United States Patent

Farrar et al.

[15] **3,650,103**

[45] **Mar. 21, 1972**

[54] PROCESS AND APPARATUS FOR TEXTURIZING YARN

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[73] Assignee: **Uniroyal Inc.**, New York, N.Y.

[22] Filed: **Nov. 10, 1969**

[21] Appl. No.: **875,069**

[52] **U.S. Cl.** ....**57/34 HS,** 28/62, 57/77.3, 57/157 TS, 57/157 MS, 242/147 R, 57/106 T

[51] **Int. Cl.** **D02j 13/00,** D01h 13/28, D02g 1/02

[58] **Field of Search**........................57/34, 36, 51, 51.2, 55.5, 57/34 HS, 77.3, 77.45, 106, 140, 156, 157; 28/62, 71.3, 72; 242/18 A, 46.2, 46.6, 154, 147

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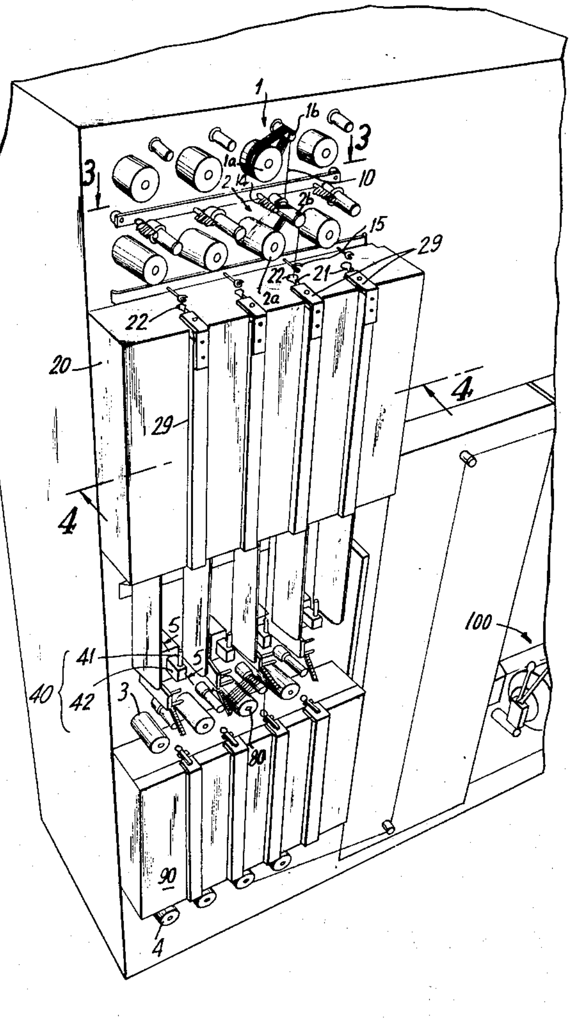
[57] **ABSTRACT**

A process and apparatus for texturizing yarn by false twisting. Means supply yarn to a first novel oven at controlled tension and speed. The yarn is then applied to an air jet twisting assembly having two separate upper and lower bodies with a disc insert with slots to direct and provide a whirling air stream within the twister assembly, thereby providing a false twist to the yarn. An air diffuser is placed between the twisting assembly and the first oven and a second oven is provided after the twisting assembly to heat-relax and remove some of the twist. The tension of the yarn is continuously controlled throughout. Novel means are provided for winding and doffing the texturized yarns as well as for controlling the speed and tension of the yarn throughout.

50 Claims, 27 Drawing Figures



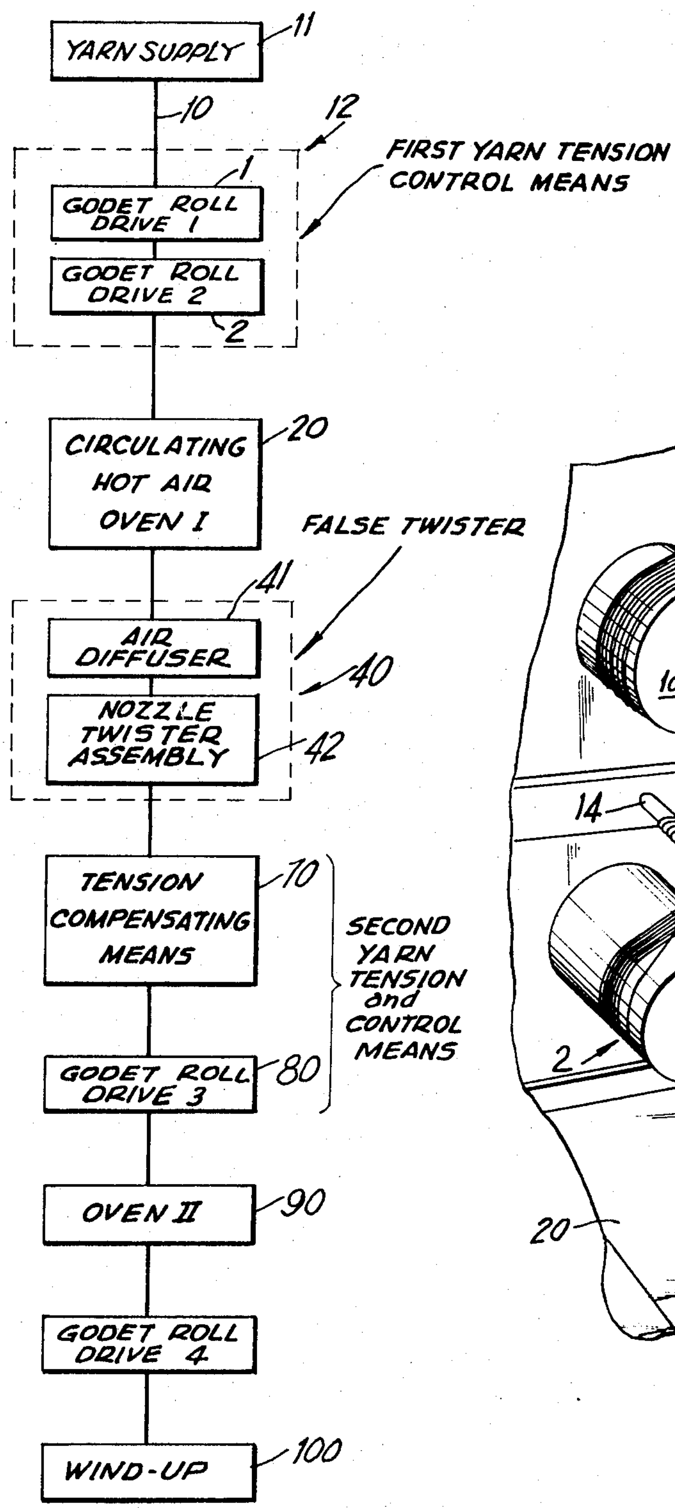


FIG.1

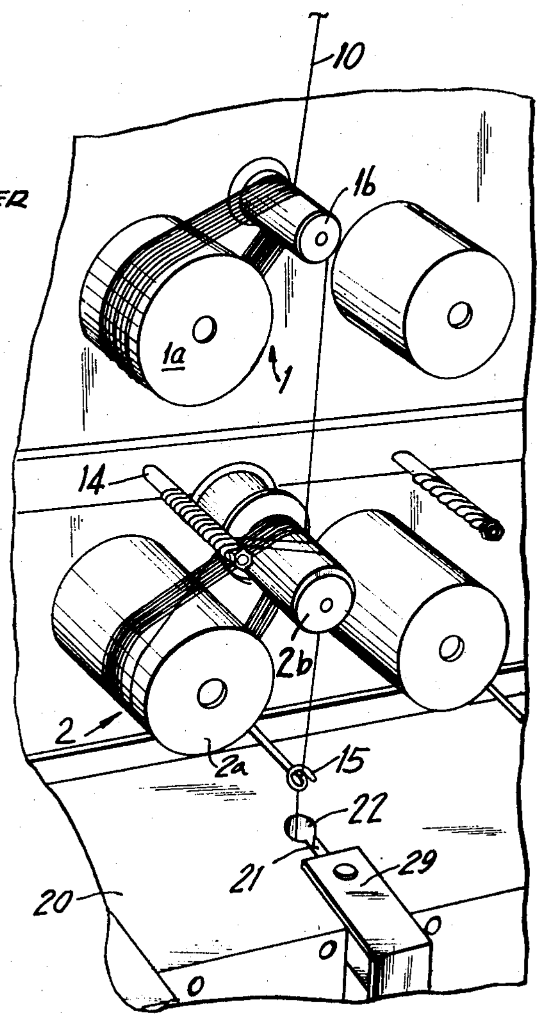


FIG.3a

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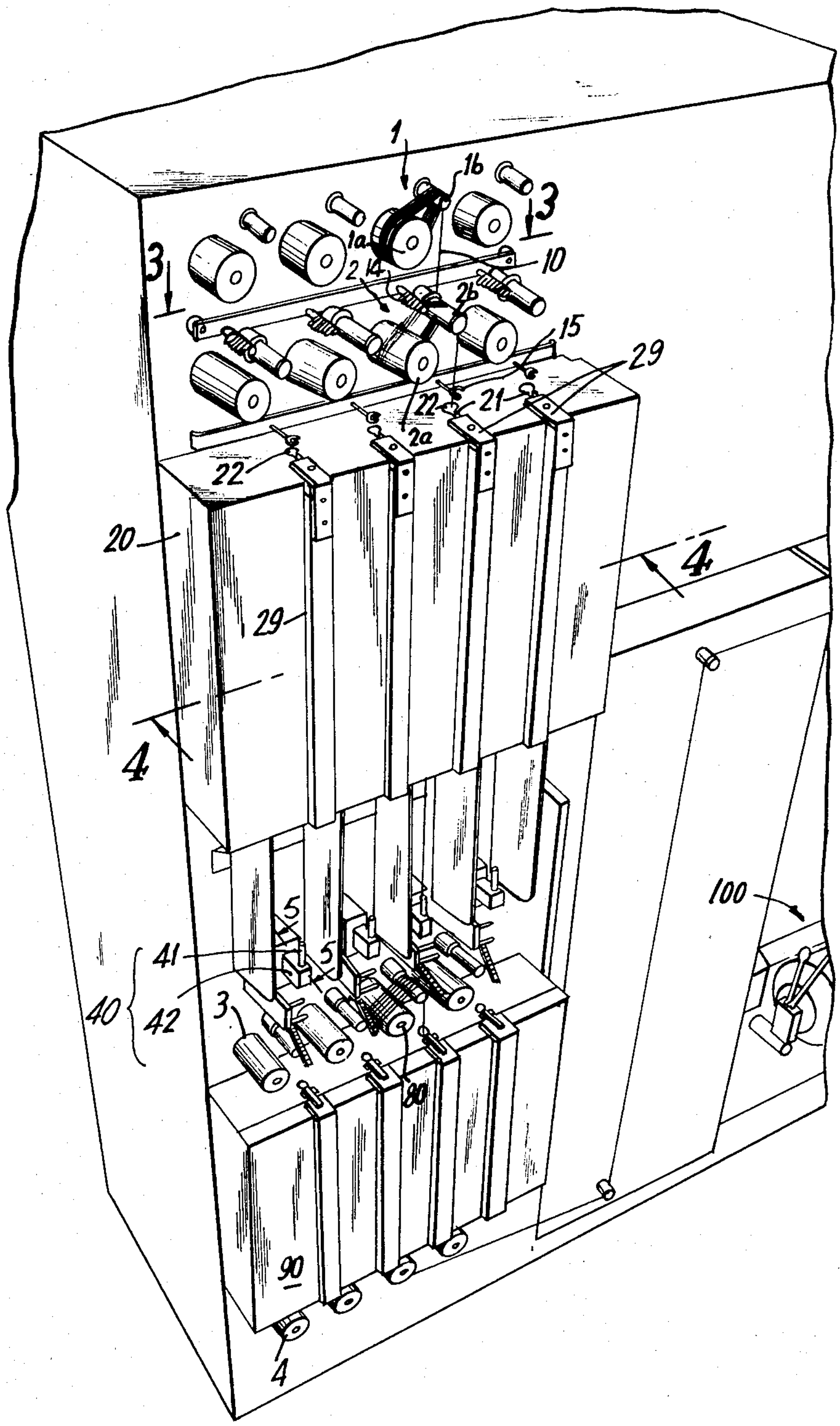

FIG. 2

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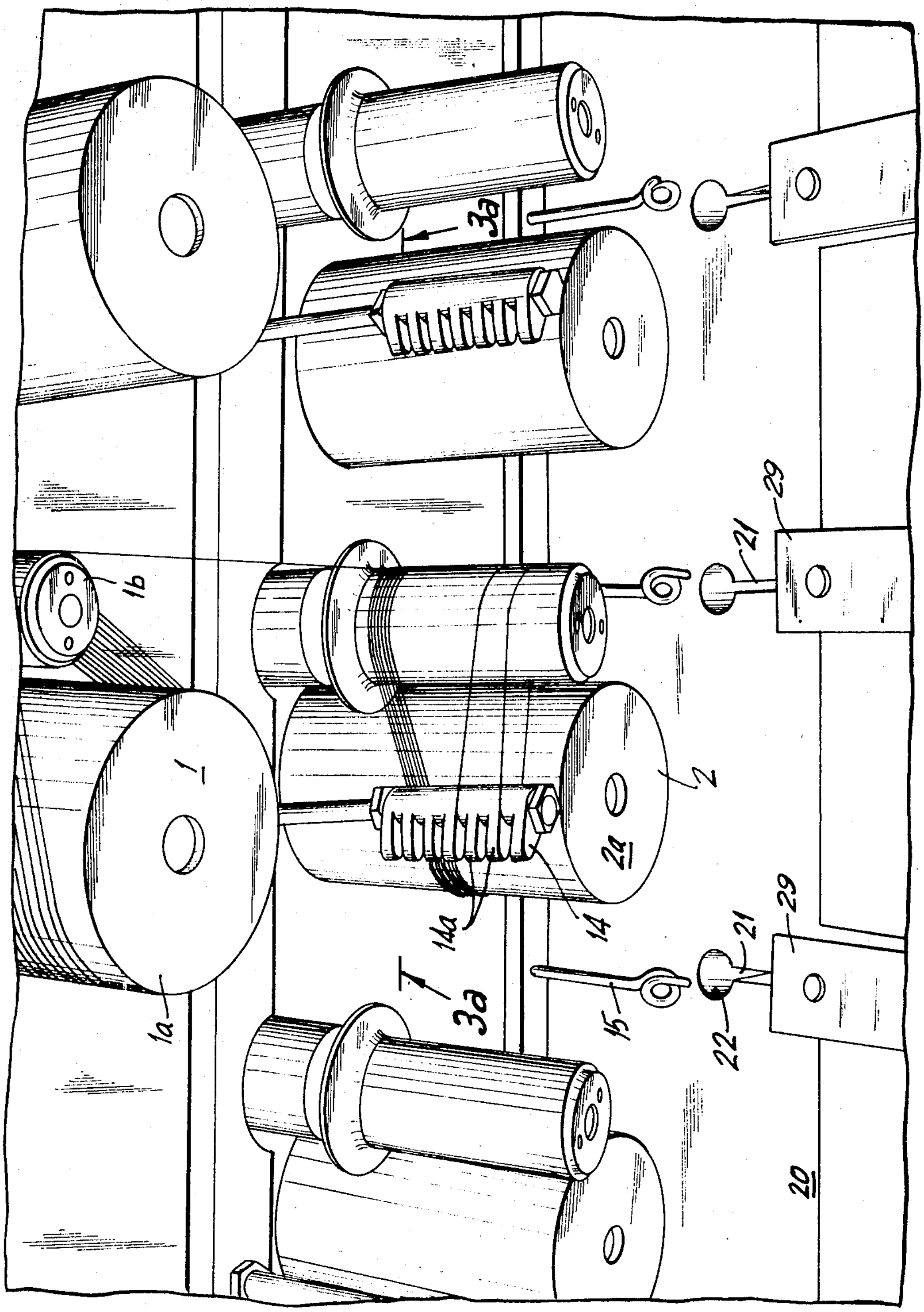

FIG. 3

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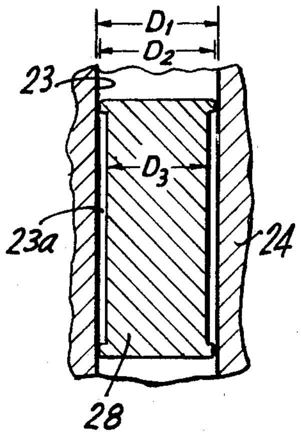

FIG. 4b

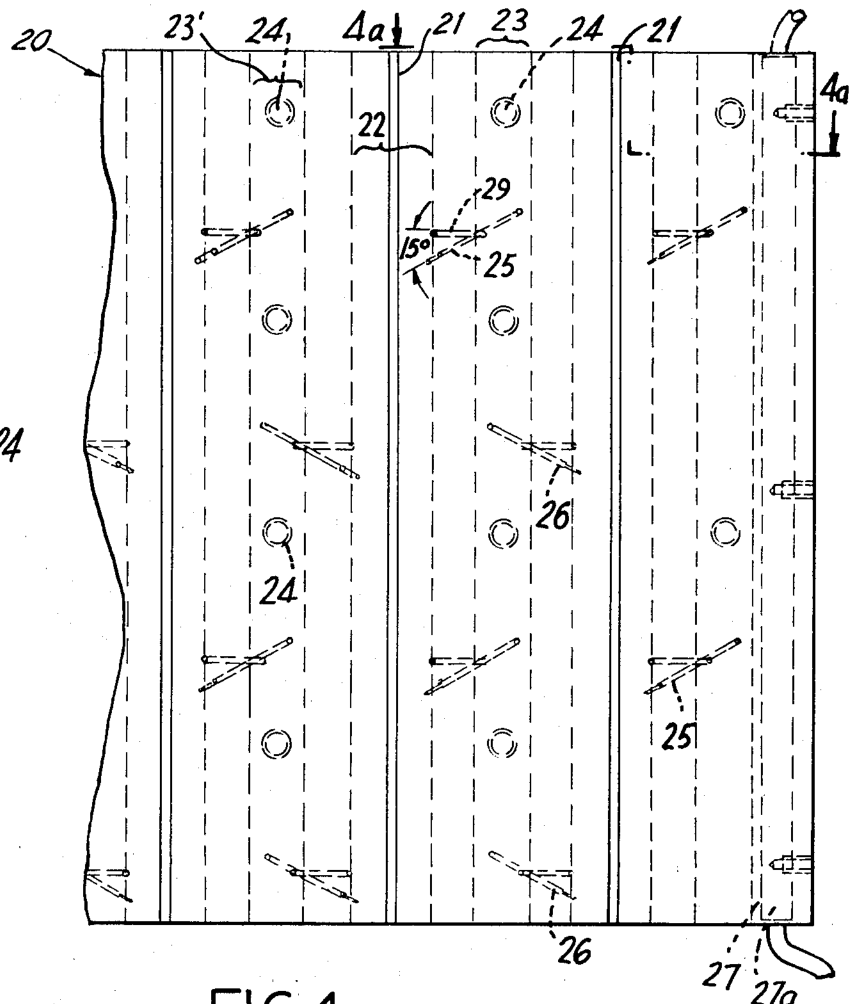

FIG. 4

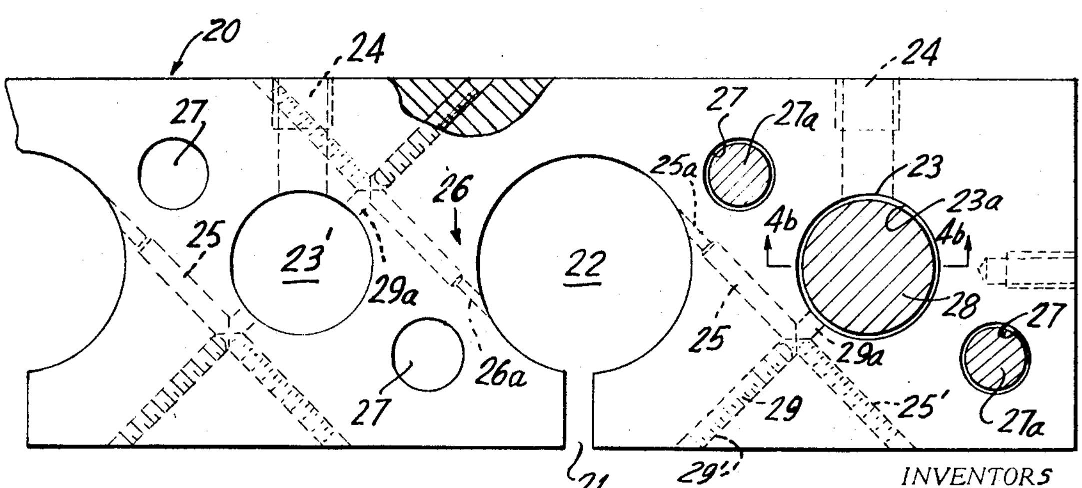

FIG. 4a

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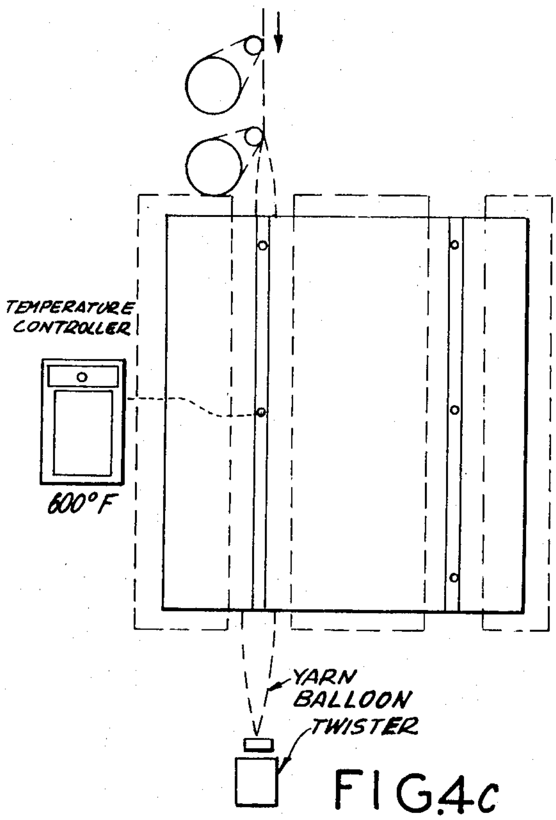

FIG.4c

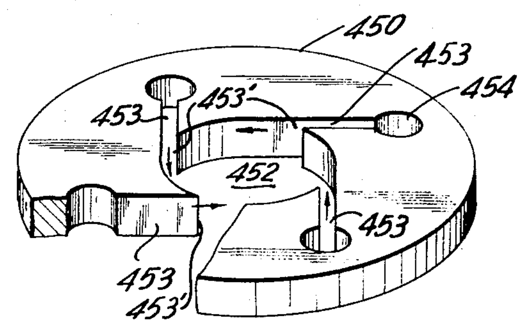

FIG.7

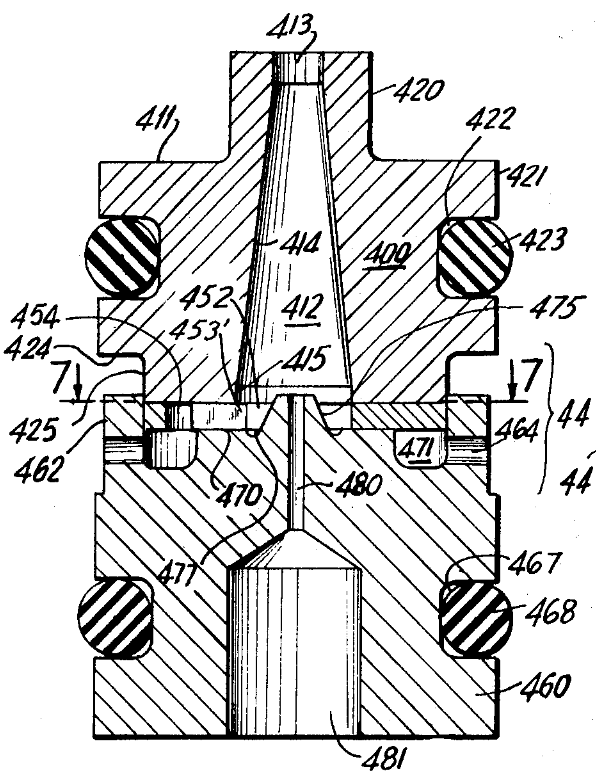

FIG.6

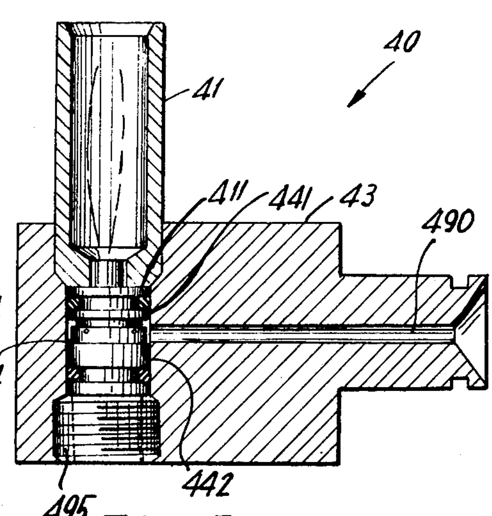

FIG.5

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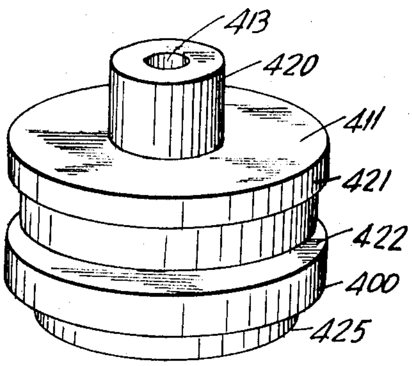

FIG.6a

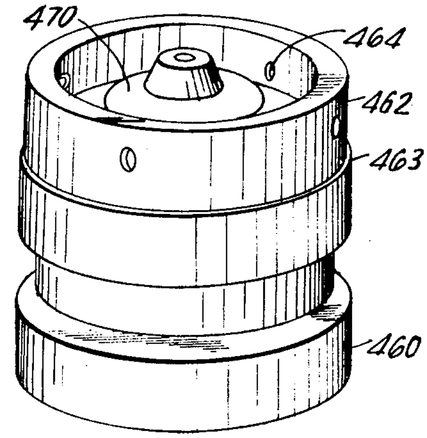

FIG.6b

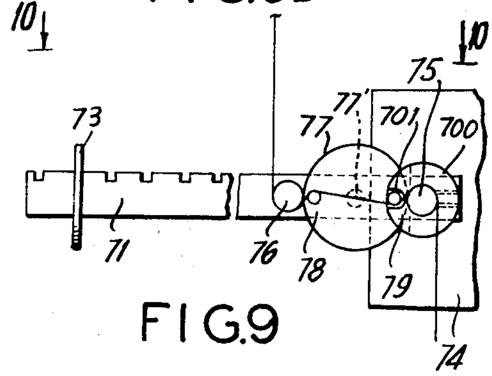

FIG.9

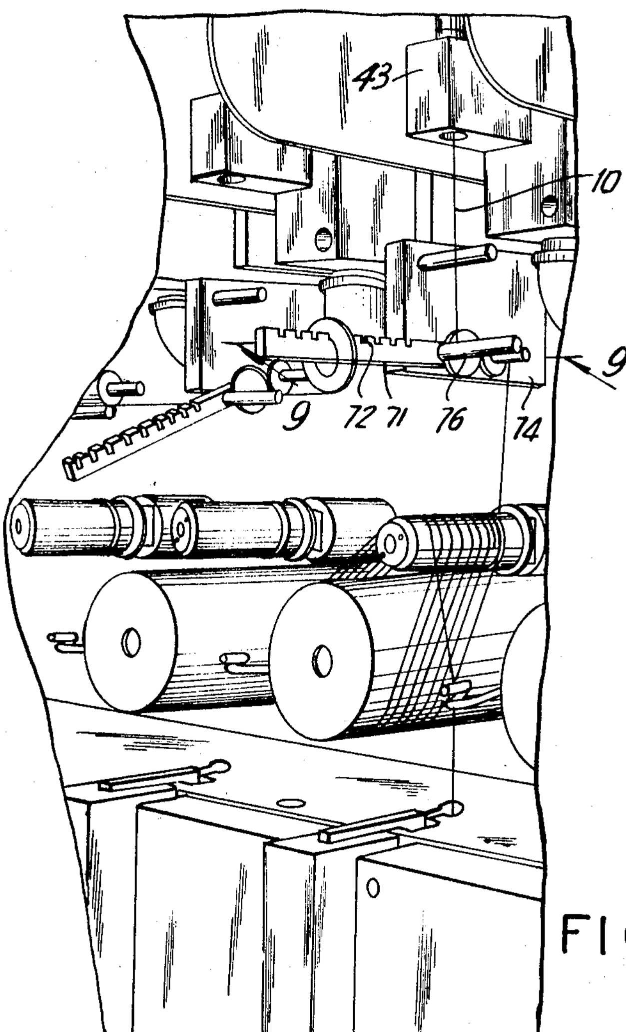

FIG.8

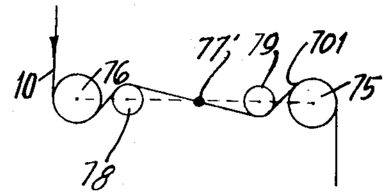

FIG.9a

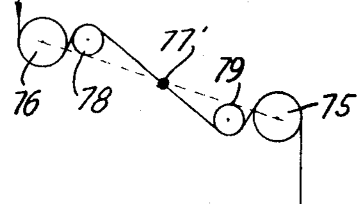

FIG.9b

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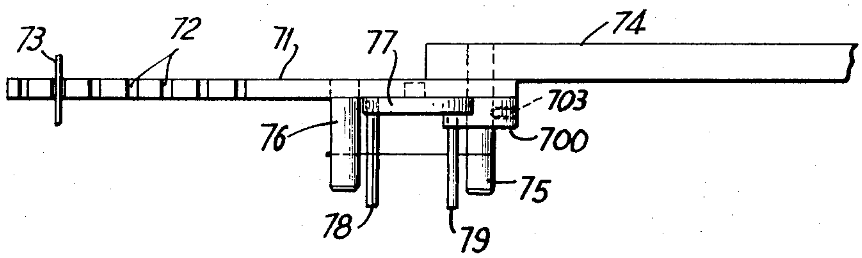

FIG. 10

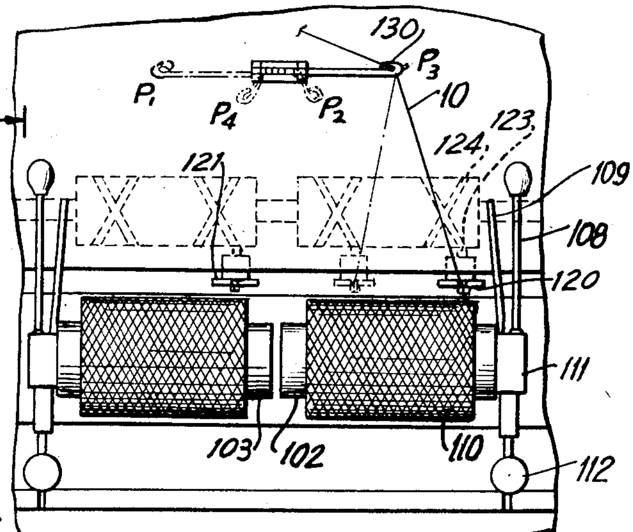

FIG. 11

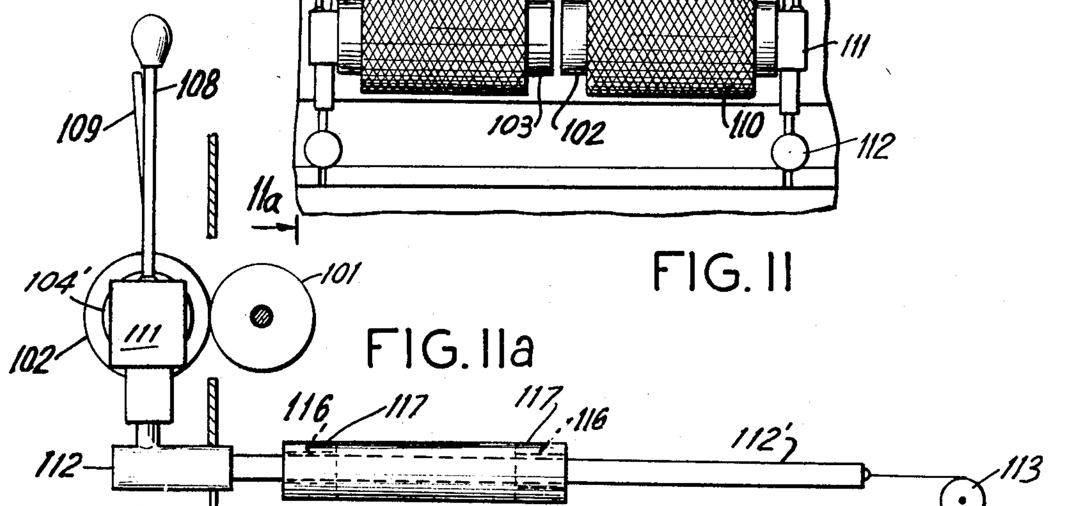

FIG. 11a

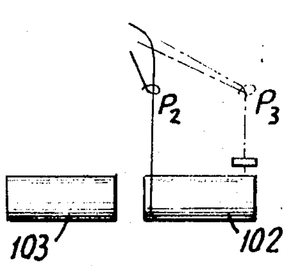

FIG. 11b

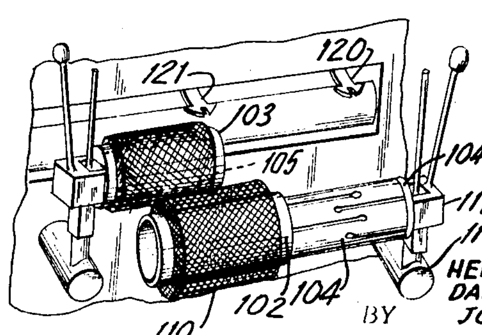

FIG. 11c

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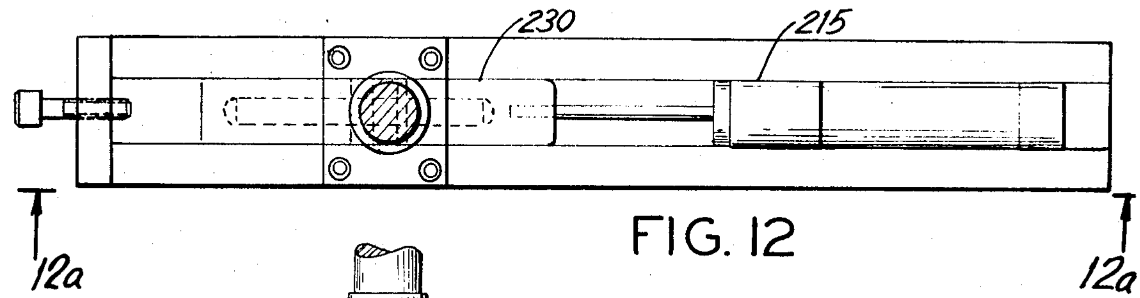

FIG. 12

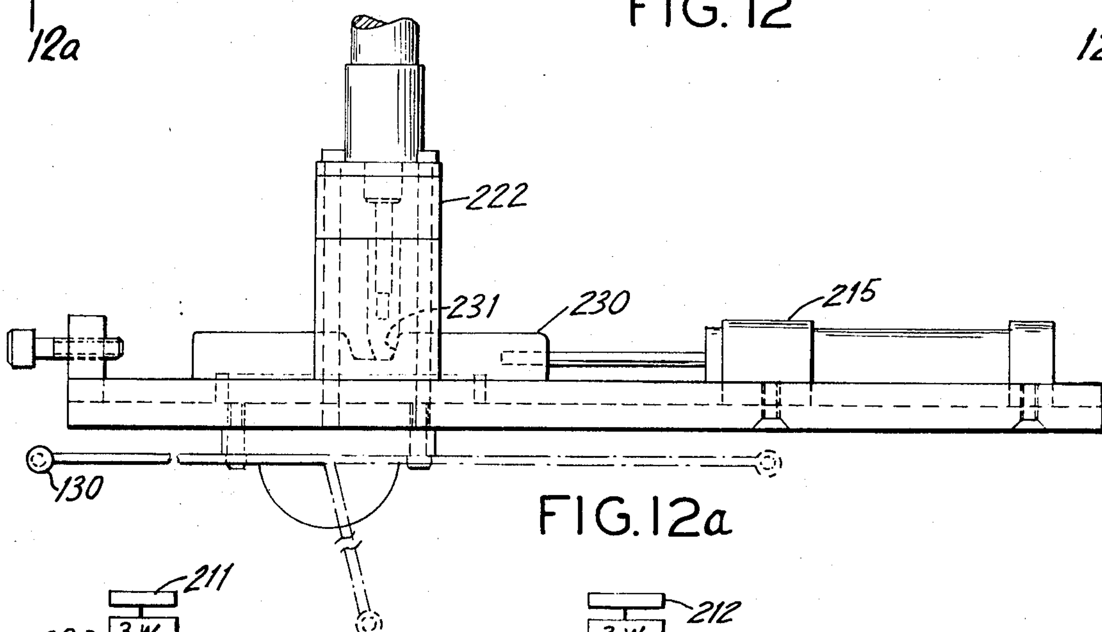

FIG. 12a

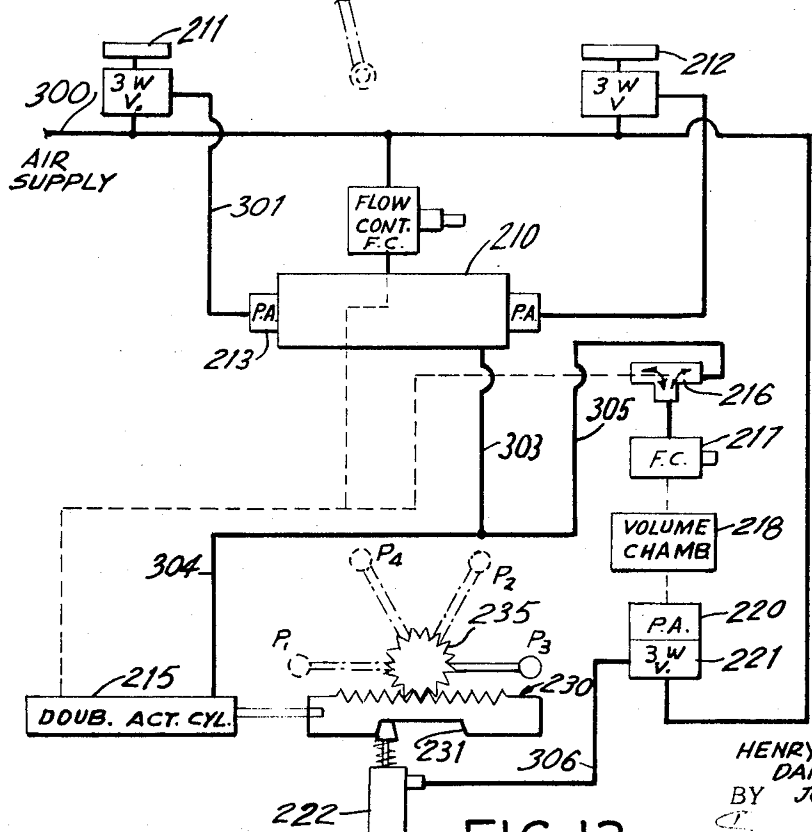

FIG. 13

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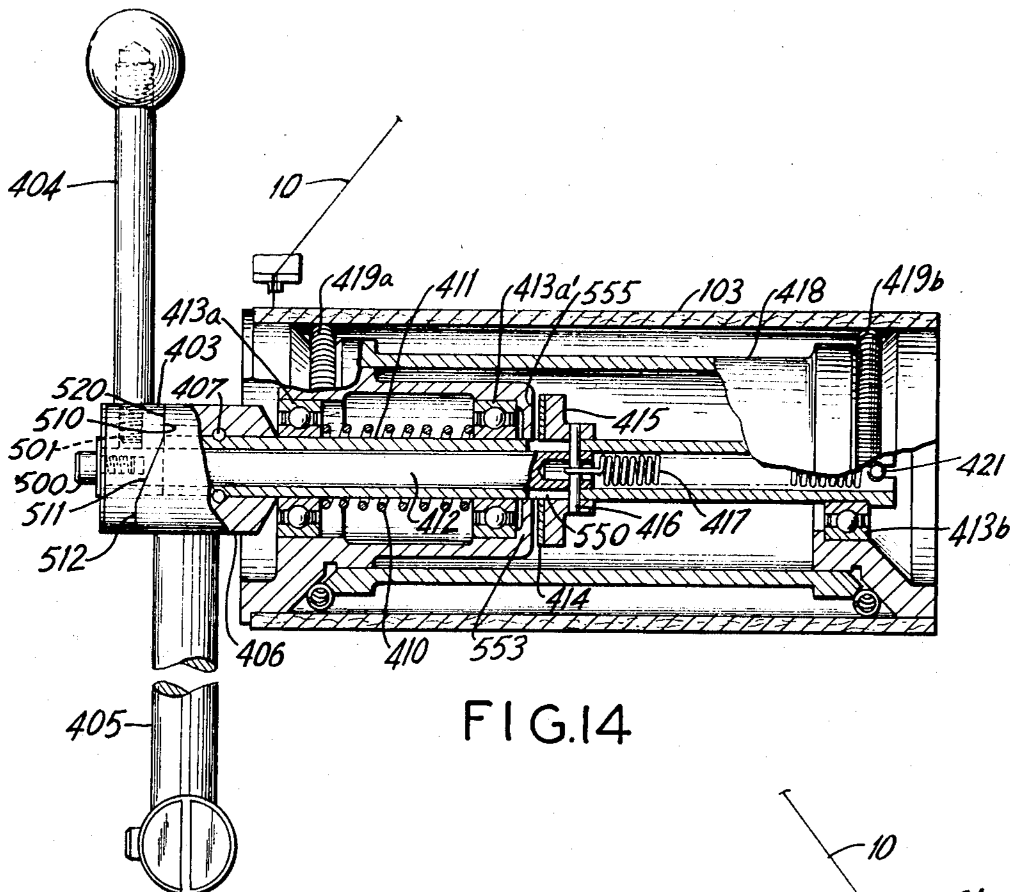

FIG.14

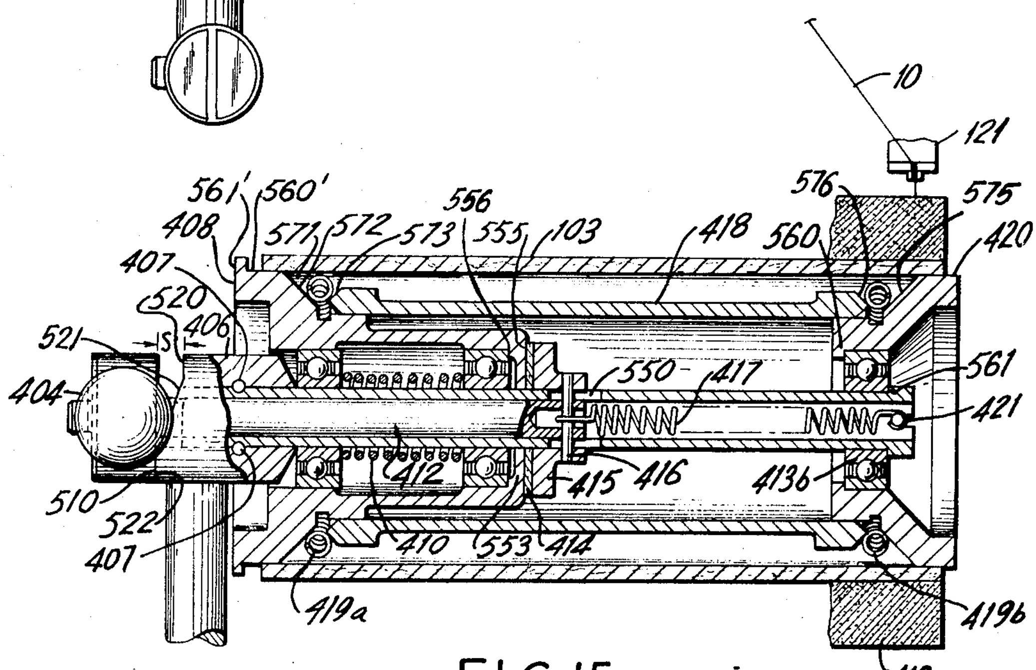

FIG.15

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PROCESS AND APPARATUS FOR TEXTURIZING YARN

FIELD OF INVENTION

This invention relates to synthetic yarn texturizing. More specifically, this invention relates to improvements in apparatus and methods for texturizing yarn utilizing a fluid or airjet twisting nozzle. This invention further relates to improvements to the texturizing apparatus and methods, nozzle and diffuser disclosed in Foster et al., U.S. Pat. No. 3,204,396, for "Method for Texturizing Thermoplastic Yarn and Apparatus;" Foster et al. Pat. No. 2,515,299 for "Apparatus for Imparting False Twist to Strands;" and Shichman U.S. Pat. No. 3,340,684 for "Yarn DESCRIPTION Apparatus and Fluid Diffuser Therefor."

DESCRIPTION OF PRIOR SYSTEMS

Continuous multi-filament thermoplastic textile yarns, such as nylon, polyester (e.g., that sold under the trademark "-Dacron"), polypropylene, etc., are textured by highly twisting the yarns, heat-relaxing them in the twisted condition, and thereafter removing part of the initial twist. Commonly, the resultant yarn is used in a ply yarn construction with another yarn that had been twisted in the opposite direction when it was heat-relaxed.

Conventionally, the process is as follows: The untexturized yarn is fed into a first heating area, for a relatively short period of time, where it is softened, to permit the induced twist to set, then the yarn passes through an airjet yarn twister assembly having a nozzle in which a whirling fluid, such as air, is introduced in jets so as to whip the yarn in a circular fashion and thus induce a twist. The twisted yarn then passes through a second heating area in which it is heat-relaxed so as to remove part of the twist so as to provide the desired texture.

The air nozzle twister permits operation at very high twisting speeds, which, in turn, permits high linear yarn speeds through the apparatus for a desired degree of twisting. The air type false twister also achieves rapid cooling of the heat-set yarn before untwisting because the incoming yarn is subjected to the refrigerating effect of the compressed air that is escaping from the nozzle. A circulating air oven is employed in Foster et al. to heat-relax the yarn. With this device, yarn processing speeds of 800 to 1,200 feet per minute have been achieved in which all the fibers in the yarn were well set in the oven.

In the Shichman patent, a diffuser is interposed between the nozzle and the first oven to direct cool air from the nozzle away from the exit end of the oven. Cool air lowers the temperature at the exit end, in effect, lowering the time that the yarn is exposed to sufficient heat for the softening desired. Increasing the temperature of the oven is accompanied by adverse side effects such as non-uniform yarn texturizing and poor economy of operation. Lowering the speed of the yarn passing through the oven to increase the yarn softening time adversely effects the overall speed of operation and machine efficiency. However, the system disclosed in this patent does not completely eliminate the flow of cool air from the nozzle into the exit end of the oven.

Efficient air twist nozzles are disclosed in Foster et al. U.S. Pats. No. 3,204,396 and No. 2,515,299. This twister has a passage for the yarn including a chamber, desirably conical in shape, in which whirling fluid, such as air, acts on the yarn to twist it. A nipple, perferably frusto-conically shaped, points into that chamber opposite the direction of yarn advance, and has a bore centrally therethrough for the yarn to pass through. The air is introduced in jets opposite this nipple. Twisting speeds of over one million revolutions per minute had been achieved with this nozzle without fouling the nozzle.

Further, in such prior art nozzles, a number of circular holes had to be drilled precisely tangential to the inner cavity of the nozzle in order to have the air more rapidly in a circular manner within the inner cavity. Owing to the small size of the holes and the tangential conditions required, this proved to be difficult and expensive.

OBJECTS OF THE INVENTION

In the present invention, a number of novel improvements have been made in the elements comprising the apparatus for texturizing yarn.

A basic improvement is made in the entire system as a whole in which specific parts are improved as well as the relationship of the various parts. The yarn feed-in includes controlled tension means and also prevents the run-back of yarn twist and yarn foul up. In this invention, the first oven allows the false twist to set and further includes air bleeds providing downwardly directed wisps of air, that is, downward directed circulating air, which flow counter to the air currents from the diffuser produced by the twister nozzle which tend to flow up into the oven. This provides for greater uniformity and heat control in the oven.

A further and important improvement lies in the airjet twisting nozzle itself. The present invention obviates the aforesaid problem of drilling precisely tangential holes by separating the nozzle body into two parts, drilling the inlet holes radially in the nozzle body and having a flat disc as an insert into the nozzle body with slots milled tangentially to an inner circular opening in said disc placed within the nozzle. In this manner, the need to drill tangential holes is eliminated as the milled disc directs the airjet to move in a circular path and yarn passing through this area will be rapidly twisted.

This invention employs yarn tension and speed control means throughout, before and after the ovens and between the nozzle and the second oven. As stated, the yarn feed-in prevents run-back and foul up of yarn, but also provides tension to predraw the yarn, compensating to some extent any tension change due to the variable nature of the raw materials. In addition, drive means operate at different selected speeds before and after the second oven. Further, a yarn tension compensator means, having a unique extending arm arrangement and drag pins, with different torque producing weights or positions is used to finely control or modulate the functional drag on the yarn before it enters the second oven. The resulting system thereby provides enchanced yarn control throughout, having the capability of varying the yarn tension and speed to accommodate changes in the yarn either because of the yarn nature or the rapid operation of the system.

The resulting apparatus and machine provided is thereby more efficient and reliable.

A further novel improvement resides in the wind-up and doffing means. The wind-up includes a guide pigtail spaced above the two yarn guide eyelets, each of which reciprocates over a respective spool mounted over a winding chuck. The guide pigtail positions the yarn to facilitate the winding of a plurality of border yarns, or tie-in yarns allowing for automatic winding from one spool to the next. While conventional doffing means may be used with the winding means to remove the spool, further novelty resides in the doffing means which utilizes an arm to brake and release the spool having simple construction, ease of operation and utilizes fewer parts.

Further and specific objects of the invention are here set forth.

An object of this invention is to provide an improved method, apparatus and system for texturizing yarn by false twisting.

A further object of this invention is to provide an improved, efficient and more easily manufactured twisting nozzle.

Still another object is to provide a twister nozzle having air passages that are more easily machined and can be repeatedly made with precision.

Yet another object of this invention is to provide a twister nozzle having the critical disc which provides tangential air flow as a separate and replaceable element.

Another object is to provide an improved oven in which wisps of air are bled into a yarn chamber around the yarn and are directed in a downward direction.

Another object is to provide an improved twister nozzle-diffuser-oven subcombination in a system for texturizing yarn using false twisting techniques in which the air flow from the oven counters the air flow from the diffuser, providing improved oven operation.

A further object is to provide a texturizing system having a fluid nozzle as part of a false twisting system in which the control of the twist runback is provided by means above the input of the circulating oven.

Yet another object of this invention is to provide means for controlling the tension and speed of the yarns which are to be texturized throughout the system.

Yet another object of this invention is to provide yarn tension compensating means.

Still another object is to provide an automatic winding and automatic doffing means with tie-in tail.

Another improvement relates to the automatic wind-up and doffing which cooperates with the entire system to wind the yarn as well as the tension control means. The wind-up and doffing allows quick and reliable wind-up of yarn on separate, removable tubes.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by references to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, in which:

DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic flow diagram illustrating the sequence of steps carried out in our invention;

FIG. **2** is a front perspective view of the apparatus of our invention;

FIG. **3** is a top view, partially in perspective, along **3—3** of FIG. **2** looking downwardly into the top of the first oven;

FIG. **3***a* is a side view, partially in perspective, along the lines **3***a*—**3***a* of FIG. **3**;

FIG. **4** is a front sectional view of the first oven along **4—4** of FIG. **2**;

FIG. **4***a* is a top sectional view along the lines **4***a*—**4***a* of FIG. **4**;

FIG. **4***b* is a greatly enlarged front view along **4***b*—**4***b* of FIG. **4***a* showing the position of the spool in the air chamber;

FIG. **4***c* is a diagram illustrating the temperature control in the oven of FIG. **4**;

FIG. **5** is a cross-sectional view along lines **5—5** of FIG. **2** illustrating the novel false twister nozzle assembly;

FIG. **6** is a detailed cross-sectional view of the nozzle assembly shown in FIG. **5**;

FIG. **6***a* is a perspective view of the upper nozzle element;

FIG. **6***b* is a perspective view of the lower nozzle element;

FIG. **7** is a partially, cut-away perspective top view of the nozzle disc insert;

FIG. **8** is a greatly enlarged view, partly in perspective, illustrating the relationship of the false twister assembly, the tension compensator, the third pair of Godet and separator rolls and the second oven;

FIG. **9** is a sectional view of the tension compensator along **9—9** of FIG. **8**;

FIGS. **9***a* and **9***b* are diagrams of the tension compensator illustrating the conditions of no tension and increased tensions, respectively;

FIG. **10** is a top sectional view along **10—10** of FIG. **9**;

FIG. **11** is a diagrammatic front view of the winding mechanism for the yarn including the automatic doffing and tie-in tail mechanism;

FIG. **11***a* is a sectional view along the lines **11***a*—**11***a* of FIG. **11**;

FIG. **11***b* is a diagram illustrating the shift of the pigtail from positions P2 to P3 and the yarn engagement with the guide eyelet;

FIG. **11***c* is a diagram illustrating the doffing of a spool;

FIG. **12** is a detailed front sectional view of the automatic doffing and tie-in tail mechanism;

FIG. **12***a* is a top sectional view along the lines **12***a*—**12***a* of FIG. **12**;

FIG. **13** is a pneumatic circuit diagram illustrating the control of the mechanisms of FIGS. **11** and **12**;

FIG. **14** is a longitudinal sectional view of an alternate and preferred embodiment of a doffing mechanism in the drive position; and

FIG. **15** is a similar view of the doffing mechanism of FIG. **14** in the release position.

First Yarn Tension Control Means

Referring now to FIGS. **1** and **2**, there are shown the system including the overall process and apparatus of the invention. A yarn supply **11** provides a yarn **10** to a first yarn tension and control means **12** (FIGS. **3**, **3***b*) which includes drive **1** having Godet roll **1***a* and a separator roll **1***b* moving the yarn at a speed v_1 to drive **2** having a Godet roll **2** and a separator roll **2***b* moving the yarn at a speed v_2 faster than v_1. This differential in velocity between v_2 and v_1 produces a predrawing of the yarn, tending to make the stresses in the raw material more uniform.

The yarn emerges from the drive **2** and is applied over a twist resisting separator bar **14** (FIGS. **2**, **3**, **3***a*), resembling a comb and which prevents yarn entaglement. Bar **14** has spaced-apart pins or teeth **14**a (FIG. **3**) between which the yarn is wrapped a plurality of times along with the wrapping of the yarn over the Godet and separator rolls. The last few wraps of yarn on the second roll are slightly separated from the other wraps by the pins of a separator bar. When the twist runs up the yarn and as far back as a few wraps on the second roll, the yarn tends to move on the roll inwardly towards the first wrap; the separation between the yarn wind-ups prevents entanglement.

The yarn from drive **2** then passes into the first circulating hot air oven **20** (FIG. **3***a*). At the exit end and below is the twister assembly **40**.

Circulating Oven I

The circulating air oven **20** comprises, in general, a tubular yarn heating chamber, separated radiant heating elements and separated spool chambers having an air bleed to the yarn heating chamber. A plurality of passageways is provided between the heat providing spool chambers to the yarn chamber, thereby allowing wisps of heated air to flow into the yarn heating chamber at a downwardly directed angle (15° vertical angle shown as an example in FIG. **4**), but substantially tangent to the yarn chamber (FIG. **4***a*).

Referring specifically to FIGS. **2**, **4**, **4***a*, **4***b* and **4***c*, there is shown the oven **20** comprising a heat conductive (preferably aluminum) block. Yarn **10** is allowed to pass into the inlet **22** of the yarn chamber. At start-up, the yarn is laid into a narrow vertical opening **21** or string-up slot which communicates with the larger cylindrical yarn chamber **22** through which the ballooned twisted yarn passes after the yarn is in position. Closure plates **29** (FIG. **2**) substantially seal the vertical opening **21** allowing only the inlet **22** to remain unsealed.

Separated from the yarn chambers **22** are a plurality of heating element bores **27** (FIGS. **4**, **4***a*), each containing electrical heating cartridges **27***a*. These heating elements heat the entire oven to desired temperature, which is controlled by conventional temperature control means (FIG. **4***c*) which responds to the output of a thermocouple positioned in the center of heating block. The temperature of oven I is maintained at approximately 600° whereas the temperature of oven II, element **90**, is less, i.e., approximately 505°.

Heat and circulating air are applied to the yarn heating chamber through air heating chambers **23**. These chambers are spaced apart bores containing spools **28** (FIGS. **4***a*, **4***b*). In FIGS. **4***a*, chamber **23'** is illustrated without the spool **28** for simplicity, while chamber **23** includes spool **28** and shows the resulting peripheral heated air chamber **23***a* providing a rapidly heated, film of air.

FIG. **4***b* is greatly enlarged to illustrate the bore or heat chamber **23**, diameter D_1 (as for example 1.000 inches), a spool **28**, generally cylindrical, having upper and lower flanges to tightly fit in bore **28** (flange diameter, for example, 0.995±0.002 inches) and the internal body diameter D_3 being only slightly less than D_2 (for example, 0.965±0.002 inches) leaving a peripheral, thin, film-like, cylindrical opening **23***a* as the air chamber (for example, the cylinder thickness is 0.03 inch).

In operation, pressurized air is forced into the air chambers **23** (or **23***a*) through a plurality of air inlet ports **24** in the back of the oven block. A plurality of restricted passageways, each comprising a small bleed hole **25**, are drilled at a downwardly directed angle (15°, FIG. **4**) from a location close to chamber **23** into yarn chamber **22**, and a second hole **29** (FIGS. **4**, **4***a*) is drilled horizontally through hole **25** to chamber **23** allowing hole **25** to communicate at passageway **29***a*, which extends from **29**. The unused portions of these holes are plugged up by screws or the like, as suggested by in the cross-hatched areas **25'** and **29'**. In this way, pressurized air is applied from inlet port **24** into the cylindrical air chamber **23***a*, conducted radially downwardly and horizontally over passageway **29***a* and then at a downward angle through passageway **25** and into the restricted or orifice and **25***a* into yarn chamber **22** essentially in a tangential direction. It will be noted that there are a plurality of vertically spaced, downwardly directed passageways feeding heated air tangentially and downwardly into the yarn chamber and that, on the opposite side of chamber **22**, a passageway **26** having orifice end **26**a feeds from the left side, also downwardly directed. Passageway **26** is the same as **25** except that it enters from the left. It will also be noted that the passageways **25** and **26** are substantially diametrically opposed but feed air in a counterclockwise direction.

The heated air thus circulates throughout the yarn chamber, enhancing the twisting effect, creating greater uniformity of heat and thereby yarn texturizing and the downwardly directed air stream counteracts the colder air coming up from the diffuser and nozzle to minimize the cooling problem at the exit end. This simplifies the oven control and provides for greater temperature uniformity throughout the oven.

Air Jet False Twisting Means

The false twisting **40** (FIGS. **1**, **2**, **5**) means includes a nozzle assembly **42**, an assembly holder **43**, and an air diffuser **41**.

The nozzle assembly comprises an upper nozzle element **400** (FIG. **6**), a disc insert **450** and a lower nozzle element **460**.

Upper Nozzle Element

Referring to FIGS. **6**, **6***a*, **6***b* primarily, the upper nozzle element **400** comprises a generally cylindrical body having an internal chamber or bore **412** through which the yarn passes and is whirled about primarily from the lower regions of the bore. The body is narrowed at the upper part defining a tubular extension **420** and a top seating platform **411** for the diffuser. The chamber **412** has a narrowed aperture **413**, and from this aperture the conical walls **414** of the chamber flare outwardly and downwardly. The flaring stops short of the bottom so that walls **415** are straight. The diameter of the chamber at its bottom is substantially the same diameter as the diameter of the hole **452** in disc **450** and the slots **453** of the disc are substantially tangent to the bottom wall **415** of chamber **412**.

The outer wall **421** of the upper nozzle element has a recess or groove **422** to accommodate O-ring **423**. The diameter of the cylindrical nozzle receiving cavity or bore **441** (FIG. **5**) of holder **43** defined by the cavity wall **442** is substantially the same as the diameter of the outer wall **421** of the upper nozzle to provide a tight fit and the O-ring **423** perfects the seal.

The bottom of the upper nozzle assembly is undercut at **424** and therefore the sidewall **425** of the bottom is recessed. The recessed wall **425** provides a guiding and mating surface for the upper hollowed, shell-like wall **462** of the bottom nozzle element; the inner diameter of wall **462** is about the same (allowing for tolerances) as the outer diameter of the bottom wall **425** of the upper element.

The upper and lower nozzle elements fit together to provide an internal chamber to receive the pressurized air fed into longitudinal port **490** of the holder **43**. The air circulates around the circumferential air space **44** and enters the chamber of the nozzle through the plurality of spaced apart inlet or small openings **464** in the hollowed upper wall **462**. These inlets are radial and are easily formed by drilling.

Before discussing the lower nozzle element in detail and the manner by which the nozzle assembly fits together into the holder, the nozzle insert or disc must be considered.

By application of the novel concept utilizing a separate disc insert **450** (FIG. **7**), the air from the inlets **464** is rapidly whirled about. Disc **450** is thin, flat, preferably metallic (brass) and very hard. It is preferably circular having easily formed central, circular hole **452** of a diameter equal to the bottom of the internal chamber walls **415** of the upper nozzle element. A plurality of tangentially-extending slots **453**, are cut away by a simple milling step. The tips **454** of the slots may be drilled first, providing circular openings terminating short of the outer circumference, that is, the tips **454** are within the periphery of the disc and the slot thereafter milled.

The disc is supported on a central, upper platform **470** of the lower nozzle assembly in special relationship to the inlets **464** as will be described, although other means for supporting the disc to define the plenum chamber communicating with the slots will be within the concept of this invention.

The Lower Nozzle Element

The lower nozzle element **460** comprises a generally cylindrical body having a very narrow central vertical bore **480** to allow a yarn to pass, the bore widening at **481** at the lower part of the nozzle body. The outer wall **460** is the same diameter as wall **421** of the upper element and fits within the cavity **442** of the holder. The upper part of wall **460** is slightly recessed and defines recessed wall surface **462**. The recess thus formed provides the linking passageway from port **490** to the radial openings **464** in the nozzle assembly. Wall **460** is recessed at **467** to accommodate O-ring **468** to securely seal the lower surface of the circumferential air space **44**. It may be noted that a hollowed set screw **495** (FIG. **5**) bears against the bottom **460** (FIG. **6**) of the lower nozzle body to keep it in secure position in the holder and that air is also sucked up through the hollowed opening.

The upper wall **462** is cylindrical and has a diameter slightly less than wall **421** of the upper element, upper wall **462** defining also the inside of the circumferential air space.

Centrally within wall **462** and extending upwardly from the body itself is a platform **470** and from the platform, a frustoconical nipple-like element **475**. The narrowed bore **480** passes through nipple **475**. The yarn balloons upwardly from this nipple.

Between the platform **470** and the cylindrical wall **462**, an annular recess is formed defining the intake plenum **471**. The platform is also grooved or recessed along its base to define a smaller, circumferential air opening **477**. This groove is positioned coincident with the part of the disc **453'** where the slot meets the center opening, so that air from the plenum passes through the slot and hits the nipple wall; air which becomes downwardly directed flows around the small annular groove. It will be noticed that upper nozzle element is seated on the disc supported on the platform of the lower element. The undercut surface **424** is spaced from the top of shell **464**, this space adding to the linking passageway **44** (FIG. **5**).

The radial inlets **464** formed in the hollowed upper wall are below the platform **470** and hence below disc **450** so that the pressurized air from inlet **464** passes through the lower nozzle plenum chamber **471**, up into tangential slots **453** at the ends **454** to be directed inwardly into the central opening **452** as suggested by the arrows in FIG. **7**. This whirling air acts on the yarn from above the nipple and which is central within opening **452** to twist the yarn filaments. The air exits whirling upwardly through chambers **412**, **413**; the whirling effect being enhanced by the narrowing of chamber **412** to increase the air pressure as the air moves up. The whirling effect is then diffused in the chamber of the diffuser **41** before exiting upwardly.

Tension Compensator

The yarn **10** passes through the twister and is threaded in the tension compensator means **70** just below. Means are shown in FIGS. **8**, **9** and **10** and the operation is diagrammatically illustrated in FIGS. **9***a* and **9***b*.

The compensator includes an extending arm **71** to which a weight, such as slug **73** may be supported. A series of slots **72** are provided to allow for variation in the position of the weight, essentially providing for a selectable, variable torque. The arm is pivotally attached to a bracket **74** by horizontally extending pin **75** constituting the main pivot for the compensator system. Another front horizontal pin **76** is attached to the arm around which yarn **10** is first applied.

A disc **77** is pivotally secured to the arm between pins **75** and **76** and has two horizontal diametrically opposed pins **78** and **79** about a center point **77'**. A retaining collar **700** having a slot **701** for pin **79** and a central aperture for pin **75** holds the disc in horizontal position when a set screw **703** is tightened.

Since collar **700** may be rotated, the position of slot **701** can be varied relative thereto, which in turn defines the position of pin **79**. Slot **701** is slightly larger than pin **79** to allow it some degree of preferably slidable motion.

The tension compensator is preferably set to run with its arm in the horizontal position in which case the centers of pins **76, 78, 79, 75** and disc center **77'** are horizontally aligned, as suggested in FIGS. **9**, **9***a*. This is controlled by placing the weight **73** at a given point along the arm length as illustrated in FIG. **9**. Any change of tension in the length of yarn between Godet rolls **2** and **3** due to uncontrollable conditions in the raw material or any other reason can be compensated for in the compensator. For example, if the tension increases the yarn will lift the compensator arm (FIG. **9***b*) and thereby change the position of the drag pins **79** and **75** on the compensator; this in turn holds back on yarn going to third roll and thereby decreases the tension. By the same token, if tension decreases in the area between Godet rolls **2** and **3**, the compensator arm will be lowered and will in turn lessen the drag on the drag pins. This will permit more yarn to go through to the third roll, thus increasing tension. It will be noted that a frictional force exists as the yarn passes under pin **79** up and around pin **75**.

As the arm **71** is pulled up because of increased tension, disc **77** rotates about its center **77'**, while arm **71** rotates about pin **75**. Thus, pin **76** moves upwardly, pin **78** moves upwardly, pin **79**, rotating about the disc center, tends to move downwardly and the frictional force of the yarn around pins **76, 78, 79** and **75** is increased.

For purpose of explanation, this increased drag force tends to grip or pinch the yarn; since the yarn is being driven downwardly from roll **2**, the tension force is relieved as the yarn may tend to bunch. Essentially, the tension force compensator controls the tension imposed from the lower drive roll **3** by modulating the downward force applied.

It will be seen that the position of the arm determines the yarn tension, and yarn tension is increased by downward arm movements, and the desired tension may be adjustably provided by the variable torque forces from moving the position of the weights **73**.

The second yarn tension and control means therefor also includes drive **3**, similar to drives **1** and **2**, but operating at a speed slower than drive. Other means for controlling the yarn tension could be provided by variably controlling the speed of drive **3**, to slow it down when the tension of the yarn is increased.

Oven II

Oven **90** is preferably the same as oven I but operates at a somewhat lower temperature. Other types of ovens could be used in place thereof and its operation is thus conventional. It may be understood, however, that if a high stretch yarn is desired, then the second oven need not be used, or, if used, could be run at substantially lower temperatures.

Drive 4

Drive **4** is similar to drive **3** except much slower. This tends to avoid imposing any tension in the yarn between drives **3** and **4** as the yarn passes through oven II. The third roll may run, for example, at 850 f.p.m. and receives seven wraps of yarn. The fourth runs at 725 f.p.m. and a minimum of six wraps are put on it. The yarn is overfed approximately 125 f.p.m. into oven II and shrinkage of the yarn removes a portion of the stretch. The yarn is now taken from the fourth roll and guided by pigtail guides and idler rolls to the winding section. The winding section preferably includes the automatic winding and doffing means shown in FIGS. **11, 11***a*, **11***b* and **11***c*. However, it will be understood that other types of take-off means or other machines may be used to take up the yarn and may thus be considered within the winding means.

Winding and Doffing

There is shown in FIGS. **11, 11***a*, **11***b* and **11***c* an automatic winding and doffing means comprising rotating spools **102, 103** around which yarn **10** is wound to provide the yarn package **110**. These spools **102, 103** are supported on drive chucks, also referred to as sleeves or cores **104, 105**. These chucks are supported by a biased clutching arrangement so as to frictionally engage a rotating drive member **101**.

There is shown in FIGS. **11** and **11***a* a brake handle **108** and a release handle **109**. When brake handle **108** is actuated, the winding chuck is braked and when the release handle **109** is actuated, the spool is released. The winding chucks **104, 105** are each supported between a pair of conventional metallic sleeve ends, one such end, **104'**, being shown in FIGS. **11***a* and **11***c*. The sleeve ends are supported for rotation about a shaft mechanism, not shown, which is journalled in block **111**. The chuck is conventionally a sleeve, made of phenolic, for example, having a plurality of longitudinal slots, to facilitate chuck or sleeve expansion. When the spool is supported for rotation on the chuck, the chuck **104** is expanded by the motion of one sleeve and to the other, thereby gripping the spool **102**. When release handle **109** is moved, the sleeve ends are released, the chuck collapses, and the spool may be doffed as illustrated in FIG. **11***c*.

When the two handles **108, 109** are squeezed, the brake is actuated first, stopping rotation. The entire winding mechanism may then be pulled out and upon further squeezing the chuck or core is compressed, releasing the spool. This doffing mechanism is otherwise conventional.

The block **111** is mounted on a horizontally movable bar **112**. Bar **112** is biased rearwardly by a tension device including a pulley **113** and a weight **114**. Bar **112** has an extension **112'** which is fastened to a cord wound over pulley **113**. Bar **112** is supported for horizontal movement within a linear motion bearing **117** housed in a cylindrical block **116** anchored to the machine. Thus, the bar **112** can be moved outwardly by pulling on a handle attached thereto or on the brake and release handles. Obviously, when pulled out, there is no contact with the drive roller.

The winding mechanism is novel and includes standard traversing yarn guide elements **120, 121** which reciprocate back and forth above the top surface of the rotating spools so that the yarn is wrapped thereover. The guides **120, 121** (FIG. **11***c*) have an arcuate or angled front section with a central slot and eye through which the yarn falls and is held in place, guided for back and forth movement, to build up the package **110**. Guides **120, 121** are moved by providing a cam follower **123** mounted for engagement in a rotating cam **124** having criss-crossing diagonal, circumferential cam grooves providing reciprocating motion to the follower.

There is provided a pigtail or second yarn guide **130** which may assume four positions, P_1, preferably being between the left end and the center, and as illustrated, at the extreme left end; P_2 a position to the right of center at approximately 100° from P_1, which is just over the left end of spool **102**; P_3 corresponding to the right of P_2, preferably between the middle and right end of spool **102**; and P_4 a position 100° from P_3 and just over the beginning or right end of spool **103**.

Before describing the operation of the winding mechanism and the relative movements of the first and second yarn guides **120, 130**, and the resulting provision of a core border comprising a predetermined number of yarn windings, we will first describe the mechanism of FIGS. **12, 12***a* and **13**, which control the movement of guide **130** to the sequence of positions P_1, P_2, P_3, P_4.

Schematic Description

There is shown a pneumatic circuit in FIG. **13** comprising a four-way valve **210** and control buttons **211**, **212** or respective three-way valves.

Pushing the left hand button **211** on the three-way valve and holding it allows air from the supply line **300** to pass through the valve over line **301** to a pressure actuator **213** that activates a four-way valve **210**. The four-way valve now being actuated allows air from the supply to flow over lines **303**, **304** through to a double acting air cylinder **215** also flowing over line **305** through a directional tee **216**, flow control valve **217**, volume chamber **218** and into a pressure actuator **220**. The pressure actuator then opens a three-way valve **221** allowing air from the supply line to flow through a single acting cylinder **222** over line **306**. Actuating of this cylinder is delayed somewhat over the double acting cylinder because of the flow control valve feeding the volume chamber. This delay allows the double acting cylinder to advance a rack **230** until the rod end of the spring loaded single, acting cylinder **222** plunges into a notch **231** and stops the movement of the rack. This initial movement of the rack drives gear **235** and constitutes the first 100° swing of the pigtail. When the flow control valve allows enough air to enter the volume chamber to actuate the pressure actuator, which in turn opens the three-way valve, permitting air from the supply to flow through to single acting cylinder and withdrawing plunger, the rack then is free to travel to completion of its stroke thereby producing a full 180° rotation of the pigtail.

The operation of the winding mechanism may now be understood by referring to FIG. **11**. The winding of package **110** on spool **102** will be considered, although the packages on the other spools are formed in the same manner.

Yarn **10** is passed through the pigtail **130** which we may assume is at P_1. This is actually the ending position of the package winding on spool **103**. The pigtail moves from P_1 to P_2 where the yarn begins to wind around spool **102**. However, the yarn has not been picked up by guide **120**. When the yarn is in the P_2 position, the yarn will not ever be picked up by guide **120** and thus the yarn dwells at the position P_2 forming a core border that is used for the tie-in tail. After a short pause, the pigtail is moved to P_3, a position in the path of traverse guide **120**, and the yarn is picked up by guide **120**. This guide then reciprocates back and forth for a relatively long period of time building up package **110**.

When package **110** has been completed, the operator pushes the respective button of three-way valve **212**, to swing the pigtail 100° to P_4, where a tie-in tail is wound on spool **103**. When the pigtail moves to P_1, the yarn is picked up by guide **121** and package build-up begins. When the second package is built up, the operator may press the other button **211** to begin the process anew.

It is within the principles of this invention to provide for complete automatic operation by the use of a pressure switch, spaced from the respective spools, to control the three-way valve. Other means for providing automatic control of the three-way valves will occur to those skilled in the art.

Thus, there has been described a surface driven winder having the automatic doffing and the ability to put 9 tie-in tail on the finished package. This allows for high speed winding and doffing, consistent with the improved operation of the entire system.

Preferred Doffing Mechanism

Referring now to FIGS. **14** and **15**, there is shown the preferred and novel embodiment of the doffing mechanism. There is shown a rotatable handle **404**, fixedly coupled by a screw **500** to central rod **412**, and by another screw **501** to a cam plate **403**. The cam surface is three-dimensional and has a first, planar surface **510** transverse to the center line of the mechanism, a second transverse planar, or flat surface **512** parallel to surface **510** and laterally spaced therefrom towards the handle, and a connecting inclined surface **511** therebetween. Each surface occupies a portion, approximately one-third of the exposed end of the cam plate.

Rod **412** is longitudinally movable within sleeve **411** which extends through the mechanism. Coupled to sleeve **411** by a carrier assembly **406** is a fixed support rod **405**. Carrier **406** is essentially a hollow block through which the sleeve passes and is held by pins **407**. It will be noted that rod **412** is longitudinally movable in sleeve **411**, but for a limited distance as will be discussed later.

The left face of the block also has a three sectional cam surface **520**, **521**, **522** (FIG. **15**). Cam surfaces **520** and **522** are parallel, planar, and transverse, with surface **522** laterally spaced from **520** towards the handle. Surfaces **510** and **520**, **511** and **521**, **512** and **522** are mating surfaces. Further, surfaces **510** and **522** are mating surfaces as illustrated in FIG. **15**. These surfaces define three positions of operation: (1) When cam surface **510** engages surface **520** (FIG. **14**), the mechanism is engaged for rotation and spool **103** is frictionally engaged as will be explained; (2) When cam surface **510** engages surface **521**, the inclined portion, the mechanism is braked, but the spool **103** is frictionally engaged and as cam surface **510** approaches cam surface **522**, the spool is frictionally released (FIG. **15**); and (3) When cam surface **510** engages cam surface **522**, handle **404** is locked in position and the spool and package may be doffed.

In operation, the operator rotates handle **404** to the second position to brake the mechanism. Then, by gripping the handle, the entire mechanism may be pulled outwardly, the bar **112** of FIG. **11***a* being slidable in the linear motion bearings **117**. Subsequently, the operator rotates handle **404** to the third position and the package may be doffed.

Braking

The brake comprises a brake disc **414** on a brake shoe **415** fixedly coupled to rod **412** by a pin **416** which also extends through a longitudinal slot **550** formed in sleeve **411**. Thus, the rod can move in the sleeve, carrying pin **416** along with it for a distance limited by the ends of the slot.

There are shown sleeve ends **408** and **420** which support outer sleeve body **418**. Cylindrical springs, that is, circular, toroidal coils of wire, **419***a* and **419***b*, are supported between the spool ends and outer sleeve respectively for expansion. FIG. **14**, these springs are shown in the expanded condition and frictionally engage spool **103**. In FIG. **15**, the springs are in the collapsed state and are separated from spool **103** so that the spool may be easily doffed by pulling the spool off to the right.

The left sleeve end **408** is supported on the inner sleeve **411** on bearings **413***a*, **413***a'* so that it may rotate along with spool **103** and outer sleeve **418** when the package engages the drive roll. When the brake **414** engages in the inner face **555** of the spool end, braking occurs since sleeve **411** and rod **412** are not rotatable. It will be noted that a compression spring **410** bears against the bearings **413***a*, **413***a'* to retain the left sleeve end **408** in position. More specifically, a shoulder **556** is provided on the inner surface of the end wall **553** which provides a seat for bearing **413***a'*. The right end of sleeve **408** has a transverse wall **553** and a central aperture through which sleeve **411** passes.

Bearing **413***a* is held in place by engagement with the right end of the carrier assembly **406** which is stationary throughout the entire operation of the mechanism. The right sleeve end **420** has a shoulder **560** to retain bearing **413***b* in position. Sleeve **411** has an outwardly directed shoulder **561** which defines the other retainer for the bearing. Sleeve end **420**, therefore, rotates along with sleeve end **408**.

A tension spring **417** is centrally positioned within sleeve **411** and is connected on its left end to pin **416** and its right end to a pin **421** which fits within a slot formed in the sleeve **411** on its right end. Spring **417** thus urges the brake disc and shoe to the right and out of engagement with the free sleeve end **408**. It will be noted that when rod **412** is pulled to the left, which occurs when handle **404** is rotated, that pin **416**, moving in slot **550**, pushes the brake disc and shoe against the brake surface **555** and also pulls on spring **417**. In the position of FIG. **15**, handle **404** has been moved so that the cam surfaces **510** and **522** are seated against each other, the brake has been locked, compression spring **410** has been compressed and sleeve end **408** has been moved to the left a sufficient amount to release the coil springs **419***a*, **419***b*. As the handle **404** is moved back to the brake and the drive position, spring **410** pushes against the bearing **413***a* which in turn pushes against the shoulder **556** of the sleeve end to expand the coil springs.

The right sleeve end **420** has a flat top surface over which spool **103** may slidably pass. Sleeve end **408** has a similar, flat top surface **560'** over which the spool **103** may slidably pass, but also an enlarged flange end **561'**'defining a stop for the spool **103**. A spring receiving groove **571** is formed between a inclined wall **572** of the carrier assembly and the opposing end wall **573** of the outer wall of sleeve **418**. Wall **573** comprises upper and lower angled surfaces. Walls **572** and **573** form an angle and they are movable relative thereto. As these walls come together, that is, when the sleeve end **408** is moved to the right, wall **572** and wall **573** act as complementary wedges against the underside of the spring **419***a*, forcing it to expand and engage spool **103**.

The right sleeve end **420** also has an inclined sleeve **575** which cooperates with an inclined surface **576** of the outer sleeve to define a receptacle for the spring **419***b*.

More specifically, the upper wall surface cooperating with the wall of the sleeve end to provide a wedge and the lower wall surface cooperating with the wall of the sleeve to transmit movement from the sleeve end through the sleeve body to the other wall of the sleeve body and thus to the other sleeve end to provide expansion force to the respective spring between said other sleeve end and sleeve body.

As the handle **404** is rotated to the position shown in FIG. **14**, the left sleeve end **408** is pulled to the right by the action of compression spring **410** until the inclined walls **572** and **573** touch, at which time the continued movement of wall **572** against the outer sleeve **418** pushes the sleeve **418** to the right to wedge against spring **419**b and expand it upwardly.

In the non-brake position of FIG. **14**, the brake disc **414** is spaced from the brake surface of drum surface **555** by a distance which is less than the space S (FIG. **15**) which is the lateral distance between the parallel cam surfaces. It is important to recognize that within the distance S, there are in fact two cam positions, that is, the cam position which provides for braking first and then at some position beyond the braking position, the release of the coil springs **419***a*, **419***b* occurs because of the leftward movement of the sleeve end **408**.

In comparison with prior doffing mechanisms, the parts used herein are by and large standard parts or parts easily made. Further, fewer parts are used than the other doffing mechanisms and the operation is simple. The operator merely grips the support **405** while rotating the handle **404**. Support **405** may also be used to pull the doffing mechanism out. Handle **404** is used for both braking and spool release.

EXAMPLES

The following are examples of speeds given for various rolls, and temperatures for several heaters.

Example 1

A 150-denier, Du Pont Dacron polyester yarn, **34** filaments per yarn was crimped in the apparatus. The false twister pressure ranged from 64 p.s.i. to 70 p.s.i. The supply yarn had 85 to 95 grams tension on it as it was fed to the first Godet roll. The roll speeds for rolls **1**, **2**, **3** and **4** were respectively 845, 855, 850 and 725 feet per minute. The take up speed of the wind-up means was 770 feet per minute. The first heater temperature was set for 600° F; the actual temperature measured by thermocouple in the center of the first oven was 500° F. The second heater temperature was 490° F. The finished crimped yarn had 22 crimps per inch. The tension compensator was used throughout the run and enough weight was added to the arm to keep the arm from touching the top and bottom limit of travel.

Example 2

A 70-denier, Du Pont nylon yarn, 34 filaments, with one-half *z* twist was crimped. The roll speeds and heater temperatures were the same as the above example with the exception that the second oven was not used. 11 grams of tension was used on the supply yarn. The twister pressure was 74 pounds per square inch.

Example 3

A 100-denier nylon yarn, 34 filaments, one-half *z* twist was crimped in false twist apparatus. The roll speeds on rolls **1**, **2**, **3** and **4** were respectively 845, 855, 843 and 725 feet per minute. The take-up speed was 770 feet per minute. The first oven heater was 560° F. The second heater was not used. There was 50 grams of tension on the supply package. The air pressure to the nozzle was varied from 68 p.s.i. to 78 p.s.i. with exceptable crimp within that range.

Example 4

A 150-denier nylon was crimped with the first heater temperature at a 650° setting, the actual temperature being 603° F. The nozzle pressure was 84 p.s.i. The yarn supply was maintained at 50 grams tension. Roll speeds were 845, 855, 850 and 725 per minute for rolls **1**, **2**, **3**, and **4**. The take-up speed was 770 feet per minute.

Example 5

A 150-denier Kodel polyester yarn, 32 filaments per yarn was crimped in the false twist apparatus. The supply yarn had 70 to 80 grams of tension on it. The false twist nozzle was supplied with 80 p.s.i. air. The first oven was set at 635° F., the second oven was set at 535° F. The roll speeds for rolls **1**, **2**, **3** and **4** were respectively 818, 835, 825 and 690 feet per minute. The take-up speed was 750 feet per minute.

While the foregoing description sets forth the principles of the invention in connection with specific apparatus, it is to be understood that this description is made only by way of example and not as a limitation of the scope of the invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. A system for texturizing yarn for filamentary thermoplastic strand material comprising:

means for supplying yarn at controlled tension and speed;

a first heating oven including a yarn heating chamber having inlet means for receiving said yarn from said supply means, and including yarn outlet means to allow the yarn to pass out of the oven;

an airjet yarn false twisting means having a nozzle assembly, said assembly having an upper yarn receiving element, a lower element and a disc in between said elements having slots therein to direct the air stream providing a whirling stream to induce twist in said yarn;

an air diffuser having yarn inlet and outlet orifice means, coupled directly to said upper nozzle element, whereby yarn ballooning in said diffuser may occur;

second yarn tension and speed control means coupled to the lower nozzle element to control the tension and speed of the yarn passing out of the said lower nozzle element;

a second oven coupled to said second yarn tension and speed control means to heat said yarn to heat-relax the yarns and remove at least some of said induced twist and winding means to receive the yarn from the second oven to wind up said yarn on a spool.

2. The system of claim **1** in which the false twisting means includes a holder to receive the nozzle assembly and to receive and support the diffuser, the holder including a passageway for pressurized air;

the upper nozzle element comprising a generally cylindrical body having an internal bore, and an undercut at the peripheral edge of the bottom surface defining a peripheral recess and a central contact surface for said disc whereby the lower nozzle may be received;

the lower nozzle element comprising a generally cylindrical body and having a first narrow vertically oriented passageway defining the guide passageway for said yarn;

the body having a recess in the upper part defining a shell-like wall fitting into said peripheral recess of the upper nozzle element, the bottom of said recess having a central, upwardly extending platform and a nipple extending centrally up from said platform, the nipple including the extending first narrow-vertically oriented passageway;

an intake air chamber being defined between the platform and the shell-like wall, said intake air chamber being generally below said platform;

a disc, said disc supported on said platform, and thereby above said intake air chamber;

a plurality of radial air intake openings in said shell-like wall communicating directly with said intake air chamber;

said disc having a plurality of spaced slots formed therein to direct the intake air and to cause the air to move in a rapidly whirling stream, the ends of said slots communicating with said intake chamber.

3. The system of claim 1 in which the yarn inlet to said diffuser is positioned relatively close to the outlet means of said heating oven whereby some of the whirling air stream from the diffuser tends to pass into said oven through the yarn outlet means of said oven;

said first heating oven including means to apply heated air into said yarn heating chamber at an angle extending downwardly from horizontal, whereby the heated air circulates throughout said yarn heating chamber and about the yarn, and whereby the downwardly directed heated air counteracts the cooling effect of the relatively cooler air stream from the diffuser.

4. A yarn false twisting means including a holder to receive a nozzle assembly and to receive and support a diffuser, the holder including a passageway for pressurized air;

said nozzle assembly including upper and lower nozzle elements and a disc, the upper nozzle element comprising a generally cylindrical body having an internal bore, and an undercut at the peripheral edge of the bottom surface defining a peripheral recess and a central contact surface for said disc whereby the lower nozzle body may be received;

the lower nozzle element comprising a generally cylindrical body and having a first narrow vertically oriented passageway defining the guide passageway for said yarn;

the body of the lower nozzle element having a recess in the upper part defining a shell-like wall fitting into said peripheral recess of the upper nozzle element, the bottom of said recess having a central, upwardly extending platform and a nipple extending centrally up from said platform, the nipple including the extending first narrow-vertically-oriented passageway;

an intake air chamber being defined between the platform and the shell-like wall, said intake air chamber being generally below said platform;

a disc, said disc supported on said platform and thereby above said intake air chamber;

a plurality of radial air intake openings in said shell-like wall communicating directly with said intake air chamber;

said disc having a plurality of spaced slots formed therein to direct the intake air, the ends of said slots communicating with said intake chamber.

5. The system of claim 2 in which the disc is substantially circular and the slots thereof terminate within the disc and substantially tangentially oriented.

6. The false twisting means of claim 4 in which the disc is substantially circular and the slots thereof terminate within the disc and are substantially tangentially oriented.

7. The system of claim 1 in which said winding means includes:

two separate rotating chucks,

spools for each chuck,

driving means releaseably movable into drive engagement with said spools,

first yarn guide means including a pair of reciprocable guide means one for each spool to position said yarn for windup relative to said spools,

means to control the position of a second yarn guide above said first guide means, said means including a plurality of positions, said yarn engaging said guide means when the positioning means is in the two outer positions.

8. Yarn winding means including:

two separate rotating chucks;

spools for each chuck;

rotating driving means releaseably linearly movable into drive engagement with said spool;

first yarn guide means including a pair of reciprocable guide means, one for each spool to position said yarn for windup relative to said spools,

means to control the position of a second yarn guide, above said first yarn guide, said means including a plurality of fixed positions, said means being adapted to position said second yarn guide in said fixed positions, said yarn engaging said guide means when the positioning means is in the two outer positions.

9. The system of claim 1 in which said means for supplying yarn at controlled tension and speeds includes means for predrawing the yarn including first and second Godet rolls operating at different speeds, and means to limit the backward twist and prevent yarn entanglement including spaced apart guide elements between which the yarn is unwrapped in conjunction with the second rolls.

10. Means for supplying yarn at controlled tension and speeds includes means for predrawing the yarn including first and second pairs of Godet rolls operating at different speeds, and means to limit the backward twist and prevent yarn entanglement including spaced apart guide elements between which the yarn is unwrapped in a plurality of loops which extend about both said guide element and said second roll.

11. The system of claim 1 in which said oven includes an air chamber separate from said yarn heating chamber, means to supply pressurized air to said chamber, means to heat the air in said heating chamber, and a plurality of narrow restricted passageways coupling said air chamber to said yarn heating chamber and creating thereby wisps of air around said yarns.

12. An oven including a yarn heating chamber and an air chamber separate from said yarn heating chamber, means to supply pressurized air to said chamber, means to heat the air in said heating chamber, and a plurality of narrow restricted passageways coupling said air chamber to said yarn heating chamber terminating in bleed holes which create thereby only wisps of air around said yarns.

13. The system of claim 11 in which said passageways are substantially tangential to the surface of said yarn chamber and extending downwardly at an angle.

14. the oven of claim 12 in which said passageways are substantially tangential to the surface of said yarn chamber and extending downwardly at an angle.

15. The system of claim 1 in which the means for supplying yarn at controlled tension includes first and a second of Godet rolls and separator rolls the second Godet roll moving the yarn at a speed greater than that of the first, thereby predrawing the raw yarn to make yarn stresses more uniform.

16. The system of claim 3 in which said means to apply heated air at an angle extending downwardly includes at least one downwardly directed air passageway communicating with said yarn heating chamber, and means to apply heated air through said air passageway.

17. The system of claim 16 in which said oven includes an air chamber means including means adapted to receive air and an outlet port communicating with said air passageway, said oven having heating means heating the air in said air chamber means.

18. An oven comprising a heat conductive block having at least three separate chambers including:

a yarn heating chamber;

an air chamber bore;

a heat providing chamber;

at least one downwardly directed passageway extending from the air chamber to said yarn heating chamber.

19. The oven in claim 18 in which said air chamber includes a spool having a slightly recessed outer wall, the resulting air chamber being between the spool wall and the walls of the air chamber bore;

a plurality of vertically spaced, downwardly directed passageways extending through said block from ports in the air chamber bore into said yarn chamber;

means to apply air to the air chamber;

a plurality of heat providing chambers, and heating elements positioned in said heat providing chambers.

20. The oven of claim 19, in which said spool has top and bottom flanges closely fitting into said air chamber bore;

a peripheral recess being defined between the top and bottom flanges, the inner wall of the air chamber bore and the spool outer wall, said recess being the peripheral air chamber;

air supply ports coupled to said peripheral air chamber.

21. A nozzle body assembly for use in connection with a false twisting yarn means,

said nozzle body assembly comprising upper and lower body elements,

each body element having a vertically extending yarn passageway,

said body elements having internal recesses along their mating surfaces,

a disc element having circular central aperture and a plurality of slots, terminating within the disc, said slots being spaced apart and arranged substantially along tangents of the aperture,

said body elements including means to support said disc element with the space provided by the said internal recesses;

said body elements having a plurality of air intake openings, said body elements comprising passageways communicating said intake openings with said slots, said passageways being below the disc surface.

22. The nozzle body assembly of claim 21 in which said lower nozzle body is centrally recessed in the upper surface defining a shell-like wall,

said intake openings comprising a plurality of spaced radial holes in said wall,

a platform extending from the bottom of said recess upwardly whereby said disc may be supported thereon,

a nipple extending from said platform upwardly and having a narrow yarn passageway,

said lower nozzle body defining an annular groove between the shell-like wall and the platform, said groove communicating with the outer portion of said slot and said radial holes,

said holes being located below the platform, thereby being under said disc.

23. The nozzle body assembly of claim 22 having a second annular groove adjacent said nipple and platform and communicating with the inner portion of said slot, wall adjacent said second annular groove being the conical surface of said nipple.

24. The nozzle body assembly of claim 23 in which the outer cylindrical wall is recessed to define a vertical air chamber, whereby when said nozzle elements are inserted in a holder, a peripheral air chamber is provided,

said recessed cylindrical wall communicating with said radial holes.

25. The nozzle body assembly of claim 24, in which the upper nozzle element fits over said lower nozzle body and defines a chamber to receive whirling air from the lower nozzle body and disc.

26. The nozzle body assembly of claim 25 in which the bore of the upper nozzle body flares outwardly downwardly, and communicating with the central aperture of said disc.

27. The system of claim 1 in which the means for supplying yarn at controlled tension and speed includes a first drive means receiving said yarn, including a drive Godet roll and a separator roll, driving said yarn at a speed v_1,

and a second, successive drive means driving said yarn at a speed v_2,

and in which said second yarn tension and speed control means includes a drive roll at a speed v_3,

said speeds v_1, v_2, v_3, being related, v_1 being slower than v_2, v_3 being slower than v_2.

28. The system of claim 27 in which said second yarn tension and speed control means includes yarn tension compensator means, to modulate the frictional drag imposed on said yarn.

29. The system of claim 27 in which said yarn compensator includes:

an arm having a plurality of different and selectable torque producing means, and first an second extending pins,

pivot means for pivoting said arm about said second pin,

a disc having extending third and fourth pins, said disc being pivotally mounted at the center thereof to said arm;

said yarn passing over and under the respective series of pins.

30. The system of claim 29 in which said pivot means includes means to rotatably support the said fourth pin,

the center of rotation of said second and fourth pins being offset.

31. The system of claim 30 in which said pivot means includes a collar having a central aperture to receive pin 2 and a peripheral aperture to receive pin (4), and means to adjustably fix the position of said collar, thereby adjustably fixing the positions of pins (2) and (4) and thereby providing initial control of the yarn tension.

32. A yarn tension compensator means including an arm having a plurality of different and selectable torque producing means, and first and second extending pins,

pivot means for pivoting said arm about said second pin,

a disc having extending third and fourth pins, said disc being pivotally mounted at the center thereof and intermediate said first and second pins to said arm;

said yarn passing over and under the respective series of pins.

33. The system of claim 32 in which said pivot means includes means to rotatably support the said fourth pin,

the center of rotation of said second and fourth pins being offset.

34. The system of claim 33 in which said pivot means includes a collar having a central aperture to receive pin 2 and a peripheral aperture to receive pin (4), and means to adjustably fix the position of said collar, thereby adjustably fixing the positions of pins (2) and (4) and thereby providing initial control of the yarn tension.

35. A yarn winding system comprising windup and doffing means including two spaced apart spools positioned on a common axis on which the yarn may be wound, frictional drive means for engaging the spool surfaces, means to selectively move each of the spools out of the drive position whereby the wound package may be removed, chuck means, each of said spools being positioned over respective drive chuck means, each chuck means including a sleeve to support said spools, said chucks having expanding means to expand radially within the spool and frictionally engage said spool and control means for releaseably actuating said expanding means, a rotatable handle, a cam plate fixed to said handle, and a cam surface against which said cam plate bears to control the expansion of said expanding means.

36. The system of claim 35 in which the expansion means comprises a circular coil spring and said sleeve ends and spool center have walls which are at and angle to each other and define a spring receiving receptacle, whereby the movement of the sleeve ends towards each other acts as a wedge to provide radial expansion forces to said springs.

37. A yarn winding system comprising windup and doffing means including two spaced apart spools positioned on a common axis on which the yarn may be wound, frictional drive means for engaging the spool surfaces, means to selectively move each of the spools out of the drive position whereby the wound package may be removed, chuck means, each of said spools being positioned over respective drive chuck means, each chuck means including a sleeve to support said spools, each said sleeve having a central section and two movable

sleeve ends, each said chuck having expansion means positioned between respective sleeve ends and the sleeve body to expand radially within the spool and frictionally engage said spool, means to control the expansion of said expansion means in accordance with the movement of said sleeve ends towards and away from each other, whereby when said sleeve ends are close together said expansion means is expanded to engage the windup spool, and control means for releaseably actuating said expanding means, said expansion means comprises a circular coil spring and said sleeve ends and spool center have walls which are at an angle to each other an define a spring receiving receptacle, whereby the movement of the sleeve ends towards each other acts as a wedge to provide radial expansion forces to said springs.

38. The system of claim **37** in which said rod extends throughout a predetermined distance less than the entire length of said shaft, a spring coupled to said rod and to the other end of said shaft by coupling means, said coupling means also controlling the position of a brake element.

39. The system of claim **37** in which the cam surfaces define three positions of operation (1) nonbraking and spool engagement, (2) braking and spool release, and (3) braking, spool release and locking.

40. The system of claim **39** in which said coupling means includes a pin, said pin being fastened to a brake shoe having a brake disc on the surface thereof, one of said sleeve ends having a transverse, apertured wall through which said shaft passes, said wall defining the braking surface against which said brake disc may bear against, said shaft having a longitudinal slot to accommodate limited movement of said pin.

41. The system of claim **40** including spring means coupled between the carrier assembly of the stationary rod to urge said sleeve end to the closed position to bear against the central sleeve portion.

42. The system of claim **41** in which the wall surface of the sleeve end and the opposing wall surface of the central sleeve body are at an angle to each other, the wall surface of the sleeve body comprising upper and lower angled surfaces and the upper wall surface cooperating with the wall of the sleeve end to provide a wedge and the lower wall surface cooperating with the wall of the sleeve to transmit movement from the sleeve end through the sleeve body to the other wall of the sleeve body and thus to the other sleeve end to provide expansion force to the respective spring between said other sleeve end and sleeve body.

43. The system of claim **7** in which said winding means includes:

plural windup and doffing means including two spaced apart spools positioned on a common axis on which the yarn may be wound, frictional drive means for engaging the spool surfaces, means to selectively move each of the spools out of the drive position whereby the wound package may be removed, chuck means, each of said spools being positioned over respective drive chuck means, each chuck means including a sleeve to support said spools, said chucks having expanding means to expand radially within the spool and frictionally engage said spool and control means for releaseably actuating said expanding means.

44. The system of claim **27**, in which said winding means includes plural windup and doffing means including two spaced apart spools positioned on a common axis on which the yarn may be wound, frictional drive means for engaging the spool surfaces, means to selectively move each of the spools out of the drive position whereby the wound package may be removed, chuck means, each of said spools being positioned over respective drive chuck means, each chuck means including a sleeve to support said spools, said chucks having expanding means to expand radially within the spool and frictionally engage said spool and control means for releaseably actuating said expanding means.

45. A system for texturing yarn for filamentary thermoplastic strand material comprising:

means for supplying yarn at controlled tension and speed;

a first heating oven including a yarn heating chamber having inlet means for receiving said yarn from said supplying means, and including yarn outlet means to allow the yarn to pass out of the oven;

an airjet yarn false twisting means having a nozzle assembly, said assembly having an upper yarn receiving element, a lower element and a disc in between said elements having slots therein to direct the air stream providing a whirling stream to induce twist in said yarn;

an air diffuser having yarn inlet and outlet orifice means, coupled directly to said upper nozzle element, whereby yarn ballooning in said diffuser may occur;

and second yarn tension and speed control means coupled to the lower nozzle element to control the tension and speed of the yarn passing out of the said lower nozzle element.

46. The system of claim **45** including winding means to receive the yarn from the second yarn tension and speed control means and to wind up said yarn on a spool.

47. The system of claim **45** in which the false twisting means includes a holder to receive the nozzle assembly and to receive and support the diffuser, the holder including a passageway for pressurized air;

the upper nozzle element comprising a generally cylindrical body having an internal bore, and an undercut at the peripheral edge of the bottom surface defining a peripheral recess and a central contact surface for said disc whereby the lower nozzle may be received;

the lower nozzle element comprising a generally cylindrical body and having a first narrow vertically oriented passageway defining the guide passageway for said yarn;

the body having a recess in the upper part defining a shell-like wall fitting into said peripheral recess of the upper nozzle element, the bottom of said recess having a central, upwardly extending platform and a nipple extending centrally up from said platform, the nipple including the extending first narrow-vertically oriented passageway;

an intake air chamber being defined between the platform and the shell-like wall, said intake air chamber being generally below said platform;

a disc, said disc supported on said platform, and thereby above said intake air chamber;

a plurality of radial air intake openings in said shell-like wall communicating directly with said intake air chamber;

said disc having a plurality of spaced slots formed therein to direct the intake air and to cause the air to move in a rapidly whirling stream, the ends of said slots communicating with said intake chamber.

48. The system of claim **45** in which the yarn inlet to said diffuser is positioned relatively close to the outlet means of said heating oven whereby some of the whirling air stream from the diffuser tends to pass into said oven through the yarn outlet means of said oven;

said first heating oven including means to apply heated air into said yarn heating chamber at an angle extending downwardly from horizontal, whereby the heated air circulates throughout said yarn heating chamber and about the yarn, and whereby the downwardly directed heated air counteracts the cooling effect of the relatively cooler air stream from the diffuser.

49. The system of claim **46** in which said winding means includes:

two separate rotating chucks,

spools for each chuck,

driving means releasably movable into drive engagement with said spool,

first yarn guide means including a pair of reciprocable guide means one for each spool to position said yarn for windup relative to said spools,

means to control the position of a second yarn guide above said first guide means, said means including a plurality of positions, said yarn engaging said guide means when the positioning means is in the two outer positions.

50. The system of claim **45** in which the means for supplying yarn at controlled tension includes first and a second of Godet rolls and separator rolls, the second Godet roll moving the yarn at a speed greater than that of the first, thereby predrawing the raw yarn to make yarn stresses more uniform.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,650,103 Dated March 21, 1972

Inventor(s) Henry C. Farrar, et. al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 16, cancel lines 61-66; line 67, "37" should read -- 36 -- . The following claim should be inserted as claim 38: 38. The system of claim 36 in which said system includes a central hollow shaft, a rod within said shaft, a stationary support coupled to said shaft and having a carrier means to engage said shaft, a handle coupled to said rod by a second carrier assembly, said carrier assemblies having facing cam surfaces, whereby when said handle is rotated with respect to the support, the rod and shaft move relative to each other in accordance with positions of the cam surface, said sleevebody and sleeve ends being rotatable with respect to said shaft, brake means coupled to said shaft and to said sleeve and control in accordance with the relative position of said rod and shaft, the position of said sleeve ends for providing expansion force also being controlled by the relative positions of said rod and shaft. -- . Column 13, line 37 and column 18, line 31, "vertically oriented" should read -- vertically-oriented -- . Column 16, line 11 and column 17, line 11, "an" should read -- and -- . Column 16, line 47, column 16, line 67, column 17, lines 8 and 49, and column 17, line 62 "wind up" should read -- wind-up -- . Column 17, line 21, "non braking" should read -- non-braking -- .

Signed and sealed this 20th day of March 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents