March 24, 1970 F. B. SATTERWHITE 3,501,819

YARN PROCESSING METHOD AND APPARATUS

Filed Oct. 13, 1966 2 Sheets-Sheet 1

Fig. 1.

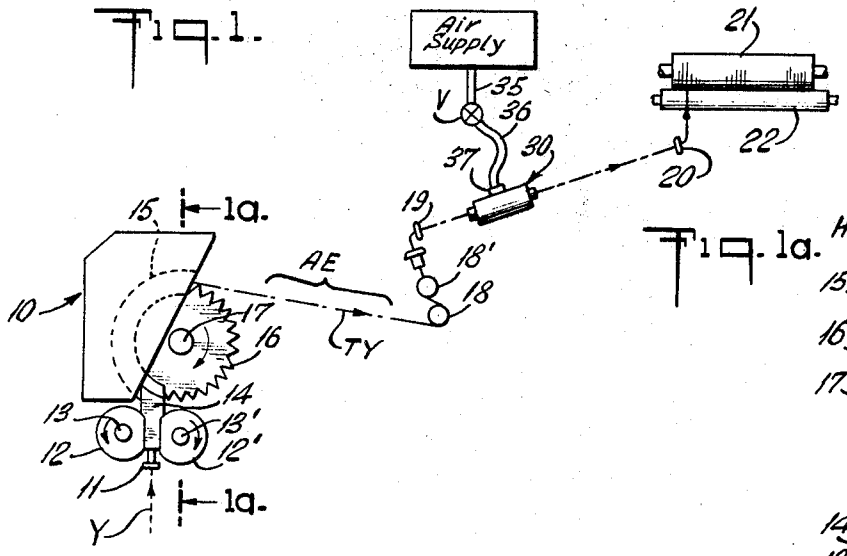


Fig. 1a.

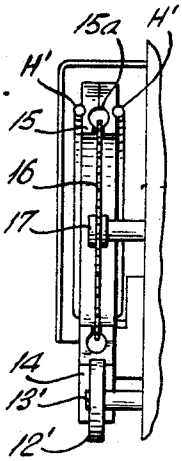


Fig. 2.

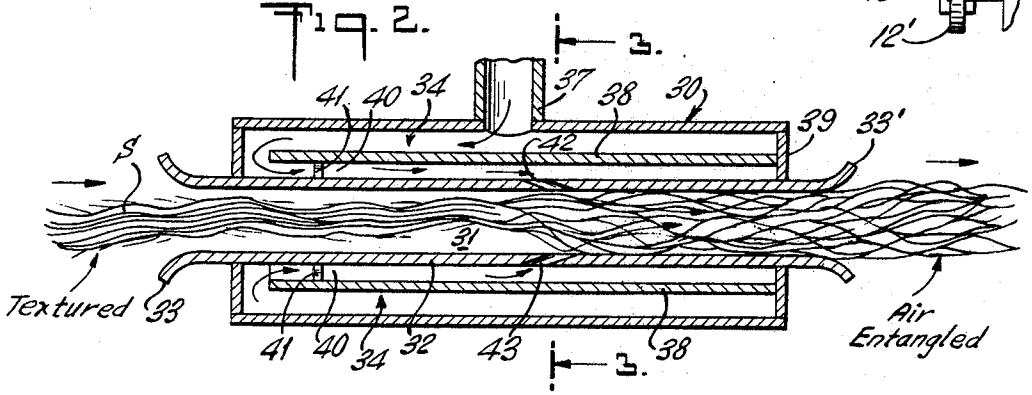
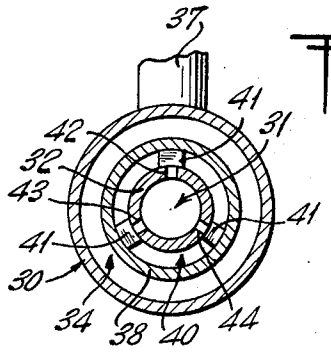


Fig. 3.



INVENTOR
Fred B. Satterwhite

BY Nolte & Nolte
ATTORNEYS

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Fig. 4.

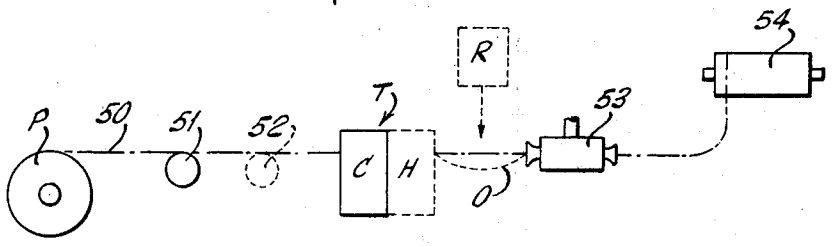


Fig. 5.

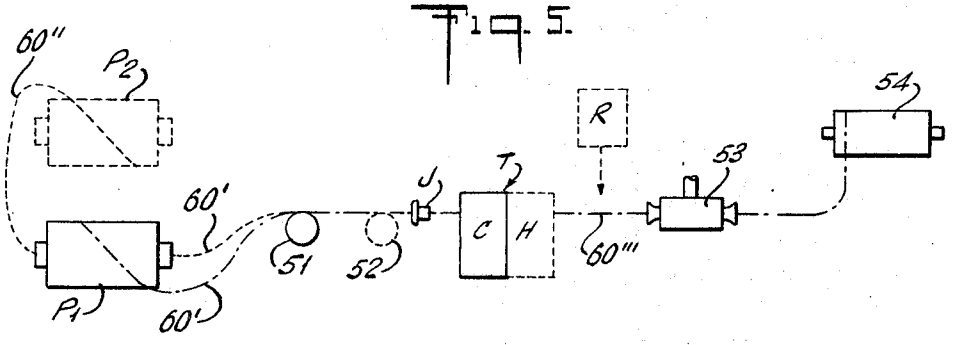
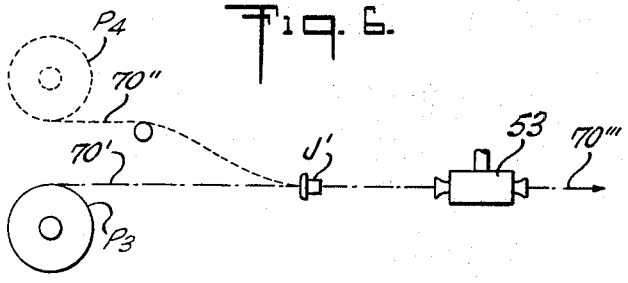


Fig. 6.



INVENTOR
Fred B. Satterwhite
BY
Nolte & Nolte
ATTORNEYS

United States Patent Office 3,501,819
Patented Mar. 24, 1970

3,501,819

YARN PROCESSING METHOD AND APPARATUS

Fred B. Satterwhite, Williamsburg, Va., assignor, by mesne assignments, to The Klinger Manufacturing Company Limited, London, England, a corporation of Great Britain

Filed Oct. 13, 1966, Ser. No. 586,491
Int. Cl. B02g 1/16, 1/18
U.S. Cl. 28—1.3 18 Claims

ABSTRACT OF THE DISCLOSURE

Filaments of multi-filament yarn are entangled, preferably by directing streams of fluid under pressure on to the yarn, either before or after texturizing the yarn. A continuous yarn treating process includes drawing and texturizing the yarn by longitudinally compressing the yarn while hot, setting the yarn in the texturized condition and entangling the filaments of the yarn by air streams while the yarn is under little or no tension. Two or more ends of multi-filament yarn may be processed to form a single end of texturized yarn the filaments of which are entangled internally of the yarn by combining the two ends to form a single end texturizing the single end and entangling the filaments of the single end before or after texturizing.

This invention relates to processing multi-filament yarn and has particular application to texturized yarn and the treating of the same to produce a yarn having suitable characteristics for subsequent processing such as weaving, knitting, and tufting. Even more particularly, the invention relates to treating texturized multi-filament yarn having little or no twist to entangle the filaments thereof to render the yarn more suitable for subsequent processing.

It is an object of the invention to provide a method of producing a texturized yarn including the step of interentangling the filaments thereof to thereby render the total bundle of filaments more compact. The invention contemplates the entangling of the yarn filaments by subjecting the yarn to fluid, such as air, under pressure.

Another object of the invention is to entangle the filaments of yarn having little or no twist to render the yarn more suitable for subsequent processing.

The invention also contemplates a continuous process for yarns having a thermoplastic component and includes the steps of orienting yarn having little or no twist by drawing, and which step may include heating the yarn, then texturizing the yarn after or during which heat may be applied to the texturized yarn to assist in setting it, and then entangling the filaments of the drawn and texturized yarn.

Still another object of the invention is to entangle the filaments of a single end of yarn composed of two or more ends of multi-filament yarn which have been combined and for all intents and purposes have lost their individual identity, and in this respect the invention also contemplates the production of the single end of texturized yarn suitable for subsequent processing where the filaments of the individual ends may have different crimp parameters (amplitude, frequency, etc.) but are so blended that the crimp differential does not adversely affect the subsequent processing steps.

A further object of the invention is to air entangle the filaments of yarn while the yarn is under minimum or no tension so that entanglement is enhanced.

Also contemplated by the invention is the use of air entanglement of texturized yarn filaments to render the yarn more amenable to subsequent processing while at the same time assisting in cooling the yarn which has been heated in the texturizing process to thereby preserve the bulk properties which have been developed in the texturizing step.

It is also an object of the invention to provide apparatus for the continuous processing of yarn on the run, including thermoplastic yarn or yarn having a thermoplastic component, said apparatus including a device for entangling the filaments of texturized yarn. In keeping with this aspect of the invention it is contemplated to provide such a filament entanglement device for the purposes set forth.

The invention is applicable to processing many types of yarn including those of the continuous multi-filament type as well as those which have been fibrillated from film.

In processing yarn, for instance for eventual tufting operations in the manufacture of carpets, it has been found desirable to devise continuous processes for the treating of yarn having a thermoplastic component, on the run, in certain circumstances from the "raw" undrawn state to the final texturized form of the yarn. In certain other circumstances the processing of such yarn may commence with yarn which has been drawn and wound but not twisted or from drawn yarn which has had only a slight twist imparted to it, such as up to about one turn per inch. Under such conditions, when the yarn is texturized by stuffer box crimping, for instance, the texturized yarn will also have little or no twist in it. As a result, the bundle of filaments in the textured yarn may be loose, and this may cause difficulty in the tufting of the yarn and may also result in poor yarn coverage.

This condition may be aggravated by the combining of two or more ends of yarn in the texturizing process, particularly if the conditions in the processing of the ends results in a differential of crimp development in the initially separate yarn ends.

This same problem arises when it is desired to combine two or more ends of already texturized yarn having little or no twist, to form a single end of texturized yarn in which the individual combined yarns lose their separate identity.

In accordance with some aspects of the invention, one or more ends of untwisted or relatively untwisted, oriented yarn are, or may have been, texturized and in the case of more than one end, texturing may take place either before or after combining the separate ends, for instance, by joining the ends on the run with little or no twist imparted to them. The filaments of the resulting single end of untwisted or relatively untwisted, texturized yarn are then entangled, and this may be accomplished by subjecting the yarn while still on the run to a continuous stream or streams of air under sufficient pressure to internally entangle the yarn without affecting the texture of the yarn. The stream or streams of air under pressure may be made to surround the yarn and to impinge upon it at an angle to the yarn axis and toward the direction of yarn travel.

While not essential to the invention, it has been found that the entanglement process is enhanced when the air pressure is applied to the yarn when under slight or no tension and this would be most advantageous if the yarn filaments being treated have not as yet been texturized.

It has also been found advantageous, though not essential to the invention, to deliver yarn on the run from the texturizing step under slight or no tension particularly where the yarn is still relatively hot from the texturizing process, and to air entangle the filaments of the heated yarn at this point so that the air under pressure acts to cool the yarn and thus assist in preserving the bulk properties developed in the yarn during texturizing.

While the invention is most applicable to texturized yarn having little or no twist, it can be envisioned that processing relatively twisted texturized yarn according

to the invention can have advantageous effects in rendering such yarn more compact and in eliminating or reducing the number of "stray" filaments.

The invention will best be understood by reference to the following description of specific embodiments thereof taken in conjunction with the drawing of which:

FIG. 1 is a diagrammatic elevational view of apparatus utilized in carrying out the method of the invention;

FIG. 1*a* is an end view, partly broken away, taken along the line 1*a*—1*a* of FIG. 1;

FIG. 2 is a sectional view through the longitudinal center line of an air entanglement device in use;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is a diagrammatic elevational view of apparatus utilized in carrying out the method of the invention from the step of orienting undrawn yarn and also indicating a modification of the method of the invention;

FIG. 5 is a diagrammatic elevational view of apparatus similar to FIG. 4 and showing the invention as applied to two ends of undrawn yarn; and

FIG. 6 is a diagrammatic elevational view of apparatus used in practicing the invention as it may apply to one or two ends of already texturized yarn.

In FIG. 1 a single end of previously oriented, multifilament yarn Y of the type having a thermoplastic component, such as polypropylene, polyester or nylon, for example, and which has been heated by means, not shown, is being fed into texturizing apparatus **10** the operative details of which are disclosed in U.S. Patent No. 3,212,157, and which is shown here as providing a yarn guide **11** guiding the yarn into the nip of a pair of rollers **12, 12'** which are driven via shafts **13, 13'** and which feed the yarn into a chamber **14** where the yarn is subjected to linear compression to thereby form a plug of crimped yarn.

The crimping chamber **14** communicates, at its upper end at **14***a* with an arcuate passage **15***a*, within an arcuate member **15**, shown in FIG. 1 is housed within cover C.

The plug of crimped yarn is engaged by the peripheral, tooth-like projections of wheel **16** which is driven via shaft **17**, and transported, with substantially no slippage or change in the crimp characteristics imparted to the yarn in chamber **14**, through the confinement of passage **15***a* of arcuate member **15**, where advantageously, the yarn may again be subjected to further heat via heating elements H (FIG. 1*a*), so that the heat level in the plug of crimped yarn is retained and crimp in the yarn is permitted to set. The heat level in arcuate chamber may, of course, be varied in accordance with the particular yarn being treated and/or with the heat level imparted to the yarn prior to its entry into chamber **14**.

As the plug of yarn nears the exit end of arcuate passage **15***a* the yarn is drawn off the plug, around guides **18, 18'** which, conveniently may comprise tensioning means, thence, between guides **19** and **20** which define the ends of the filament entangling zone, from whence the processed yarn is wound upon take-up package **21** which may be driven, for example, by drive roller **22**. The yarn may be laid back and forth upon package **21** by any convenient traversing mechanism, such as yarn guide paths, not shown, within the drive roller **22**.

As the now texturized yarn TY runs through the filament entanglement zone, it passes through the longitudinal axis of air nozzle **30** (FIGS 1 and 3) comprising yarn passage **31** defined, in this instance by a cylindrical wall **32** having outwardly flared ends **33, 33'** providing smooth entry and exit surfaces for the yarn.

The wall **32** is surrounded by a chamber **34** into which air under pressure from an appropriate supply (FIG. 1) is provided via supply lines **35** and **36** through a control valve V, line **36** communicating with chamber **34** through port **37**. Air distributor **38** surrounds yarn passage **31** and closes off the forward end of chamber **34** where it is secured to end piece **39** of air nozzle **30**, and directs the air under pressure around the yarn passage wall **32** via port **40** situated toward the entry end of the nozzle. Appropriate spacers **41** retain the port end of distributor **38** in spaced relation from yarn passage wall **32**.

The air under pressure within distributor **38** communicates with circumferentially spaced discharge ports **42, 43** and **44** which are set at oblique angles toward the exit end of the yarn passage **31**. As will be appreciated, the forward angular setting of ports **42, 43** and **44** is preferred as against a setting of 90° to the axis of the nozzle, for instance, to insure a transverse and longitudinal impingement of air upon the yarn for more effective filament entanglement without affecting the crimp characteristics of the textured yarn.

As seen in FIG. 2, the textured yarn enters the nozzle at **33** where stray filaments S, and the generally separated paths of the filaments (exaggerated for clarity) define the condition of the yarn, which in the illustration, is shown in elevation as also being substantially flat.

Upon the filaments being entangled via the air under pressure acting somewhat in the manner indicated by the air-flow arrows, the yarn becomes less flat and more compact in that the filament paths are now intertwined.

As previously indicated, the filament entanglement zone may be variously placed after the texturizing step, for instance closer to the exit end of arcuate chamber **15***a*, as indicated by the bracketed area AE in FIG. 1 and in such a case the air under pressure would assist in cooling the yarn which has, as noted, been heated in the texturizing processes. The yarn would ordinarily be caused to travel through the zone under no tension or perhaps under slight tension to assure even take-off from the plug.

Such a procedure, having a cooling effect, would help maintain the bulk imparted to the yarn in the texturizing step prior to its being drawn under tension or greater tension onto the take-up package which tension could adversely affect the crimp development in the yarn if the yarn is still too warm.

In the same instance, as the texturized yarn is under little or no tension, the entanglement of the filaments would tend to be enhanced and this would result whether the entanglement zone were situated to accept warm or cool yarn.

Referring now to various applications of the invention, in FIG. 4 a supply package P of untexturized yarn **50** having little or no twist and having a thermoplastic component is delivered to a heated driven roller or godet **51** around which it may be wound several turns and thereby heated and from whence it is fed into the crimping zone C of stuffer box texturizing apparatus T. If the yarn **50** from package P is "raw," that is unoriented, then the yarn may be oriented by drawing between godet **51** and driven godet **52** (shown, as are other components in FIGS. 4, 5 and 6, in dash lines to indicate the alternate case) the yarn being wound around godet **52**, which is rotated at a faster speed than godet **51** and which may also be heated and from whence the yarn is fed into the crimping zone C.

Upon leaving zone C, the yarn may then be heat set in which event heat setting zone H is provided. In any event, the yarn leaves the texturizing apparatus T and is brought through the filament entanglement device **53** from whence it is taken up on take-up package **54**.

It may be desirable, for instance when texturizing polypropylene yarn to provide a relaxing zone after texturizing, particularly where the yarn has been heat set, to assure sufficient residence time in plug form and to assure cooling before taking up the yarn. In such a case the yarn in plug form may be transported from the texturizing apparatus T to a relaxing zone R which may provide, for instance a "J-box" to receive the plug and from which the yarn is drawn from the plug through the filament entanglement device **53**.

In any case, the yarn may be relaxed, i.e., fed under

little or no tension (as indicated in dash lines at O) through the filament entangling device **53**.

FIG. 5 shows the same apparatus operating in the same way as described in FIG. 4 with the godet **51**, texturizing apparatus T, filament entanglement device **53** and take-up package **54** and with alternative provision for a second godet **52**, a heat setting zone H and a relaxing zone R. However, supply package P_1, is disposed in such a manner that the yarn **60'**, as it is taken off end-wise of the package, has imparted to it a slight twist, possibly around one turn per inch, i.e., below the twist found in yarn having been previously processed on draw twisting apparatus; i.e., around three turns per inch.

FIG. 5 is also illustrative of the application of the invention to processing at least two ends of yarn **60'**, **60''** from a pair of supply packages P_1 and P_2 where the ends are wound upon godet **51** as desired, combined by joining on the run through guide J, and crimped together in the texturizing apparatus where they lose their individual identity, and emerge as a single end of yarn **60'''** which is then run through the filament entanglement device **53** to the take-up package **54**.

Similarly, FIG. 6 shows alternative applications of the invention wherein supply package P_3 supplies already texturized yarn **70'** having little or no twist, to the filament entanglement device **53** from whence it is taken up upon a take-up package, not shown. Again, the invention is illustrated as applying to the filament entanglement of at least two ends of yarn **70'**, **70''** delivered from supply packages P_3 and P_4, combined by joining on the run through guide J' and then entangling the filaments of the joined ends in device **53** resulting in a single end of finally processed yarn **70'''** which may be taken up in the usual manner.

As will be understood by those versed in the art to which the invention pertains, various conditions must be considerd when practicing the invention. Illustrative only of some of the ranges within which the invention may be practiced, yarn, between around 500 and 2000 denier running at between approximately 400 and 500 meters per minute through the various processes discussed supra, have been successfully treated in the filament entanglement zone by passing the yarn through a nozzle, substantially as shown in FIGS. 2 and 3, wherein air under pressure at 15 pounds per square inch is caused to impinge upon the yarn.

In apparatus of the type discussed with reference to FIGS. 4 and 5 processing similar yarn deniers at similar speeds, the godet **51** may be heated to around between 85° C. and 185° C., and so may godet **52**, while the heat level in the heat setting zone may range in the 200° C. area more or less considering the amount of heat which may have been imparted to the yarn while traveling upon the godets.

As will be appreciated, various motor drive means, not shown, operatively connect the shafts **13**, **13'**, **17**, the drive roller **22** and the godets **51**, **52** and which means are synchronized and varied for particular applications.

Again, as will be appreciated by those skilled in the art, the invention is not limited to continuous multi-filament yarn having a thermo-plastic component but is certainly applicable to such yarn where orienting "raw" yarn which has little or no twist imparted to it is one of the initial steps in processing the yarn. The invention is also clearly applicable to any multi-filament yarn, including yarn which has been fibrillated from film and where the multi-filament yarn has been texturized. The invention clearly contemplates the initial step of texturizing and then entangling the filaments of the multi-filament yarn and also has application to entangling filaments of untexturized yarn which is to be subsequently texturized. To this end, the air nozzle may be disposed before the guide **11** (in FIG. 1) where, however, there may be made provision for a relaxation zone and/or for sufficient air pressure to effect the entanglement of the yarn filaments which are running in more or less parallel paths in this area as opposed to yarn filaments which have been texturized and extend through crimped paths, making entanglement more facile.

As can be further appreciated, the invention is most effective in the production of a single end of yarn composed of two or more ends which have been combined. The process of the invention assures cohesiveness and compactness of the resulting end, as is also true of single end processing according to the invention, by virtue of the action of the fluid under pressure in passing through and around the yarn in transverse and longitudinal paths in the yarn passage **31** and at the exit end thereof, where the air is suddenly released at pressures and velocities consonant with filament entanglement.

In any event, the invention is not to be considered limited by the specific embodiments just discussed.

What I claim is:

1. A method of producing a single texturized multi-filament yarn from at least two multi-filament yarn ends, comprising individually texturizing each of said ends, feeding said texturized ends each from a discrete source spaced from the sources of the other of said ends to yarn guide means, bringing said ends together at said guide means while said ends are on the run and while the ends are still on the run subjecting said ends to a stream of fluid under pressure, thereby to entangle together the filaments of the ends and form a single texturized yarn in which the formerly individual ends have lost their individual identities.

2. Apparatus for producing a single texturized multi-filament yarn from at least two multi-filament yarn ends, comprising means for individually texturizing each of said ends, means for feeding said texturized ends each from a discrete source spaced from the source of the other of said ends, yarn guide means positioned to receive said ends as said ends are fed from said sources and thereby to bring said ends together and means for subjecting the ends which have been brought together to a stream of fluid under pressure thereby to entangle together the filaments of the ends and form a single texturized yarn in which the formerly individual ends have lost their individual identities.

3. A method of producing a single texturized multi-filament yarn from at least two multi-filament yarn ends, comprising feeding said ends each from a discrete source spaced from the sources of the other ends to yarn guide means, bringing said ends together at said guide means while said ends are on the run and while said ends are still on the run subjecting said ends to a stream of fluid under pressure thereby to entangle together the filaments of the ends and then texturizing the resultant combined entangled ends, thereby to form a single texturized yarn in which the formerly individual ends have lost their individual identities.

4. A method according to claim **3**, in which said texturizing comprises longitudinally compressing and setting the filaments of said combined ends into crimped configurations.

5. A method of producing a single texturized multi-filament yarn from at least two multi-filament ends, comprising feeding said ends each from a discrete source spaced from the sources of the other of said ends to yarn guide means, bringing said ends together at said yarn guide means while said ends are on the run and while said ends, now together, are still on the run texturizing said ends and then subjecting said ends to a stream of fluid under pressure thereby to entangle together the filaments of the ends and form a single texturized multi-filament yarn in which the filaments are interentangled.

6. The method of claim **5**, in which the yarn is texturized by longitudinal compression, while hot, in a stuffer box.

7. The method of claim **5**, in which the stream of fluid under pressure is directed to impinge upon the combined

ends at an angle to the longitudinal axis thereof and toward the direction of travel thereof.

8. A method according to claim 5, in which the texturizing of the ends is by longitudinal compression of the ends.

9. Apparatus for producing a single texturizing multi-filament yarn from at least two multi-filament yarn ends, comprising means for feeding said ends each from a discrete source spaced from the sources of the other of said ends, yarn guide means positioned to receive said ends as said ends are fed from said sources and thereby to bring said ends together, means for texturizing the ends which have been brought together and means for thereafter subjecting the ends, while still together, to a stream of fluid under pressure thereby to entangle together the filaments of the ends and form a yarn in which the filaments are interentangled.

10. Apparatus according to claim 9 wherein said entangling means defines a passageway for the yarn and further includes means for directing fluid into said passageway at an angle to the longitudinal axis of the combined ends and towards the direction of travel thereof.

11. Apparatus according to claim 9, in which said texturizing means comprises means for longitudinally compressing the ends.

12. Apparatus according to claim 11, in which said longitudinal compression means comprises a stuffer box.

13. A method of producing a single, texturized multi-filament yarn from at least two ends of multifilament yarn, comprising feeding said ends each from a discrete source spaced from the sources of the others of said ends to yarn guide means, bringing said ends together at said yarn guide means while said ends are on the run and while said ends, now together, are still on the run entangling together the filaments of said ends and thereby combining the ends to form a single end of yarn and then texturizing the resultant single end of yarn.

14. A method according to claim 13, in which said entangling together comprises subjecting the ends to a stream of fluid under pressure.

15. A method according to claim 13, in which said

texturizing comprises longitudinally compressing and setting the filaments of said yarn into crimped configurations.

16. Apparatus for producing a single, texturized multi-filament yarn from at least two ends of multi-filament yarn, comprising means for feeding said ends each from a discrete source spaced from the sources of the others of said ends, yarn guide means for receiving said ends from said feeding means and bringing said ends together, entangling means for receiving the ends from the yarn guide means and entangling together the filaments of said ends and thereby combining the ends to form a single end of yarn and texturizing means for receiving the resultant single end of yarn from the entangling means and texturizing said single end.

17. Apparatus according to claim 16, in which said entangling means comprises means for subjecting the ends to a stream of fluid under pressure.

18. Apparatus according to claim 16, in which said texturizing means comprises means for longitudinally compressing and setting the filaments of the yarn into crimped configurations.

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LOUIS K. RIMRODT, Primary Examiner

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28—72.11; 57—140, 157