Feb. 11, 1969 F. McCUTCHAN, JR 3,426,406

APPARATUS FOR INTERLACING MULTIFILAMENT YARN

Filed May 18, 1967

FIG. 1

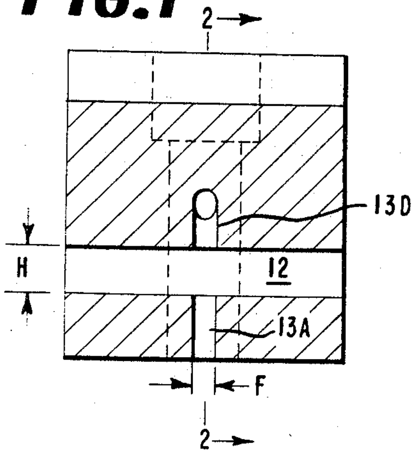


FIG. 2

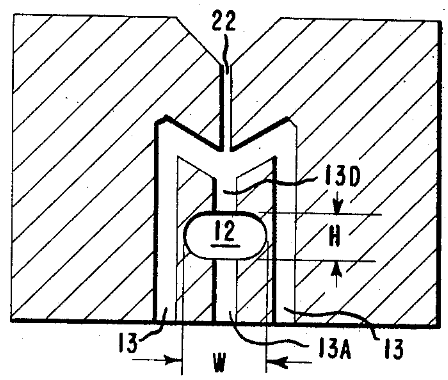


FIG. 3

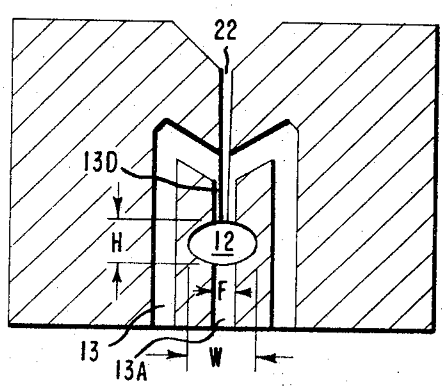


FIG. 4

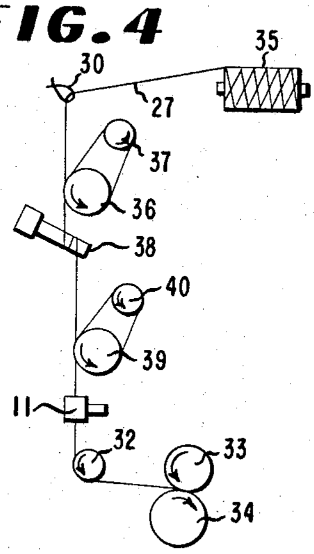


FIG. 6

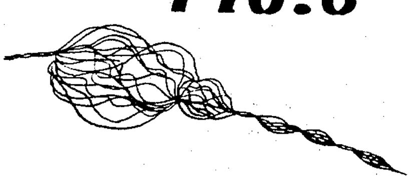


FIG. 5

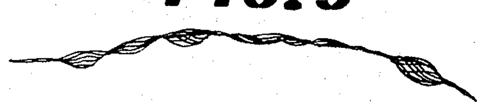


FIG. 7

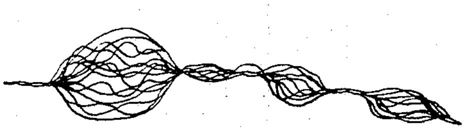
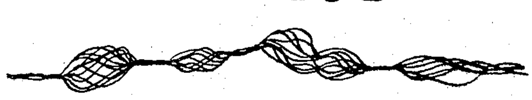


FIG. 8



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APPARATUS FOR INTERLACING MULTIFILAMENT YARN

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U.S. Cl. 28—1 **5 Claims**
Int. Cl. D02g *1/16*

ABSTRACT OF THE DISCLOSURE

An improved jet for interlacing and plying multifilament yarn comprising a body member, a yarn passageway through the body along a straight axis, and at least one pair of opposed fluid conduits having a common longitudinal axis which intercepts and is perpendicular to the axis of the yarn passageway, the yarn passageway being further characterized by having a cross section in the vicinity of the fluid conduits corresponding to an ellipse or a rectangle having semicircular ends, the cross section having a width to height ratio within critical limits for improved interlace uniformity and greater fluid efficiency.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to improved fluid interlacers which impinge opposed jets of fluid on yarn for producing interlaced multifilament yarn of improved interlace uniformity.

Description of the prior art

The use of fluid interlacers of this general type for producing interlaced yarn is disclosed in Bunting et al. U.S. Patents Nos. 2,985,995 and 3,110,151 and in Bunting et al. U.S. application Ser. No. 485,438 filed Sept. 7, 1965, now U.S. Patent No. 3,364,537. The utility of the apparatus described in these patents is well known, as shown by the expanding trade acceptance of yarns produced by this equipment in place of twisted yarns. However, a special problem arises in certain fabrics, such as taffetas and satins of cellulose acetate, where appearance uniformity is especially critical. The regions of greatest filament entanglement in the usual alternating pattern of tight and loose interlace sections create noticeable streaks or barré in such fabric. Reducing the average degree of interlace to the point where the tighter sections are no longer evident also reduces the cohesion of the looser sections, allowing the yarn bundle to separate which creates processing problems such as the snagging of filaments in mill equipment.

SUMMARY OF THE INVENTION

This invention provides a fluid interlacer for yarn which produces more uniform spacing of maximum interlace points along the threadlines than existing equipment. This invention also provides an interlace jet that requires a smaller amount of interlacing fluid to produce a yarn having a given average level of interlace cohesion. Also provided is an interlacer that produces a yarn having less variation of filament entanglement.

The improved fluid interlacer of this invention comprises an interlacer body having a yarn passageway and a pair of opposed fluid conduits which are positioned within the body to direct streams of high velocity fluid perpendicular to the axis of the yarn passageway. The yarn passageway at the point where the fluid conduits intersect is rectilinear with semicircular ends, oval, or elliptical in cross section with critical dimensions as speci-

fied in the description of the preferred embodiments and the claims. The yarn passageway cross section need not be the same in form throughout its length. The two opposed fluid conduits have a common longitudinal axis and may be circular in cross section or any suitable configuration such as rectangular, oval, or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

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 cross-sectional end view taken on line 2—2 of FIGURE 1, showing another embodiment of this invention;

FIGURE 4 is a diagrammatic illustration of the use of the improved fluid interlacer in a process of successively drawing and interlacing yarn;

FIGURE 5 is an illustration of yarn which has been interlaced by an interlacer of this invention;

FIGURE 6 shows yarn interlaced by an interlacer of the prior art which has a yarn passageway of a circular cross section;

FIGURES 7 and 8 illustrate yarn interlaced in an interlacer in which the ratio of the width W of the oval yarn passageway to the height H of the passageway exceeds the critical limits of this invention.

More particularly, FIGURE 1 illustrates a representative fluid interlacer of this invention which has lengthwise yarn passageway **12** and opposed fluid conduits 13A and 13D. Fluid conduits 13A and 13D have a common longitudinal axis and intercept yarn passageway **12** at right angles such that the longitudinal axis of the fluid conduits and the longitudinal axis of the yarn passageway are perpendicular.

FIGURE 2 illustrates an embodiment of the invention in which the yarn passageway **12** has a rectilinear cross section as defined by a rectangle having semicircular ends.

FIGURE 3 illustrates another embodiment of the invention in which the yarn passageway **12** has a cross section as defined by an ellipse. The performance of the interlacer having the elliptical yarn passageway of FIGURE 3 is not significantly different from the interlacer of FIGURE 2 having the rectilinear yarn passageway.

In the drawings the height of yarn passageway **12** is indicated by H and is measured along the axis of the opposed fluid conduits **13A** and **13D**. The width of yarn passageway **12** is indicated by W and measured perpendicularly to each end at the intersection of the axis of fluid conduits **13A** and **13D** and the longitudinal axis of yarn passageway **12**.

The diameter of the fluid conduits **13A** and **13D** is referred to as F.

Air or other fluid can be supplied to the opposed fluid conduits by a suitable manifold arrangement.

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 4 shows apparatus useful for interlacing as part of the drawing operation. It 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 the windup assemblies.

The process of this invention can also be carried out in conjunction with a spinning operation whereby yarn may be continuously interlaced. FIGURE 8 of Bunting et al. U.S. patent application Ser. No. 485,438 filed Sept. 7, 1965, now U.S. Patent No. 3,364,537 shows the arrangement of an interlacer in a conventional spinning operation which is also suitable arrangement for the interlacer of this invention.

In any continuous operation, it is of considerable advantage to utilize an interlacer of the self-stringing type. All embodiments shown have stringup slots. In the embodiments of FIGURES 1, 2 and 3, a stringup slot **22** extends the length of the interlacers 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 **22**. In addition, fluid entering the yarn passageway from slot **22** prevents the yarn filaments, during the interlacing process, from contacting the edges of stringup slot **22** and thus snagging the filaments.

DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention is an improvement in an interlacer of the type disclosed in Bunting et al. U.S. patent application Ser. No. 485,438 filed Sept. 7, 1965, now U.S. Patent No. 3,564,537.

The improvement resides in critical selection of yarn passageway cross section to achieve the unexpected results of greatly improved interlace uniformity and also increased fluid efficiency, i.e. lower fluid requirements at a given degree of interlacing.

Referring to FIGURES 2 and 3 which illustrate embodiments of this invention, the dimension H should be in the range of about 1.4 to about 1.75 times the diameter of the fluid passage F. The ratio of the width W to the height H of the yarn passageway should be between about 1.5 to 1 and 2.2 to 1. The length of the yarn passages may be widely varied, but should not be less than the width W. Preferably, the length of the yarn passageway will be about 2 to 10 times its width W and should normally be not more than 20 times its width. For cellulose acetate textile deniers, the length of the yarn passageway should preferably be from about 0.2 inch to 1.0 inch. The cross-sectional areas of the opposed fluid conduits should be 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 one of the fluid conduits should be betwen about 4 to 1 and 7 to 1.

It is to be understood that the yarn passage cross section of this invention may be of any shape approximating that of the shapes shown herein while conforming to the major dimensions specified. For example, the rounded ends defined herein by radius R may be approximated by polygons, or the entire cross section may be an ellipse or other non-round assemblage of smooth curves having no reversals of curvature.

The exact mechanism by which the improvement of this invention is obtained is not entirely clear. However, it is believed that the following explanation is correct though, of course, applicant does not intend to be bound by his theory. As explained in U.S. Patent No. 2,985,995, a yarn is efficiently interlaced with a fluid jet when the yarn is first randomly splayed open, forming opposite-hand 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 while the upstream interlace section moves through the jet before the process repeats itself. It is this periodic action which gives the characteristic short-length variation in yarn cohesiveness along the threadline. The yarn normally spends varying periods of time in the different zones of the yarn channel where fluid velocity and turbulence can be quite different. Therefore, interlace nodes are normally spaced at somewhat random intervals.

Yarn passage dimensions should be as small as practical to conserve interlacing fluid and to concentrate the zone and effect of the controlled fluid turbulence. On the other hand, too small a yarn channel can constrict the filament bundle, preventing the filaments from splaying apart sufficiently to become adequately intermingled. In the present invention, the fluid force is concentrated by reducing the dimension H from that of the prior art apparatus, yet an adequate cross-sectional area of the yarn passage is maintained or increased for escape of the fluid by increasing dimension W, thus maintaining high fluid velocity at the points where fluid impinges on the yarn. The increased width W provides additional space for the yarn filaments to become separated sufficiently so that more thorough intermingling is possible.

The use of fluid interlacers having yarn passages whose cross-sectional shape is intermediate between rectangular and round, is disclosed in U.S. Patent No. 2,985,995; however, if the shape of the passage approaches rectangular, yarn tends to escape from the zone of most intense turbulence and dwell in the corners for random lengths of time. This action produces substantial areas of low yarn cohesion which can cause undesirable problems in textile operations. It has been found that the uniform action of this invention can be found only within the narrow range of shapes between rectangular and round which is specified in this invention. The heart of the present invention is the particular combination of shapes and dimensions which produce improved turbulent fluid patterns in the yarn passage to open the bundle sufficiently for increased intermingling of filaments and yet prevent the yarn from dwelling in low turbulence areas for any substantial length of time.

The following examples illustrate the interlace uniformity of yarns produced with jets of the present invention compared to yarns interlaced with jets of the prior art.

Cellulose acetate yarn is used in the examples for illustration purposes though any continuous multifilament yarn is suitable. In addition, the interlacer is arranged in a conventional spinning process though it could be appropriately locate in other positions, such as, in a drawing process (see FIG. 4).

In these examples, the degree of interlace is measured by the testing device described in U.S. Patent 3,290,932. Large pin drop node intervals indicate low degree of interlace whereas small pin drop node intervals indicate a high degree of interlace. The measurement of variation, σ^2, defined as

$$(1)\qquad \frac{\sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{N}}{N-1}$$

Where:

N=the number of observations

x=individual observations (10 consecutive pin drop measurements) is calculated from the node interval values of each of the number of samples shown in the tables. Each sample value, in turn, is the average of 10 consecutive pin drop node measurements made on a single piece of yarn.

EXAMPLE I

	Jet Identification	
	102 (Prior Art)	116 (Improved, Fig. 2 Type)
Yarn Speed, yds./min	600	600.
Yarn Luster	Bright	Bright.
Denier of Yarn	150	150.
No. of Filaments	40	40.
Yarn Tension ahead of traverse roll, grams.	5.0±0.5	5.0±0.5.
Fluid Conduit diameter (F), inches	0.0380	0.0380.
Yarn hole height (H), inches	0.076	0.055.
Yarn hole width (W), inches	0.076	0.110.
Radius of curvature of yarn hole sides defining the width (W), in.	0.038	0.0275.
Ratio, H to F	2:1	1.45:1.
Ratio, W to H	1:1	2.0:1.
Fluid conduit cross section area, in.²	1.164×10⁻³	1.164×10⁻³.
Yarn hole cross section area, in.²	4.536×10⁻³	6.31×10⁻³.
Ratio yarn hole area to fluid conduit area	3.91	5.42.
Yarn hole shape	Round	Rectangular with semicircular ends (see Fig. 2).

INTERLACE DATA

JET TYPE 102 (PRIOR ART)

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
I-A	8.5	2.88	1.63	260

JET TYPE 116 (IMPROVED)

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
I-A1	6.0	2.75	0.50	48

From the above table it is seen that the prior art apparatus used 41% higher pressure than the jet of this invention to produce much less uniform interlace which is highly significant.

EXAMPLE II

This example compares yarn interlaced with jets of the prior art having a round yarn passageway and a jet of the present invention of the type shown in FIGURE 2.

The jets of this example have larger fluid conduits (about 46% larger cross section) than the jets of Example I.

	Jet Identification	
	103 (Prior Art)	125 (Improved, Fig. 2 Type)
Yarn Speed, yds./min	600	600.
Yarn Luster	Bright	Bright.
Denier of Yarn	150	150.
No. of Filaments	40	40.
Yarn Tension Ahead of Traverse Roll, grams	5.0±0.5	5.0±0.5.
Air hole diameter (F), inches	0.0465	0.0465.
Yarn hole height (H), inches	0.093	0.076.
Yarn hole width (W), inches	0.093	0.162.
Radius of curvature of sides of yarn hole defining the width (W), inches	0.0465	0.0380.
Ratio, H to F	2:1	1.63:1.
Ratio, W to H	1:1	2.13:1.
Fluid Conduit Cross Section Area, in.²	1.698×10⁻³	1.698×10⁻³.
Yarn Hole Cross Section Area, in.²	6.793×10⁻³	11.137×10⁻³.
Ratio of Yarn Hole Area to Fluid Conduit Area	4.0:1	6.56:1.
Yarn Hole Shape	Round	Rectangular with semicircular ends (see Fig. 2).

INTERLACE DATA

JET TYPE 103 (PRIOR ART)

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
II-B	6.5	2.76	0.6656	48
II-C	7.5	2.46	0.3269	48
II-D	10	1.84	0.4619	48
II-E	14	1.28	0.2000	48
II-F	18	1.06	0.1125	48
II-G	22	.97	0.0919	48

JET TYPE 125 (IMPROVED—FIG. 2 TYPE)

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
II-B1	6.5	2.63	0.2244	48
II-C1	7.5	2.30	0.2069	48
II-D1	10	1.63	0.1175	48
II-E1	14	1.50	0.1138	48
II-F1	18	1.13	0.0494	48
II-G1	22	0.98	0.0344	48

From the above data, it is readily apparent that the type 125 jet of the present invention is substantially better over a wide range of fluid pressures than the 103 jet of the prior art in that the uniformity is much better (lower σ^2 values) for yarn interlaced with the 125 jet at about the same degree of interlace (node intervals).

The 125 jet of this invention having fluid conduits of a 46% larger cross section than the 116 jet of Example I, also a jet of this invention, produces a yarn having interlace uniformity superior to yarn produced by the 116 jet of Example I.

EXAMPLE III

This example compares the performance of an interlacer of the prior art having a circular yarn hole with an interlacer of the present invention (similar to FIG. 2) having fluid conduit cross sections 25% smaller than the prior art jet.

	Jet Identification	
	110	124
Yarn Speed, yds./min	680	680.
Yarn Luster	Dull	Dull.
Denier of Yarn	450	450.
No. of Filaments	180	180.
Yarn Tension Ahead of Traverse Roll, grams.	32	32.
Fluid Conduit Diameter (F), inches	0.070	0.0625.
Yarn Hole Height (H), inches	0.110	0.100.
Yarn Hole Width (W), inches	0.110	0.162.
Radius of curvature of sides of yarn hole defining the width (W), inches.	0.055	0.050.
Ratio, H to F	1.57:1	1.60:1.
Ratio, W to H	1:1	1.62:1.
Fluid conduit cross section area, in.²	3.848×10⁻³	3.067×10⁻³.
Yarn hole cross section area, in.²	9.5×10⁻³	14.05×10⁻³.
Ratio of yarn hole area to Fluid conduit area.	2.47:1	4.58:1.
Yarn hole shape	Round	Fig. 2.

INTERLACE DATA

JET TYPE 110 (PRIOR ART)

Run	Pressure, p.s.i.g.	Node Interval Avg. (in.)	Node Interval σ^2	N
III-A	25	0.63	0.00690	24

JET TYPE 124 (IMPROVED)

Run	Pressure, p.s.i.g.	Node Interval Avg. (in.)	Node Interval σ^2	N
III-A1	18	0.74	0.00612	48

The improved jet having smaller fluid conduits uses considerably less air than the prior art jet to give equivalent average interlace.

EXAMPLE IV

In this example the effect on yarn interlace of increasing the ratio of yarn hole width W to height H to a level outside the critical limits of the invention is demonstrated.

	Jet Identification	
	130	124 (Improved)
Yarn speed, yds./min	680	680.
Yarn Luster	Dull	Dull.
Denier of Yarn	450	450.
No. of Filaments	120	120.
Yarn Tension Ahead of Traverse Roll, grams.	28±24	28±24.
Fluid Conduit Diameter (F), inches	0.0625	0.0625.
Yarn Hole Height (H), inches	0.087	0.100.
Yarn Hole Width (W), inches	0.210	0.162.
Radius of curvature of sides of yarn hole defining the (W) width, inches.	0.435	0.050.
Ratio H to F	1.39:1	1.60:1.
Ratio W to H	2.41:1	1.62:1.
Fluid Conduit Cross Section Area, in.²	3.067×10⁻³	3.067×10⁻³.
Yarn Hole Cross Section Area, in.²	16.64×10⁻³	14.05×10⁻³.
Ratio Yarn Hole Area to Fluid Conduit Area.	5.42:1	4.58:1.
Yarn Hole Shape	Fig. 2	Fig. 2.

INTERLACE DATA

JET TYPE 130

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
IV-A	17	.976	.02948	24
JET TYPE 124				
IV-A1	17	.790	.01167	20

It is readily apparent that the Type 130 jet having the W to H ratio of 2.41 to 1 produced yarn of much less uniformity and of a lower degree of interlace than the preferred type 124 jet having the W to H ratio of 1.62 to 1, notwithstanding that both jets had yarn passageways similar to the general shape illustrated in FIGURE 2.

EXAMPLE V

In this example the performance of an interlacer having an elliptical yarn passageway similar to FIGURE 3 is compared to the performance of a prior art jet having a round yarn hole.

	Jet Identification	
	126 (Improved)	103 (Prior Art)
Yarn speed, yds./min	680	680.
Yarn Luster	Dull	Dull.
Denier of yarn	150	150.
No. of filaments	40	40.
Yarn tension ahead of traverse roll, grams.	7±1	7±1.
Fluid conduit diameter (F), in	0.0465	0.0465.
Yarn Hole Height (H), in	0.076	0.093.
Yarn Hole Width (W), in	0.120	0.093.
Radius of curvature of sides of yarn hole defining the width (W), in.	0.030	0.0465.
Radius of curvature defining portion of yarn hole adjacent fluid conduits, in.	0.090	0.0465.
Ratio H to F	1.634:1	2:1.
Ratio W to H	1.579:1	1:1.
Fluid Conduit Cross Section Area, in.²	1.698×10⁻³	1.698×10⁻³.
Yarn Hole Cross Section Area, in.²	7.16×10⁻³	6.793×10⁻³.
Ratio Yarn Hole Area to Fluid Conduit Area.	4.22:1	4.0:1.
Yarn hole shape	Approx. ellipse, Fig. 3.	Round.

INTERLACE DATA

JET TYPE 126

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
V-A	18	0.67	0.0166	40
V-B	10	1.08	0.0321	40
JET TYPE 103				
V-A1	20	1.06	0.0779	24

From the above data it is evident that the elliptical yarn hole jet exhibits outstanding performance as compared to the prior art jet. Yarn from the elliptical hole jet (Run V-A) is 78.7% more uniform than yarn from the prior art jet (Run V-A1) and has 33% more interlace in spite of the fluid pressure being 70% lower.

The elliptical hole jet (Run V-B) uses about 50% as much air as the prior art jet (Run V-A1) to make a 40% more uniform yarn having about the same degree of interlace.

EXAMPLE VI

This example shows the effect of increasing the ratio of yarn hole width W to height H to a level outside of the critical limits of this invention.

	Jet Identification	
	128	114
Yarn speed, yds./min	680	680.
Yarn Luster	Dull	Dull.
Denier of Yarn	150	150.
No. of Filaments	40	40.
Yarn Tension Ahead of Traverse Roll, grams	7±1	7±1.
Fluid Conduit Diameter (F), in	0.0465	0.0465.
Yarn Hole Height (H), inches	0.076	0.076.
Yarn Hole Width (W), inches	0.210	0.120.
Radius of curvature of sides of yarn hole defining the width (W), in.	0.038	0.038.
Ratio H to F	1.63:1	1.63:1.
Ratio W to H	2.89:1	1.574:1.
Fluid Conduit Cross Section Area, in.²	1.698×10⁻³	1.698×10⁻³.
Yarn Hole Cross Section Area, in.²	15.48×10⁻³	7.88×10⁻³.
Ratio Yarn Hole Area to Fluid Conduit Area.	9.12:1	4.65:1.
Yarn Hole Shape	Fig. 2	Fig. 2.

INTERLACE DATA

JET TYPE 128

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
VI-A	14	2.78	12.66	48
VI-B	22	1.18	0.1044	48
JET TYPE 114				
VI-A1	5.5	1.45	0.1256	48
VI-B1	6.5	1.22	0.1019	48
VI-C1	14	0.94	0.01968	48

The Type 114 jet is far superior to the Type 128 jet having an excessive W to H ratio in both efficiency and uniformity of interlace. The theory seems to be, though applicant does not intend to be bound by any theory, that the large W to H ratio of the Type 128 jet affords too large a probability for the yarn to move in and out of areas of low turbulence at the sides of the yarn hole, or stay there, to be efficiently and uniformly interlaced.

Yarn interlaced with jet 128 (having an excessive W/H) is shown in FIGURES 7 and 8, corresponding to Runs VI-A and VI-B, whereas yarn from the Type 114 jet (interlaced at 18 p.s.i.g.) is shown in FIGURE 5. For comparison, yarn interlaced with a round yarn hole jet (Type 103 jet of Examples II, IV, and V) is shown in FIGURE 6. Both the more uniform spacing of the tightest sections of entanglement and less variation of filament entanglement intensity between points of maximum entanglement is evident from yarn interlaced with an oval hole jet of this invention (FIG. 5).

EXAMPLE VII

	Jet Identification	
	127 (Rectangular Hole)	114 (Oval Hole, Fig. 2)
Yarn speed, yds./min	680	680.
Yarn Luster	Dull	Dull.
Denier of Yarn	150	150.
No. of Filaments	40	40.
Yarn Tension Ahead of Traverse Roll, grams.	7±1	7±1.
Fluid Conduit Diameter (F), in	0.0465	0.046.
Yarn Hole Height (H), in	0.076	0.076.
Yarn Hole Width (W), in	0.120	0.120.
Radius at corners, Yarn Hole, in	0.001±.001	0.038 radius of sides forming width (W).

TABLE—Continued

	Jet Identification	
	127 (Rectangular Hole)	114 (Oval Hole, Fig. 2)
Ratio, H to F	1.634:1	1.634:1.
Ratio, W to H	1.579:1	1.574:1.
Fluid Conduit Cross Section Area, in.^{2}.	1.698×10^{-3}	1.698×10^{-3}.
Yarn Hole Cross Section Area, in.^{2}	9.12×10^{-3}	7.88×10^{-3}.
Ratio Yarn Hole Area to Fluid Conduit Area.	5.37:1	4.65:1.
Yarn Hole Shape	Rectangular	Fig. 2.

INTERLACE DATA

JET TYPE 127

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
VII-1	14	1.03	0.06181	48

JET TYPE 114

Run	Air Pressure (p.s.i.g.)	Node Interval Avg. (in.)	Node Interval σ^2	Number of Samples
VII-2	14	0.94	0.01968	48

The Type 114 oval-hole jet of this invention produces much more uniform interlace and a higher degree of interlace at equivalent conditions than does the rectangular hole jet.

TABLE I.—CRITICAL DIMENSIONS OF JETS OF THIS INVENTION REFERRED TO IN THE EXAMPLES

-- Design/Ex.	Yarn Hole Shape	Radius of End (R), in.	Yarn Hole Width (W), in.	Yarn Hole Height (H), in.	W/H	Ratio Area Yarn Hole to Area Fluid Conduit
114/VI, VII	Fig. 2	0.038	0.120	0.076	1.57	4.65
116/I	Fig. 2	0.0275	0.110	0.055	2.0	5.42
124/III, IV	Fig. 2	0.050	0.162	0.100	1.62	4.58
125/II	Fig. 2	0.0380	0.162	0.076	2.13	6.56
126/V	Fig. 3 approx. ellipse, top and bottom arcs radius of 0.09 in.	0.030	0.120	0.076	1.58	4.22

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 claims.

What I claim is:

1. The improvement in yarn-interlacing apparatus of the type 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; wherein the improvement is a yarn passageway having an elliptic cross-section which is further characterized as having a width to height ratio within the range from about 1.5:1 to about 2.2:1 and sides, defining the width of said yarn passageway, which are the arc of a circle, said height of the yarn passageway being measured along the axis of the fluid conduits and said width being measured perpendicularly to the axis of the conduits and the axis of the yarn passageway at the intersection of the two axes.

2. Apparatus as defined in claim **1** wherein the yarn passageway cross section at interception with the fluid conduits is a rectangle having semicircular ends.

3. Apparatus as defined in claim **1** wherein the yarn passageway cross section at interception with the fluid conduits is an ellipse.

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 4:1 to about 7:1.

5. 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 are circular, the ratio of the height of the yarn passageway to the diameter of a fluid conduit is from about 1.4:1 to about 1.75:1.

References Cited

UNITED STATES PATENTS

3,364,537 1/1968 Bunting et al.

MERVIN STEIN, *Primary Examiner.*

IRA C. WADDEY, Jr., *Assistant Examiner.*