Jan. 23, 1968 W. W. BUNTING, JR., ET AL 3,364,537

APPARATUS FOR INTERLACING MULTIFILAMENT YARN

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FIG. 1

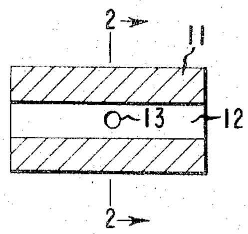


FIG. 2

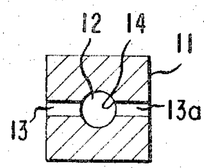


FIG. 3

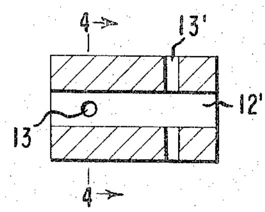


FIG. 4

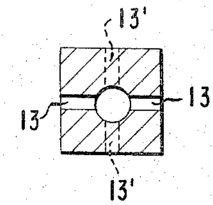


FIG. 5

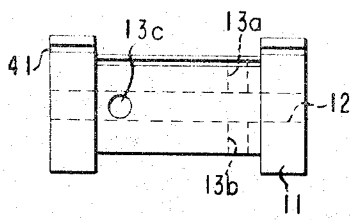


FIG. 6

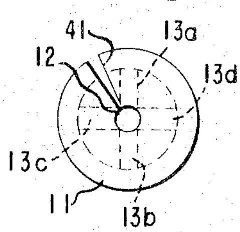


FIG. 7

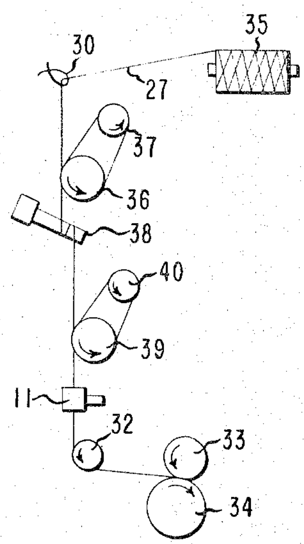


FIG. 8

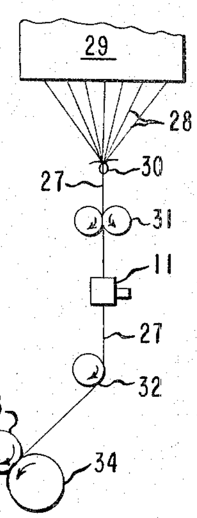


FIG. 9

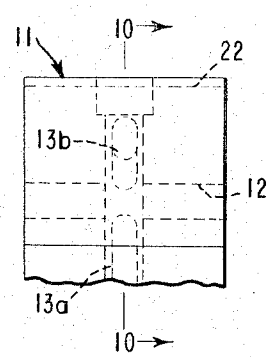
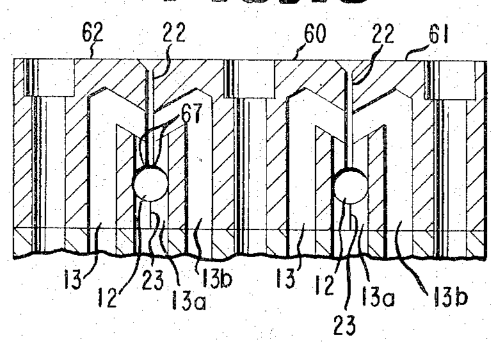


FIG. 10



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APPARATUS FOR INTERLACING MULTIFILAMENT YARN

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FIG. 11

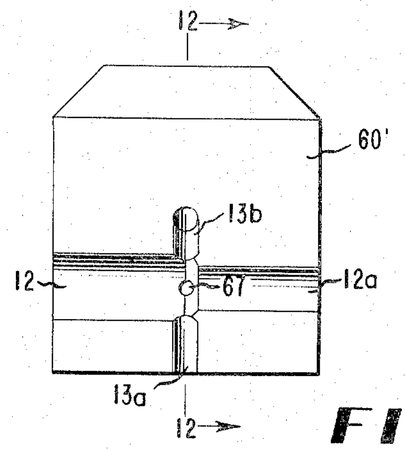


FIG. 12

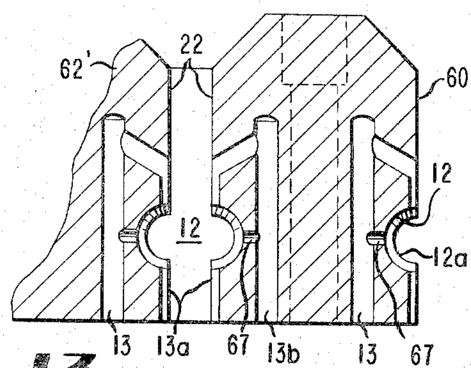


FIG. 13

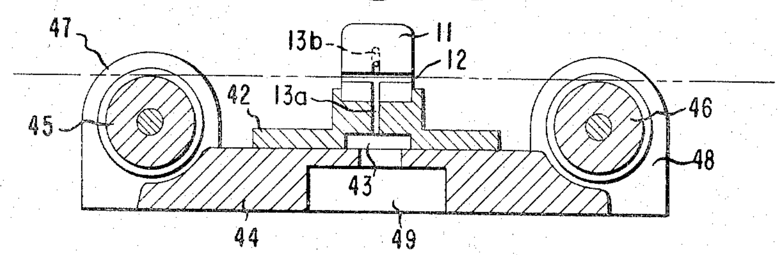


FIG. 14

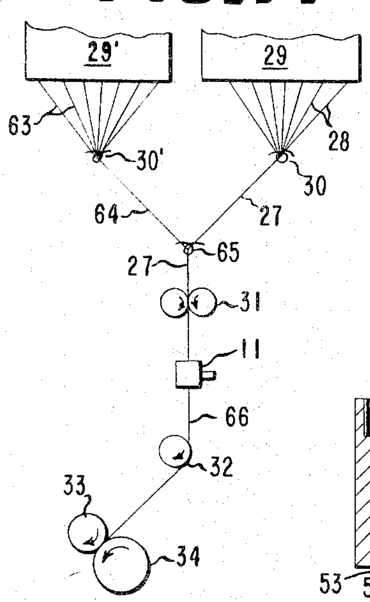


FIG. 15

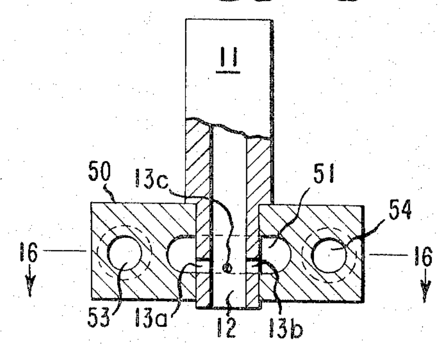
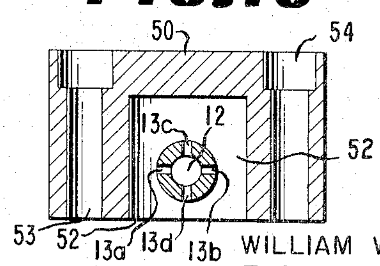


FIG. 16



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3,364,537

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3,364,537

APPARATUS FOR INTERLACING MULTIFILAMENT YARN

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Continuation-in-part of application Ser. No. 310,520, Sept. 18, 1963. This application Sept. 7, 1965, Ser. No. 485,438

7 Claims. (Cl. 28—1)

This a continuation-in-part of our application Ser. No. 310,520, filed Sept. 18, 1963, now abandoned, which, in turn, is a continuation-in-part of our application Ser. No. 112,927, filed May 26, 1961, now U.S. Patent No. 3,110,151 granted Nov. 12, 1963 as a continuation-in-part of our application Ser. No. 68,130, filed Nov. 8, 1960, now U.S. Patent No. 2,985,995 granted May 30, 1961, which is, in turn, a continuation-in-part of our application Ser. No. 752,451, filed Aug. 1, 1958 and now abandoned. The present invention relates to apparatus for producing interlaced multifilament yarn, and is more particularly concerned with fluid interlacers having means for impinging opposed jets of fluid on yarn passed continuously through the interlacer and suitable for high speed interlacing of fibers into a coherent yarn bundle.

The fluid interlacer of this invention comprises a yarn passageway in combination with one or more pairs of opposed fluid conduits positioned to direct streams of high velocity fluid perpendicular to the axis of the yarn passageway. The yarn passageway may be rectangular or circular in cross section, or it may be an open trough or slit with an axis parallel to the yarn path, or it may have any suitable cross section equivalent to these configurations. The yarn passageway cross section need not be the same in form throughout. Each opposed pair of conduits has a common length axis and when there are a plurality of opposed pairs of fluid conduits they may be disposed at intervals along the yarn passageway in the same plane or at various angles relative to each other. The fluid conduits may be circular in cross section or in any other suitable configurations, such as rectangular, oval, or the like.

The use of the fluid interlacers of this invention for producing interlaced yarn is disclosed in our above U.S. Patent No. 2,985,995 and No. 3,110,151 which are relied upon to supplement the present disclosure. The invention will be described with reference to the drawings which illustrate specific embodiments.

In the drawings,

FIGURE 1 is a longitudinal cross section taken along the axis of the yarn passageway of a fluid interlacer of this invention;

FIGURE 2 is a cross-sectional end view taken on line 2—2 of FIGURE 1;

FIGURE 3 is a longitudinal cross section taken along the axis of the yarn passageway of another fluid interlacer of this invention;

FIGURE 4 is a cross-sectional end view taken on line 4—4 of FIGURE 3;

FIGURE 5 is a side view of an interlacer similar to that of FIGURE 3 but having a stringup slot to facilitate starting the treatment;

FIGURE 6 is an end view corresponding to FIGURE 5;

FIGURE 7 is a diagrammatic illustration of the use of the fluid interlacer in a process of successively drawing and interlacing yarn;

FIGURE 8 is a similar diagrammatic representation of a process wherein the yarn is fed directly to the fluid interlacer from a spinneret as it is formed;

FIGURE 9 is a longitudinal side view of another embodiment of the invention;

FIGURE 10 is a cross-sectional end view taken on line 10—10 of FIGURE 9;

FIGURE 11 is a side view of FIGURE 12;

FIGURE 12 is an enlarged broken-away section of an end and intermediate portion of a jet similar to FIGURE 10 modified with a stepped yarn pasageway. This section is taken along line 12—12 of FIGURE 11;

FIGURE 13 is a cross-sectional side view of another embodiment of a fluid interlacer, the cross section being taken through the axis of the yarn passageway;

FIGURE 14 is a diagrammatic illustration of the use of a fluid interlacer in a process to simultaneously ply and interlace two dissimilar yarns;

FIGURE 15 is a side view of a further embodiment of a fluid interlacer, shown partially in cross section taken through the axis of the yarn passageway; and

FIGURE 16 is a cross-sectional view taken along lines 16—16 of FIGURE 15.

FIGURE 1 illustrates a representative fluid interlacer 11 useful in this invention, containing lengthwise yarn passageway 12 which, in this embodiment, is substantially cylindrical in form throughout its length. In interlacer 11, fluid conduit 13 intercepts yarn passageway 12 at 14 at right angles to the wall thereof and is positioned so that the longitudinal axes of fluid conduit 13 and yarn passageway 12 intersect perpendicularly. These relationships are seen in FIGURE 2. The opposed fluid conduit 13*a* is correspondingly positioned so that the conduits 13 and 13*a* have a common longitudinal axis. Air or other fluid can be supplied to the opposed fluid conduits by a suitable manifold arrangement. FIGURES 3 and 4 show an interlacer with two sets of opposed fluid conduits 13 and 13′ spaced longitudinally along the yarn passageway. FIGURES 5, 6, 9 and 10 illustrate other interlacers in which fluid enters the yarn passageway 12 from opposite sides that is, through conduits 13, 13*a* and 13*b*, and 13*c* and 13*d*.

The process of this invention is carried out in conjunction with one or more of the conventional textile operations, such as spinning, drawing, winding, packaging, or the like, thereby taking full advantage of the existing means for forwarding the yarn at controlled positive tension and obviating the need for a separate interlacing step. FIGURE 7 shows apparatus useful for interlacing as part of the drawing operation. FIGURE 8 illustrates an assembly of apparatus whereby yarn may be continuously interlaced during the spinning operation. FIGURE 14 illustrates an assembly of apparatus where yarn may be continuously and simultaneously interlaced and plied during the spinning of yarns having dissimilar physical properties. In the three figures, interlacing takes place prior to yarn packaging; therefore, the package to be prepared may be utilized without having to divert it through separate twisting. Referring to FIGURE 8, the filaments 28 issuing from spinneret 29 converge at guide 30 into yarn 27, to which finish is applied (by means not shown) prior to passing the nip rolls 31, which serve as forwarding means to the interlacer 11. Interlacing may also precede application of finish, if desired, or finishing may be omitted altogether. After interlacing with any one or more of the above described apparatus, yarn 27 passes feed roll 32 and then to the takeup point, back windable package 33 driven by drive roll 34.

FIGURE 7 illustrates the stringup assembly whereby interlacing occurs immediately after drawing and prior to packaging. In accordance with this embodiment, undrawn yarn 27 is withdrawn from package 35, passes through pigtail guide 30, then is passed in multiple wraps about driven feed roll 36 and its associated separator roll 37. From feed roll 36 the undrawn yarn makes one or more wraps about a snubbing pin 38 and is drawn in frictional contact therewith under the urging of draw roll **39** and its associated separator roll **40**. Draw roll **39**, of course, has a higher peripheral speed than the feed roll **36**, and the yarn is elongated to several times its original length. From draw roll **39** which serves as the feed point, the yarn passes to interlacer **11**, is interlaced then passes idler roll **32** to package **33** driven by drive roll **34**. Conventional reciprocating traversing means (not shown) are usually associated with both FIGURE 7 and FIGURE 8 windup assemblies.

In FIGURE 14 filaments **28** and **63** are issued from spinnerets **29** and **29'**, then converge at guides **30** and **30'** to form yarns **27** and **64**, each representing yarns having dissimilar properties. Yarns **27** and **64** converge at guide **65**, pass nip rolls **31** and are forwarded to the interlacer **11** where they are simultaneously interlaced and plied into a compact unitary yarn bundle **66** which is wound on a package **33** driven by drive roll **34** as described above.

In any continuous operation, it is of considerable advantage to utilize an interlacer of the self-stringing variety. Embodiments having stringup slots are shown in FIGURES 5, 6, 9 and 10 where yarn passageway **12** is cylindrical. In the embodiment of FIGURES 5 and 6, yarn passageway **12** is intersected by two pairs of fluid conduits **13*a*–13*b*** and **13*c*–13*d***, each pair having a common longitudinal axis, the two axes being disposed at right angles, one to the other. The fluid conduits **13*a*–13*b*** and **13*c*–13*d*** are spaced laterally as shown. A stringup slot **41** extends the length of the interlacer and permits stringup with a minimum loss of interlacing fluid. The turbulent action of the fluid in the yarn passageway **12** serves to "curtain" the stringup slot so that there is little likelihood of the yarn blowing out of yarn passageway **12** through slot **41**.

In the embodiment of self-stringing interlacer shown in FIGURE 10, the interlacer body **11** is provided with stringup slots **22** which extend the length of yarn passageway **12** to make the interlacer self-stringing with continuous yarn. Three fluid conduits **13**, **13*a*** and **13*b*** serve to introduce fluid into the yarn passageway **12** from opposite directions. The axis of conduit **13*a*** is perpendicular to the axis of the yarn passageway. Conduits **13** and **13*b*** bypass the yarn passageway on each side, and are then interconnected with an extension of conduit **13*a*** to supply fluid to the passageway at a position opposed to the fluid passing directly into the passageway through conduit **13*a***. The flow of fluid which passes up through passageways **13** and **13*b*** then exhausts downwardly through stringup slot **22** into yarn passageway **12**. In this manner, a negative pressure is provided at the entrance to the stringup slot which aids the yarn in entering the passageway **12**. Once the yarn is in the passageway it will not leave, since in order to jump out of the stringup slot **22** it must pass countercurrent to the fluid entering the passageway **12** through the stringup slot. In addition, fluid entering the yarn passageway from the slot **22** prevents the yarn filaments, during the interlacing process, from contacting the edges **67** of stringup slot **22** and thus snagging the filaments.

For ease of fabrication, it is convenient for the interlacer to be divided into separate, symmetrical parts at a plane passing through the stringup slot and line **23** of the drawings. Prior to the concept of making the jet from a plurality of symmetrical parts, such as **60**, **61** and **62** of FIGURE 10, the stringup slot which is critically dimensioned either had to be formed by milling or sawing. Such slots are relatively rough and, if not properly finished, yarn of poor quality results. Now the yarn slot may be accurately formed and properly finished by grinding in a matter of minutes on a surface grinder.

FIGURE 13 illustrates the above interlacer on a suitable mounting. The front half of the interlacer **11** has been removed to show the construction, and the mounting is shown in cross section along the same plane. The

interlacer is mounted on a block **42** provided with a fluid chamber **43** which communicates with the three conduits shown in FIGURE 10. Block **42** is, in turn, mounted on a base **44** provided with yarn guides **45** and **46**. These guides have the configuration of pulleys and are aligned with the axis of the yarn passageway to direct the yarn axially through the passageway for treatment. The guides are supported by members **47** and **48**, respectively, which may be molded or cast integral with base **44**. The base may be of suitable length to accommodate any desired number of interlacers and yarn guides for separately treating a plurality of parallel yarns. The base is provided with a fluid chamber **49** which communicates with chamber **43** of each interlacer block **42**. A supply line for fluid under pressure (not shown) is sealed against the outer opening of chamber **49**. The interlacer, block and base are secured together by suitable fastening means, such as bolts (not shown to avoid confusing the illustration).

FIGURES 15 and 16 illustrate another embodiment having fluid conduits entering the yarn passageway from four directions. As shown in FIGURE 15, interlacer **11** is mounted on a block **50**, assembly being affected by a mortise and tenon type joint. The interlacer is cylindrical and has yarn passageway **12** aligned with the longitudinal axis of the cylinder. One end of the cylinder is of reduced diameter, and a hole is drilled through the block to provide a snug fit for this end. Four fluid conduits, **13*a***, **13*b***, **13*c*** and **13*d***, (see FIGURE 16) are provided in this end and located where the end is within the block. These conduits are spaced 90° apart in the same plane and are perpendicular to the axis of the yarn passageway **12**. The block **50** is hollow to provide a fluid chamber **51** surrounding conduits **13*a***, **13*b***, **13*c*** and **13*d***. An opening **52** into the chamber **51** is provided on one side of block **50**. This side of the block is bolted to a suitable mounting, which may be similar to the base illustrated in FIGURE 13 having means for supplying fluid under pressure to chamber **15**. Bolt holes **53** and **54** for mounting are shown in the block.

As explained in our U.S. Patent No. 2,985,995 and No. 3,110,151, a yarn is efficiently interlaced with a fluid jet when the yarn is first randomly splayed open, forming minor interlace above and below the center line of the jet. The filaments are forced to move in and about each other forming additional interlace until it is no longer possible for the fluid forces to move the filaments; then there is a brief delay before the process repeats itself while the upstream interlace section moves through the jet. In this periodic interlacing process with a given jet at a given fluid pressure, yarn properties of filament-to-filament cohesion, tension, temperature, and the number and size of the filaments will regulate the yarn splay distance. Also, the same variables which effect the filament-to-filament cohesion and torsion and bending moduli will regulate the degree or tightness of interlace inserted. It is known that where interlacing is used to prepare plied yarn bundles that if two or more ends of yarn having different physical properties are passed simultaneously through a jet, a represented in FIGURE 1, each will splay at a different frequency with respect to time, splay at a different distance, and interlace at a different tightness. This results in unsatisfactory yarn plying, as evidenced by easily identifiable individually interlaced yarn bundles.

We have unexpectedly discovered that dissimilar yarns can be simultaneously interlaced and plied by feeding them through a jet which has a stepped yarn passageway, the step being a change in the width or diameter of the yarn passageway from small to large at the point where the fluid conduit intersects the yarn passageway. This is best shown in FIGURES 11 and 12 where FIGURE 12 represents a partial broken-away section of an end and intermediate portion of a jet similar to FIGURE 10. FIGURE 11 is a side view of an intermediate section **60'** of FIGURE 12. As previously described, the fluid conduits

13, 13*a* and 13*b* introduce fluid into yarn passageway 12 from opposite directions. However, in this preferred embodiment of the invention, the diameter of the yarn passageway changes from a smaller tubular portion or section 12*a* to a larger tubular portion or section 12 at the point where fluid conduits 13*a* and 13*b* intersect the passageway; also, relatively small conduits 67 are provided by drilling through the walls separating conduit 13*a* from conduits 13 and 13B to introduce fluid into the yarn passageway on an axis perpendicular to the axis of conduit 13*a*.

The optimum design of a specific interlacing jet depends to an appreciable extent on process and product variables such as tension, fluid pressure, fiber and yarn denier, degree of interlacing desired, yarn speed and the like. Interlacer dimensions should be as small as practicable to conserve interlacing fluid and to concentrate the zone and effect of the controlled fluid turbulence. The yarn passageway of the fluid interlace should have an internal diameter or width of 2 to 100 times the yarn diameter. For textile deniers, this will usually be between about 0.002 inch and about 0.2 inch, and preferably between about 0.015 inch and 0.075 inch. Yarn passageways, of course, can be intermediate between the cylindrical and rectangular and their cross-sectional areas at initial point of contact between the yarn and the fluid stream should preferably correspond to areas of circles having the above diameters.

The length of yarn passageway may be widely varied, but should not be less than its width (or diameter). Preferably, the yarn passageway will be about 2 to 10 times its diameter or width and should normally be not more than 20 times its diameter. Where stepped yarn passageways are used, the width or diameter of the larger section is usually between 1.1 to 3.0 times that of the smaller section. Longer yarn passageways can be used, usually in combination with more than one fluid conduit, and frequently it will be desirable to have one or more exhaust ports to release interlacing fluid and minimize back pressures. A series of unitary interlacers will normally be preferred over a single interlacer with multiple fluid conduits and a long passageway. For an interlacer with a single fluid conduit or a pair of opposed fluid conduits the length of the yarn passageway should preferably be from about 0.1 inch to 1.0 inch.

The area of the fluid conduit is usually less than the area of the yarn passageway at the point of interception and the areas of the opposed fluid conduits are preferably equal to each other at the point of interception with the yarn passageway. The ratio of the area of the yarn passageway to the area of a fluid conduit should be from about 1:1 to about 20:1.

The invention will now be illustrated by the following examples which are not to be construed as limiting to the scope of the invention.

Example I

A fluid jet of FIGURES 1 and 2 having one of its fluid conduits 13 plugged to prevent passage of air was used to interlace 70-denier 34-filament zero twist nylon yarn. This T-tube jet had a yarn passageway 0.070 inch in diameter and a single air conduit 0.035 inch in diameter which was supplied with air at 100 pounds per square inch gauge pressure.

For comparison, yarn was also interlaced with the jet arrangement shown in FIGURES 1 and 2. This jet had an opposed pair of air conduits each 0.025 inch in diameter so that the total cross-sectional area of the two was approximately equal to the single 0.035 inch of the above-described T-tube jet. All other conditions were the same in the two experiments, i.e., the same yarn, same yarn speed (1000 yds./min.), same yarn passageway diameter and same air pressure. Approximately 3000 yards of interlaced yarn were produced in each experiment.

Interlaced yarn produced using the T-tube shows a defect in that the air flow from the single orifice knifes through the yarn bundle, dividing it into two separate bundles and each bundle is separately interlaced. Such split bundles occur frequently along the yarn. They were random in nature and from 1 to 4 inches in length. These defects are readily detected in commercially dyed fabrics and show up as lustre defects which make such fabrics unsuitable for many commercial uses.

The defect was not present in the interlaced yarn produced with the jet having a pair of directly opposed fluid conduits.

Example II

The possible use of angled air hole jets in apparatus for producing compact interlaced yarn was investigated. A variety of jet arrangements were tested over a range of air pressures. These provided opposed air conduits at equal angles to the threadline (axis of the yarn passageway). Air holes at various angles were tried and tested in comparison with a control jet C similar to FIGURES 1 and 2 in which the opposed air openings were drilled along a common axis perpendicular to the threadline. The following table shows the angle at which the air hole axis inclines from the perpendicular axis (perpendicular to the threadline axis), and gives the results of these tests:

Run No.	Jet Type	Air Hole Size	Angle, deg.	Air Press. (p.s.i.g.)	Interlace Level in Yarn (peaks/100 cm.)
66	Angle hole	0.052	45	40	20
67	do	0.052	45	50	20
58	do	0.052	67.5	40	7
59	do	0.052	67.5	50	------
60	do	0.052	67.5	60	25
Control Jet C		0.025	0	40	40

It was possible to interlace with angle hole jets but the quality was inferior. The interlace level was only about one-half, or less, of that obtained with control jet C, even when using a much greater amount of air in the angle hole jets. The above table indicates the inefficient use of air in the angle hole jets. The above experiments show that angle hole jets are not effective interlacing jets.

Example III

In further tests interlacing is employed to prepare plied yarn bundles of two yarns having dissimilar physical properties in accordance with the apparatus shown in FIGURE 14. A jet as shown in FIGURES 11 and 12 with 0.098-inch diameter x 0.076 inch-diameter stepped passageway with 0.052-inch diameter major air conduits (13, 13*b*) and 0.028-inch diameter minor guide conduits (67) is used to ply 1 end of 70-denier 14-filament Dacron® polyester yarn and one end of 70-denier 17-filament nylon yarn as 3000 y.p.m., 18 grams tension on each end and 80 p.s.i.g. air pressure.

The two yarns interlaced and plied uniformly with an interlace level of 33 peaks per 100 cm.

By comparison, a jet as represented in FIGURES 1 and 2 (0.098-inch diameter yarn passageway and 0.052-diameter fluid conduits) was used to ply these yarns under the same conditions described above. Although the two yarns did interlace and ply together, the plying was irregular with random sections along its length of 12 inches or more where no plying took place. The interlace level was 8 peaks per 100 cm. or approximately one-fourth the level obtained when using the stepped splash jet.

The apparatus of this invention is inexpensive requires little maintenance, requires no moving or rotating parts, minimizes yarn contact (no yarn degradation) is practically instantaneous in its action, and is very economical to operate. Moreover, such interlacers are readily adapted to operate on extremely close centers, as required in warp interlacing. Such interlacers are simple to fabricate requiring only drilling in many cases.

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.

We claim:

1. Apparatus for high speed interlacing of multifilament yarn comprising a fluid interlacer body member, a yarn passageway through the body member extending along a straight axis; feeding and withdrawing means for continuously forwarding the yarn at controlled positive tension along the axis through said passageway; directly opposed fluid conduits into said passageway in the body member for impinging fluid against opposite sides of the yarn to separate and interlace filaments of the yarn, said opposed conduits having a common longitudinal axis which intersects the axis of the yarn passageway and is perpendicular thereto; and means for supplying fluid to said opposed conduits.

2. Apparatus as defined in claim 1 having a stringup slot extending the length of said yarn passageway in the interlacer body member, for introducing yarn, and positioned relative to said opposed conduits so that the action of the fluid curtains the slot.

3. Apparatus as defined in claim 1 having a stringup slot extending the length of said yarn passageway in the interlacer body member and passing through one of said opposed fluid conduits to make the interlacer self-stringing with continuous yarn.

4. Apparatus as defined in claim 1 wherein the cross-sectional areas of the opposed fluid conduits are equal to each other at interception with the yarn passageway and the ratio of the cross-sectional area of the yarn passageway to the area of a fluid conduit is from about 1:1 to about 20:1.

5. Apparatus as defined in claim 1 wherein there are a plurality of pairs of opposed fluid conduits spaced longitudinally along the yarn passageway.

6. Apparatus as defined in claim 1 wherein there are a plurality of pairs of opposed fluid conduits and all of said fluid conduits have longitudinal axes in a common plane.

7. Apparatus as defined in claim 1 wherein said yarn passageway is of one size up to intersection with said opposed fluid conduits and is of larger size thereafter, the width of the larger portion being between 1.1 to 3.0 times that of the smaller portion.

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ROBERT R. MACKEY, *Primary Examiner.*