all types having deniers less than about 3400. It is particularly useful in the production of coalesced spandex multifilaments. Thus as described in U.S. Patent 3,094,374 to Smith, a jet twister is placed immediately below the dry-spinning cell to cause false twist to back up into the cell to achieve coalescence of the filament bundle. An apparatus combination of this type is illustrated in FIGURE 6. In operation a spinning solution is pumped to a spinneret assembly **11** mounted in a dry spinning cell **12**. As the solution is extruded from the spinneret it is met by a co-current stream of hot inert gas introduced to the cell through inlet **14**. The solvent of the spinning solution is evaporated into the hot inert gas thereby converting the several streams of spinning solution into continuous filaments **16** as they proceed down the cell. A counter-current stream of inert gas may also be introduced at the bottom of the cell through inlet **18** to minimize dripping of solvent from the cell. The two streams of inert gas meet and are drawn off through an aspiration device **20** near the bottom of the cell. The filament bundle exits through a small hole **30** in the cell closure and passes through the jet twister **22** to the feed roll **28**. The hole in the cell closure and the jet twister are positioned with respect to the feed roll **28** such that the filaments pass from the spinneret to the feed roll without touching the cell closure or the walls of the jet, thus the only contact with a solid surface that the yarn would have prior to reaching roll **28** is an occasional or accidental contact with the wall of the jet or the hole in the cell outlet. The jet twister **22** is supplied with a steady flow of air through inlet **24**. The action of the jet is such as to twist the filament bundle **6** passing through it. The flow of air to the jet is adjusted so that this twist backs up into the cell to a point **27** which is the first point of filament-to-filament contact. Since the twist applied is false-twist the coalesced multifilament leaves roll **28** essentially free of twist. It then passes over a finish roll **32** for application of a lubricant from reservoir **33** thence to a second feed roll **34** and thence to a wind-up apparatus consisting a traversing yard guide **36**, a drive roll **38**, and is wound-up on bobbin **40**. Further details of operation of an apparatus of this type can be obtained by reference to the Smith patent, supra. With jets heretofore available, the uniform control of the air flow was often difficult because of jet design and the necessity of manual adjustment of the air stream to each twister. Consequently, the point of coalescence in the spinning cell would vary up and down the cell by as much as 3 or 4 feet (1 or 1.3 meters). The yarn cools rapidly as it approaches the bottom of the cell, variations in thermal exposure of the coalesced yarn adversely affecting denier uniformity and physical properties. With the apparatus of this invention, the coalescence point may be stabilized within a few inches at a location several feet above the cell exit, where the individual filaments are hot and sticky. The resulting yarn is significantly improved in denier uniformity and accordingly provides fabrics of superior appearance.

Another advantage of the jet twisters of the present invention is that they do not require the use of draw rolls or guides acting on the yarn before passage into the jet. Such snubbing devices are conventionally used with jet twisters of the prior art. The jet twister of this invention operates in a smooth and steady manner so that effective twisting action is achieved at tensions in the yarn approching zero. This characteristic, together with freedom from the use of draw rolls or guides upstream from the jet, renders the apparatus of this invention particularly valuable in the spandex spinning operation.

The jet twisters of this invention are easily made in very small size, thereby enabling use with multiple threadlines below a single spinning cell. The air for the jets is conveniently supplied by a manifold so that the flow to each jet is regulated by constant pressure rather than by other devices, such as rotameters. The jets of this invention have no moving parts and require only a small fraction of the air normally used with the jet twisters of the prior art.

What is claimed is:

1. In an apparatus for twisting yarns comprising (a) a single yarn passageway defined by a smooth curved concave inner peripheral wall surface, (b) a single fluid conduit intercepting said yarn passageway and positioned to direct fluid substantially tangentially to said inner peripheral wall surface, and (c) a stringup slot intercepting said yarn passageway substantially tangentially and running the length thereof to enable access of a yarn thereto; the improvement, for diminishing the tendency of a travelling yarn to inadvertently slip out of said slot, wherein said fluid conduit is positioned to intercept said slot at an angle of about 15 to about 90° and in the proximity of said yarn passageway.

2. Apparatus according to claim 1 wherein said fluid conduit intercepts said slot at an angle of about 30°.

3. Apparatus according to claim 1 wherein said yarn passageway forms an essentially right circular cylinder.

4. In an apparatus for preparing a coalesced spandex multifilament strand comprising:

a spinneret having a plurality of orifices for spinning a plurality of continuous monofilaments from a solvent-containing solution of a spandex polymer;

a dry-spinning cell for receiving said monofilaments and evaporating said solvent, said cell comprising an elongated chamber enclosing said spinneret at one end and having an opening at the other end for withdrawing said filaments, and also having openings for entrance and exit of a gaseous evaporative medium;

a fluid jet twister located immediately below said dry-spinning cell for applying a torque to said filaments and causing said filaments to be coalesced at a point inside said dry-spinning cell, said jet twister comprising (a) a single yarn passageway defined by a smooth, curved, concave, inner peripheral wall surface, (b) a single fluid conduit intercepting said yarn passageway and positioned to direct fluid substantially tangentially to said inner peripheral wall surface, and (c) a string-up slot intercepting said yarn passageway substantially tangentially and running the length thereof to enable access of the yarn thereto, and

a driven roll located immediately below said jet twister for receiving and forwarding said coalesced spandex multifilament;

the improvement wherein, in said jet twister, said fluid conduit is positioned to intercept said slot at an angle of about 15 to about 90° and in the proximity of said yarn passageway.

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