June 29, 1965 W. W. BUNTING, JR., ETAL 3,191,831

YARN-HANDLING METHOD

Original Filed Dec. 19, 1960 4 Sheets-Sheet 1

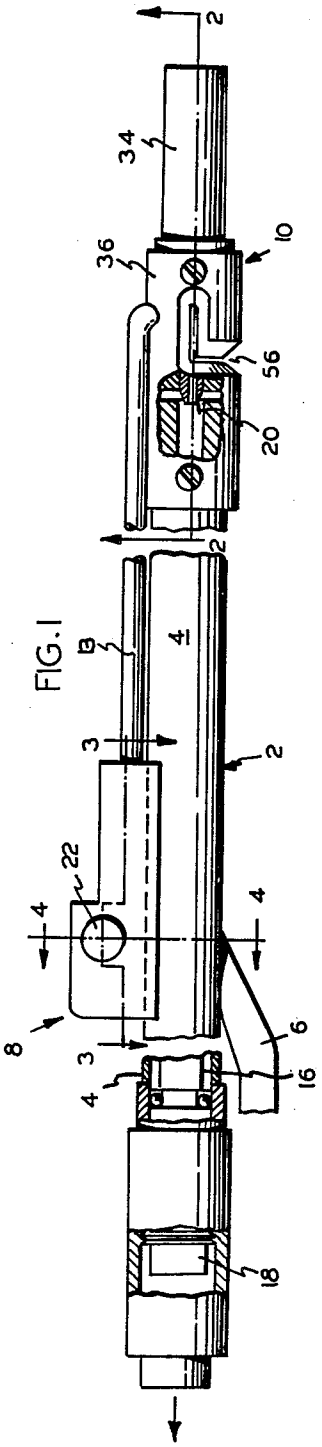


FIG. 1

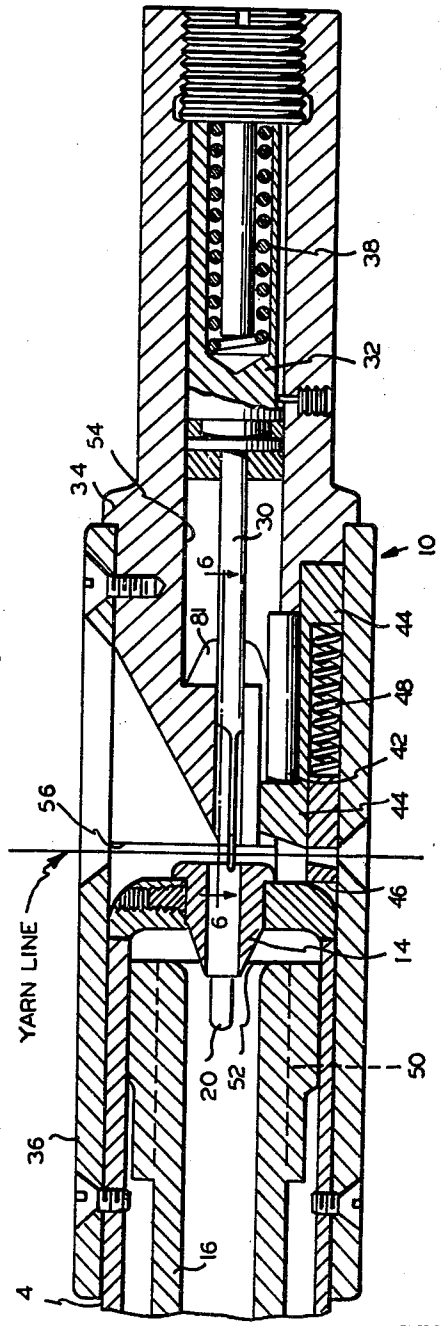


FIG. 2

INVENTORS
WILLIAM WALLAR BUNTING, JR.
ROBERT MEAGHER
KENNETH GILBERT SWAYNE
JOHN PALMER WORK
BY Harry E. Buddlike
ATTORNEY

June 29, 1965 W. W. BUNTING, JR., ETAL 3,191,831

YARN-HANDLING METHOD

Original Filed Dec. 19, 1960 4 Sheets-Sheet 2

FIG.3

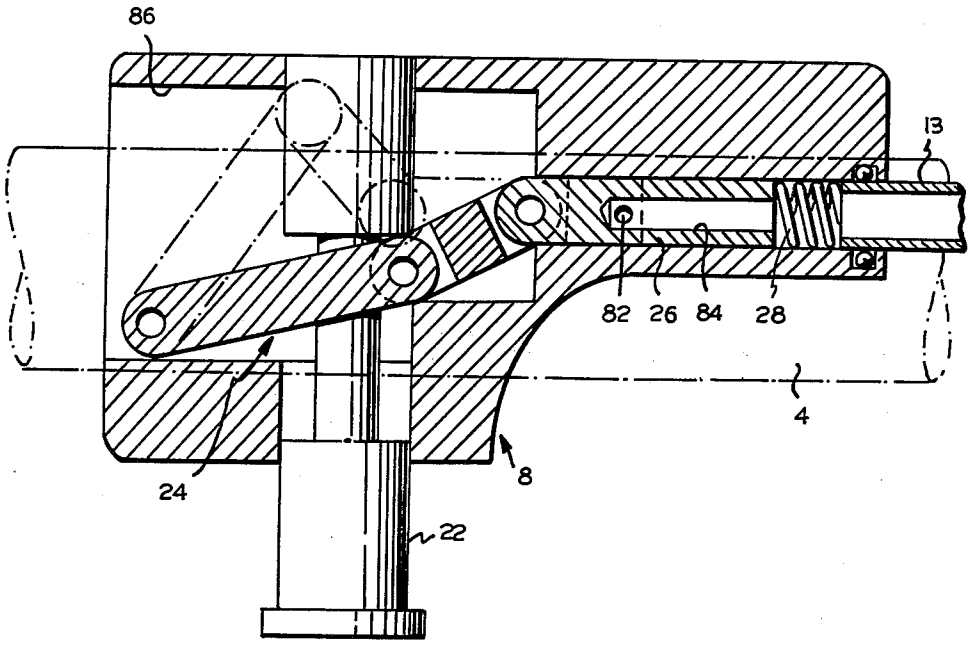
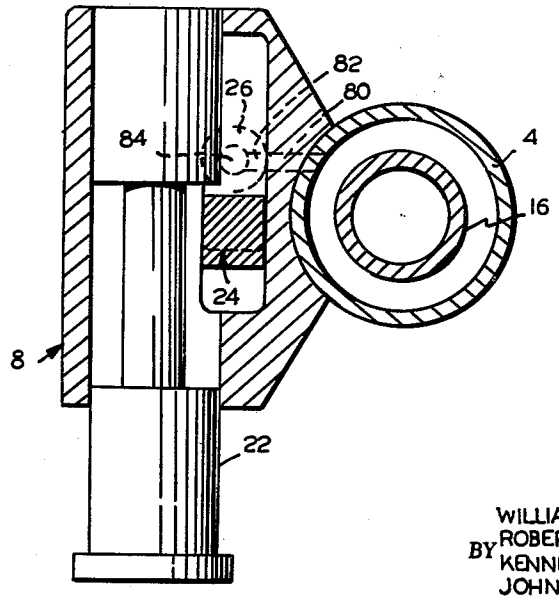


FIG.4



INVENTORS
WILLIAM WALLAR BUNTING, JR.
BY ROBERT MEAGHER,
KENNETH GILBERT SWAYNE
JOHN PALMER WORK
Harry E. Braddock
ATTORNEY

June 29, 1965 W. W. BUNTING, JR., ETAL 3,191,831

YARN-HANDLING METHOD

Original Filed Dec. 19, 1960 4 Sheets-Sheet 3

FIG. 5A

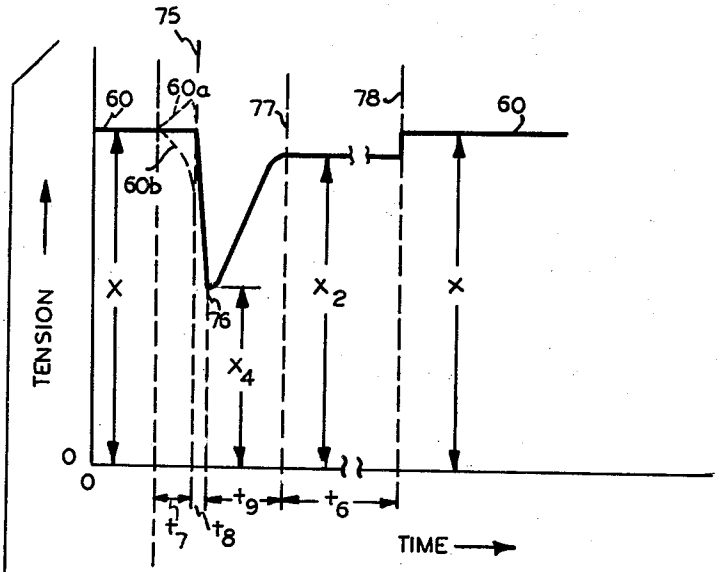
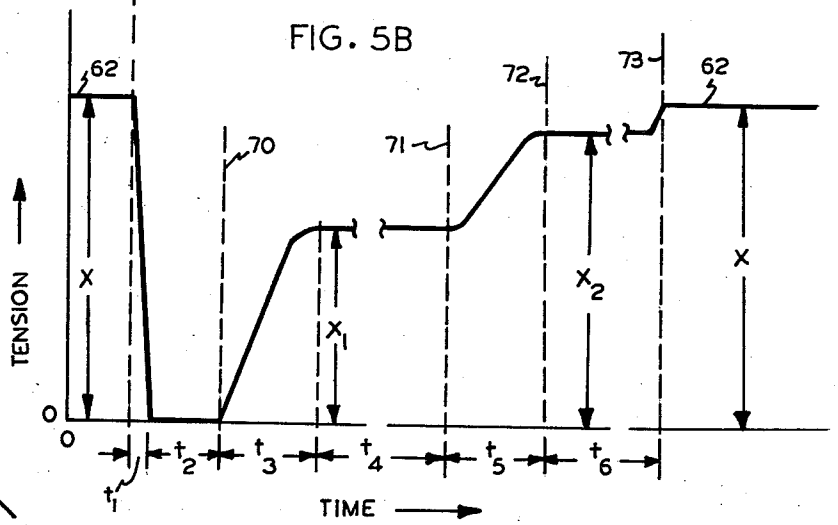


FIG. 5

64

FIG. 5B



INVENTORS
WILLIAM WALLAR BUNTING, JR.
BY ROBERT MEAGHER
KENNETH GILBERT SWAYNE
JOHN PALMER WORK
Harry E. Braddock
ATTORNEY

June 29, 1965 W. W. BUNTING, JR., ETAL 3,191,831

YARN-HANDLING METHOD

Original Filed Dec. 19, 1960 4 Sheets-Sheet 4

FIG.8

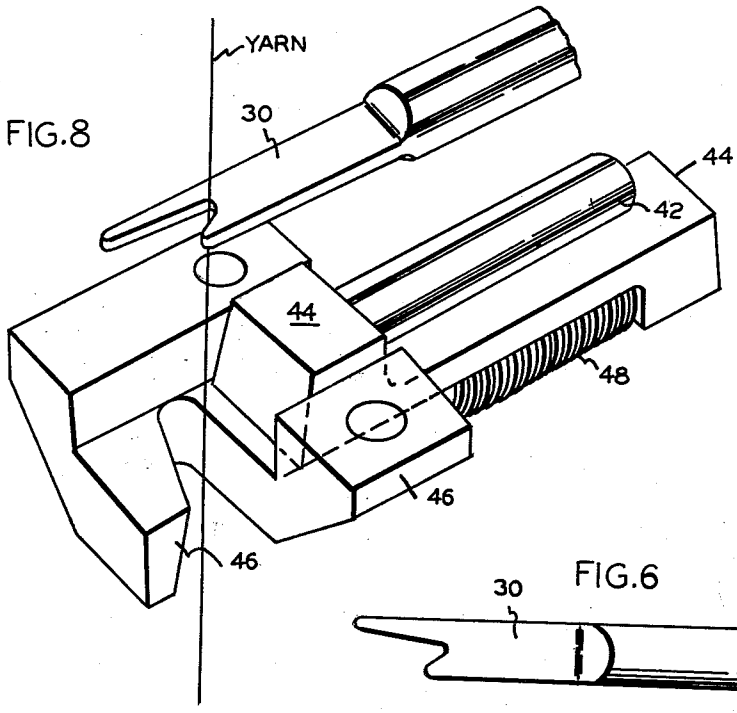


FIG.6

FIG.9

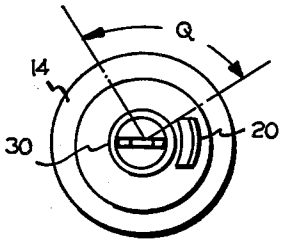
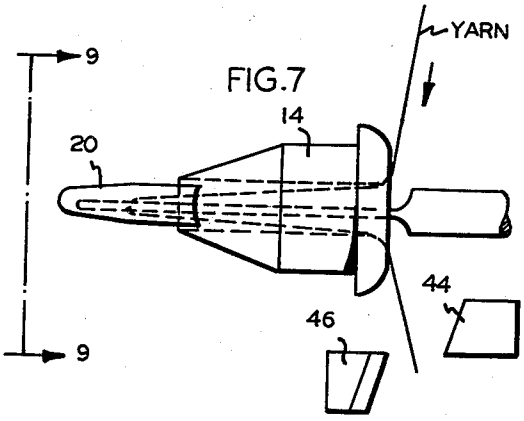


FIG.7



INVENTORS
WILLIAM WALLAR BUNTING, JR.
BY ROBERT MEAGHER
KENNETH GILBERT SWAYNE
JOHN PALMER WORK
Harvey E. Braddock
ATTORNEY

United States Patent Office 3,191,831 Patented June 29, 1965

3,191,831

YARN-HANDLING METHOD

William Wallar Bunting, Jr., Wilmington, Del., Robert Meagher, Wallingford, Pa., Kenneth Gilbert Swayne, Hockessin, Del., and John Palmer Work, Horsham, Pa., assignors to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Original application Dec. 19, 1960, Ser. No. 76,805. Divided and this application Mar. 22, 1962, Ser. No. 181,652

2 Claims. (Cl. 225—4)

This is a division of application Serial No. 76,805, now abandoned.

This invention generally relates to the field of yarn-handling devices and, in particular, to a portable device capable of rapidly picking up a high speed running length of yarn and maintaining the yarn under sufficient tension until it has been transferred to a yarn take-up or winding device.

In handling threads of either natural or synthetic origin, it is frequently desirable that the thread be collected temporarily by an auxiliary device rather than by the regular collecting apparatus. For example, U.S. Patent 2,667,964 to Miller describes such a conventional yarn-handling device. This invention is considered to be an improvement in devices of the Miller type.

In the processing of synthetic threads, it is quite important in many operations that adequate tension be maintained at all times, even when transferring the yarn from one collection point to another such as when doffing; it is also important that yarn tension should not be permitted to remain at a reduced level for a long period of time, but tension drops of extremely short duration may be acceptable. When a device similar to the Miller patent, first engages a running length of yarn, it picks up the yarn by generation of sufficient suction. Due to the nature of such devices this necessarily means that the tension that can be applied to the yarn at the time of yarn pickup is appreciably reduced, frequently reaching zero tension for appreciable periods of time. However, when the yarn has been engaged and is moving into the device, tension can then be increased, by an adjustment, to the desired level to maintain the necessary yarn velocity. However, in many fast-running processes, i.e., where the yarn is running at very high speeds, e.g., 2,000 to 3,000 yards per minute, this momentary decrease in tension during yarn pickup is sufficient to cause serious problems including yarn break-down in the upstream processing equipment.

It is an object of this invention to provide an improved, efficient yarn-handling device capable of picking up a high-speed running length of yarn very rapidly while maintaining adequate yarn tension during the cut and pickup periods and during the subsequent transfer of the running end of yarn to a windup or other device.

Another object is the provision of an improved yarn-handling device which can handle efficiently and reliably yarns moving at extremely high speeds, e.g., 2,000 to 3,000 yards per minute without the need for the conventional adjustment from high suction-low tension to the low suction-high tension condition of operations.

Another object is the achievement of successive or simultaneous pickup and handling of a plurality of high-speed running threadlines such that the threadlines may be successively or simultaneously strung to one or more winding devices or other devices.

It is a further object of this invention to provide an improved yarn-handling device which is simple in construction, easy to produce and maintain, yet efficient in operation.

Other objects will become apparent from the description hereinafter.

The aforementioned objects are accomplished by the provision of a novel, improved, portable yarn-handling device comprising in combination an air inlet tube; a yarn inlet tube; an air outlet tube; a passageway connecting the air inlet tube to the air outlet tube; the yarn inlet tube and the air outlet tube positioned to form an annular orifice; means to rapidly physically move the running yarn into and through the yarn inlet tube; and means for severing the yarn line, the yarn inlet tube and the air outlet tube forming the passageway for the yarn through the device. In addition, the configuration of the annular orifice and the outlet tube are such that air flow conditions are produced which insure maximum tension on the yarn.

Other objects and advantages will appear from a consideration of the specification, the claims and the accompanying drawings in which:

FIGURE 1 is a side elevational view of the improved device of this invention with certain parts broken away and shown partially in section;

FIGURE 2 is a partial longitudinal cross-sectional view taken at line 2—2 of FIGURE 1;

FIGURE 3 is a partial longitudinal cross-sectional view taken at line 3—3 of FIGURE 1;

FIGURE 4 is a transverse cross-sectional view taken at line 4—4 of FIGURE 1;

FIGURE 5 is a graphical representation of the variation in yarn tension vs. time for two types of yarn-handling devices, one conventional and one embodying features of the present invention;

FIGURE 6 is a plan view of the tip of a push-rod taken along line 6—6 of FIGURE 2;

FIGURE 7 is partial cross-sectional view of the yarn inlet tube, the push-rod, and the yarn after the pushrod has moved the yarn beyond the downstream end of the yarn inlet tube but before the yarn has been cut.

FIGURE 8 is an isometric view of the yarn cutter portion of the yarn-handling device of FIGURES 1 and 2; and

FIGURE 9 is an end view of the yarn inlet tube assembly taken from line 9—9 of FIGURE 7.

The portable yarn-handling device 2 comprises an air inlet tube 4 which forms the main body of the device. Mounted externally on tube 4 is the air supply tube 6 which is connected to tube 4, valve assembly 8, and push-rod assembly 10. Conduit tube 13 transmits air from the interior of tube 4 and the valve assembly 8 to the push-rod assembly 10. At the inlet end of tube 4 is secured, by suitable means, yarn inlet tube 14. Mounted inside inlet tube 4 is outlet tube 16. The position of the outlet tube 16 with respect to inlet tube 14 is adjusted by the threaded mounting and lock-bushing 18. A projecting elongated tab element 20 is mounted on the end of the yarn inlet tube 14 and extends into annular orifice 52 formed between the inlet end of the outlet tube 16 and the tapered outer section of the end of yarn inlet tube 14. This tab element is secured to yarn inlet tube 14 off-center, as shown. Element 20 serves to increase the tension which may be exerted on the yarn by reason of the high degree of agitation, a turbulence that is induced in the fluid stream by the tab element; this is particularly true when handling highly coherent multi-filament yarns, especially when wet or coated with finish or the like.

Valve assembly 8 comprises push button 22, linkage 24, and valve 26 which is biased by spring 28. This assembly selectively controls the flow of air in inlet tube 4 to the push-rod assembly. The valve 26 is provided with an axial passage 84 which intersects a radial valve passage 82. When the valve 26 is in the position shown in FIGURE 3, the radial valve passage 82 is in alignment with

a radial passage 80 (shown in FIGURE 4) in the air inlet tube 4, when the linkage 24 is moved to the position shown by the broken lines, the radial valve passage 82 communicates with the atmosphere through the open portion 86 in valve assembly 8. Tube 13 is coaxial with the bore of valve assembly 8 and abuts the end of spring 28; the tube 13 is sealed to the body of the valve 8 by means of an O ring.

Push-rod assembly 10 comprises push-rod 30 mounted on piston 32 which slides in tubular housing 34; the tip of the push-rod, as shown in FIGURE 6, is bifurcated. Housing 34 is attached to air inlet tube 4 by bushing 36. Piston 32 is biased toward the yarn inlet tube by spring 38. Also mounted in housing 34 and bushing 36 is a cutter assembly, shown in FIGURE 8, which comprises slidable push-pin 42, movable knife element 44, stationary knife element 46, and movable knife element biasing spring 48.

In operation, compressed air at elevated pressure is supplied through tube 6 and fills the annular space between the interior of air inlet tube 4 and the exterior of outlet tube 16 and flows through the ribbed section 50 of outlet tube 16 through the annular orifice 52 created between the bore of outlet tube 16 and the tapered outer section of the yarn inlet tube 14 and thence down the bore of outlet tube 16. High pressure air is also brought to valve element 26 through radial passage 80 in air inlet tube 4 (FIGURE 4). In addition, a slight outward flow of air exists through yarn inlet tube 14. Outlet tube 16 is so positioned by means of a threaded connection and locked with lock-bushing 18 that annular orifice 52, together with outlet tube 16, create and maintain air flow conditions which cause maximum tension on the moving threadline through the device 2. Normally, valve 26 is positioned so that the air pressure is supplied through radial passage 80, radial valve passage 82, axial valve passage 84 and thence through tube 13 and opening 81 into the space 54 in tubular housing 34 and acts against piston 32 forcing it to the open position and compressing spring 38. When push button 22 is depressed, linkage 24 operates valve 26 and connects space 54 to the atmosphere, thus suddenly releasing the air pressure therein. Spring 38 rapidly moves push-rod 30 to the left shifting the hooked end of the rod from its initial position adjacent the opening 56 in bushing 36 to a second position beyond the inner end of the yarn inlet tube preferably before the yarn is cut. Release of the push button 22 causes air pressure to build up again in space 54 to return the push rod and piston to their starting or "loaded" positions. In the preferred embodiment of this invention the yarn is guided to pass through the quadrant Q (FIGURE 9) adjacent the edge of the tab element that is more or less parallel to the centerline of the device. A running yarn line entering the device should be free of the push-rod. The tang of the push-rod is preferably off the centerline of the device.

In operation the operator positions the yarn-handling tool 2 such that the moving yarn line is caught into opening or gap 56 and runs therethrough. He then depresses push button 22 and as previously described, the release of the air pressure on piston 32 enables spring 38 to move push-rod 30 so that within a fraction of a second, the push-rod 30 thrusts the moving yarn into and completely through the bore of yarn inlet tube 14 such that the end of push-rod 30 is situated in the region of the high velocity fluid stream as shown in FIGURE 7; the portion of the yarn which extends around the tip of the push-rod is likewise exposed to the high velocity fluid stream about the time the yarn is cut; the amount of exposure of the yarn is ¼ inch or more. Near the end of the stroke of the push-rod, piston 32 contacts slidable pin 42 which in turn drives the movable blade element 44 across stationary blade 46, to sever the yarn line. Since the yarn line is now cut and being supplied from a continuous source, the yarn continues to move through the device 2 without a detrimental loss of tension. Since the annular orifice 52 is adjusted to a high yarn tension condition, the yarn has this tension applied to it almost instantaneously. Therefore, if a drop in yarn tension occurs, tension recovery will be rapid, occurring in a fraction of a second. This is a great improvement over previous yarn-handling devices, particularly those requiring two positions, one of minimum tension-maximum secondary air velocity for initial string-up and a second position of maximum tension-minimum suction for yarn handling.

In the preferred embodiment of this invention the annular orifice is so constructed and arranged, and the outlet tube is of such a configuration that supersonic air flow may be established in the vicinity of the orifice and extremely high air velocity is maintained substantially throughout the outlet tube. Beyond the orifice, outlet tube 16 is of substantially constant cross section, preferably slightly divergent and generally conical in shape wherein the cone included angle may be about fifteen minutes to one degree but preferably is in the range of fifteen to forty-five minutes.

FIGURE 5 shows a comparative graphical representation of yarn tension versus time; FIGURE 5A, curve 60, showing yarn tension versus time for the one-position device of this invention and FIGURE 5B, curve 62, showing yarn tension versus time for a two-position prior art device such as Miller Patent 2,667,964. At zero time, both devices are ready for acting upon a running yarn line and, for purposes of this discussion, it is assumed that the "process" tension X in the undisturbed running yarn line is identical for both cases since this "process" tension X derives from the means for advancing the yarn line (not shown) which means is (at this stage of operations) wholly independent of the two yarn-handling devices. At some time after time zero the yarn-handling devices are manually brought into appropriate position in respect to the running yarn line and, at the time indicated by line 64, string-up of the yarn into either device is undertaken by the operator; from this time onward the behavior and characteristics of the two devices is quite different and hence each will be described separately.

Consider first the prior art device FIGURE 5B, curve 62. The operator manually sets the device for maximum suction then, at time 64, he cuts the running yarn at a point slightly downstream of the device whereupon tension in the yarn line drops extremely abruptly (time period t_1) to substantially zero, remaining at zero for a finite time period t_2 which generally amounts to about 10 to 20 milliseconds but may range up to 300 milliseconds; during this time period t_2, suction draws ambient air and the cut end of the yarn into the secondary air and yarn inlet tube, causing the yarn to be carried therethrough. In some cases a loop of yarn will be drawn into the secondary air and yarn inlet tube depending on how far downstream of the device the operator cut the yarn. At the end of the time period t_2 shown by line 70, the leading or cut end of yarn has advanced to a point just beyond the end of the secondary air and yarn inlet tube to a point where it can be acted upon by the higher velocity air entering through the annular space between the secondary air and yarn inlet tube and the outlet tube; yarn tension will start to increase as seen in the portion of the curve beyond line 70, then as the leading end of the yarn moves more deeply into the outlet tube the air exerts progressively more tension on the yarn as depicted by the rising curve 62 in the time interval t_3. At the end of the time interval t_3 when the leading end of the yarn has traveled the full length of the outlet tube, the yarn will be running at a tension X_1 which tension is lower than the maximum (X_2) since at this stage the device remains set at the maximum suction condition. When the operator observes or comprehends that he has successfully introduced the yarn into the device (which latter may not always occur on the first attempt) he acts to cause the device to shift from the maximum suction condition to

the maximum air velocity or yarn tension condition. His comprehension time is shown as t_4 and may be in the order of a few tenths of a second to several seconds; he initiates the shift at the time indicated by line **71** which shift is complete in the time interval t_5 terminating at line **72**; in the period t_5, which is in the order of 100 milliseconds depending on the mechanical design of the device (i.e., size of piston, air pressure, friction, etc.), tension in the yarn line increases as shown by curve **62** until at time **72** tension reaches a new (or maximum) level X_2 which is markedly higher than X_1; thereafter, the operator manually transports the device and the high tension (X_2) running yarn line to a point where it is strung-up to the next processing element such as a windup device; at the time of such string-up depicted at line **73**, yarn entering the yarn-handling device breaks or is manually cut whereupon tension reverts to the "process" tension X which originally prevailed and the operation is complete.

In the above described prior art device it will be recognized that the danger periods are those during which zero tension exists in the yarn line (t_2) or reduced tension exists in the yarn line (t_3 and t_4) for it is during these periods that the yarn line may become slack with the consequence that back-wraps or other malfunctions may occur on processing elements immediately upstream of the yarn-handling device. When only one of a plurality of yarn ends is being handled a reduction in tension to zero is particularly bad since even a slight wavering of that one yarn line is apt to result in a snarl and back-wrapping of all of the plurality of yarn ends.

Referring to FIGURE 5A, curve **60**, it will be recalled that string-up of the yarn into the device of this invention is undertaken at the time indicated by line **64**; the undisturbed yarn line is running through the opening or slot **56** and at that time (line **64**) the operator depresses push button **22** which, in effect, causes the end of the push-rod **30** to move across the slot **56**, engaging the running yarn, the end of the push-rod then moving into and through the bore of the yarn inlet tube **14**. Transport of the running yarn into and all of the way through the yarn inlet tube occurs in the time interval t_7; during this period yarn tension is shown on curve **60** as being constant; however, depending on many factors, the tension may rise momentarily as shown by the broken line **60***a* or may fall as shown by broken line **60***b*; these factors include initial speed of yarn travel, initial tension X, friction between the yarn and any surface over which it now travels, the speed (or acceleration) of the push-rod **30**, etc. In any case, the tip of the push-rod continues its travel through and beyond the downstream end of inlet tube **14**; when the push-rod thrusts the yarn to a point at least an ⅛ inch beyond the downstream end of the inlet tube **14**, and before the push-rod has started to decelerate, the knife blades **44** and **46** co-act to cut the yarn at a point below or downstream of the portion of the yarn in the inlet tube **14**, the cut occurring at the time shown by line **75**; in the succeeding and very short time interval t_8 tension in the yarn line upstream of the device of this invention may drop abruptly to a new level X_4, but does not drop to zero by virtue of the exposure of a portion of the yarn to high velocity, agitated air. The portion of the yarn which is exposed to the high velocity agitated air just down stream of the annular orifice **52** is acted upon by that air such that, at the time indicated by line **76**, yarn tension will begin to exceed the tension X_4 to which it had momentarily been subjected. Thereafter, in the fashion of the prior art devices, progressively greater tension is exerted on the yarn as depicted by the rising portion of the curve **60** in the time interval t_9 except, unlike the prior art devices, the tension instead of having to rise from zero, rises from a finite value X_4. The magnitude of the time interval t_9 is 10 to 15 milliseconds. At the end of the time interval t_9 when the leading end of the yarn has traveled the full length of the outlet tube **16**, the yarn will be running at a tension X_2. The operator observes that string-up of the device has occurred and he proceeds to move the device and the yarn to the apparatus to be strung-up accomplishing this latter at the time shown by line **78** whereupon tension again reverts to the "process" tension X which prevailed at the outset and the operation is complete.

Throughout the foregoing discussion of yarn tensions and in the curves **60** and **62** the maximum tension of which either of the devices is assumed to be capable is shown by X_2 being depicted as less than the "process" tension X; this is not necessarily the case, for the maximum tension X_2 could be greater than or equal to the "process" tension X. In the case of the device of this invention the maximum tension X_2 could be substantially greater than the "process" tension and substantially greater than the maximum tension capability of the prior art devices by virtue of the turbulence produced by the tab element **20**.

An additional point of distinction between this invention and the prior art devices is that at the initial instant of entry of the leading end of the yarn into a high velocity fluid stream, the yarn is immediately exposed to a fluid moving at a velocity substantially greater than is the case with the prior art devices, preferably at the supersonic levels. This means that, as the fluid stream begins to act upon the yarn in this invention, the force on the yarn and consequently its tension will be greater.

It should be noted that both of the curves **60** and **62** are shown as discontinuous in the regions indicated by time intervals t_4 and t_6; the reason for this is that these time intervals are grossly greater (that is, out of scale) with respect to other time intervals shown in the curves such as, t_1,t_2, t_3, t_5, t_7, t_8, and t_9.

Referring to FIGURE 5A, curve **60**, the tension X_4 occurring in the yarn at the instant at which it is cut is shown as being approximately one-half of the maximum tension X_2 of which the device is capable; this tension need not necessarily be one-half of X_2 but could range from 0.1 to 0.5 of X_2. The minimum yarn tension X_4 which occurs in the device of this invention is primarily a function of the extent (or length) of exposure of the yarn to the highly agitated fluid stream at the instant at which the yarn is cut; to a lesser degree the minimum tension that is reached is a function of the rate of feed-in of the yarn, the degree of restraint offered by the upstream yarn feed-in device as well as yarn-to-guide friction, windage, yarn denier, and number of filaments.

It has been determined that if the push-rod **30** is accelerated at a sufficient rate by spring **38** as compared with the yarn velocity and characteristics, the action of the rod on the yarn is sufficient to cause it to be severed in the vicinity of the push-rod but in the outgoing portion of the yarn line and in such a manner that a separate cutter device is not necessary.

It will be clear that a novel and improved yarn-handling device has been provided, one which is capable of not only maintaining yarn tension levels above those attainable by conventional devices, but which also very rapidly engages and picks up a running yarn line with a very rapid action while effectively minimizing drops in the yarn line tension. The improved action of the new device provides substantial benefits in the production of commercial yarns.

While a preferred embodiment of the improved device has been described in detail in accordance with the patent statute, modifications will occur to those skilled in the art. Accordingly, the invention is intended to be limited only by the scope of the following claims.

We claim:

1. An improved method of engaging a running yarn line, severing said yarn line, and applying tension to the incoming end of the severed yarn line, comprising the steps of creating and maintaining in a given zone a moving stream of high velocity air directed substantially along a desired line of movement of the yarn line, supporting a tensioned running yarn line in intersecting relationship

to said line of movement in close proximity to said stream, and substantially simultaneously physically rapidly deflecting said running yarn line into said stream adjacent one end thereof and severing the yarn in the vicinity of the point of deflection in the outgoing portion of the running yarn line so that the incoming portion of said running yarn line is abruptly shifted into and engaged by said air stream without a significant drop in the tension of the incoming portion of the yarn line.

2. The improved method of claim 1 in which the rate of physical deflection of the running yarn line is so great with respect to the velocity of the yarn line and the extensibility of the yarn line that the effects of the deflection action itself are independently sufficient to sever the yarn line and permit engagement of the incoming portion by said stream.

References Cited by the Examiner

UNITED STATES PATENTS

2,389,376	11/45	Mandin	83—587
2,621,391	12/52	Hoffman	226—97
2,644,645	7/53	Bevenio	83—574
3,090,268	5/63	Edwards	83—913 X

FOREIGN PATENTS

809,471	2/59	Great Britain.
543,093	5/56	Italy.

ANDREW R. JUHASZ, *Primary Examiner.*

CARL W. TOMLIN, WILLIAM W. DYER, JR, *Examiners.*