

[54] **PROCESS AND APPARATUS FOR
MAINTAINING CONSTANT THREAD
TENSION**

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[57] **ABSTRACT**

The process and an apparatus for maintaining a constant thread tension is disclosed for feeding a thread to a processing textile machine. A constant air stream is blown against the thread to form a thread loop having an apex. The displacement of the loop apex resulting from thread speed fluctuations is monitored. The amount of displacement of the loop apex is used as an adjusting value for the regulation of the thread supply. The blowing operation is effected within an open ended elongated channel. Means providing at least two light barriers which extend in a direction across the path of movement for the apex of the thread loop within the air channel are used to effectuate the monitoring step. Means associated with the light barriers are used to regulate the supply of thread along its path of movement through the air channel to the processing textile machine.

12 Claims, 5 Drawing Figures

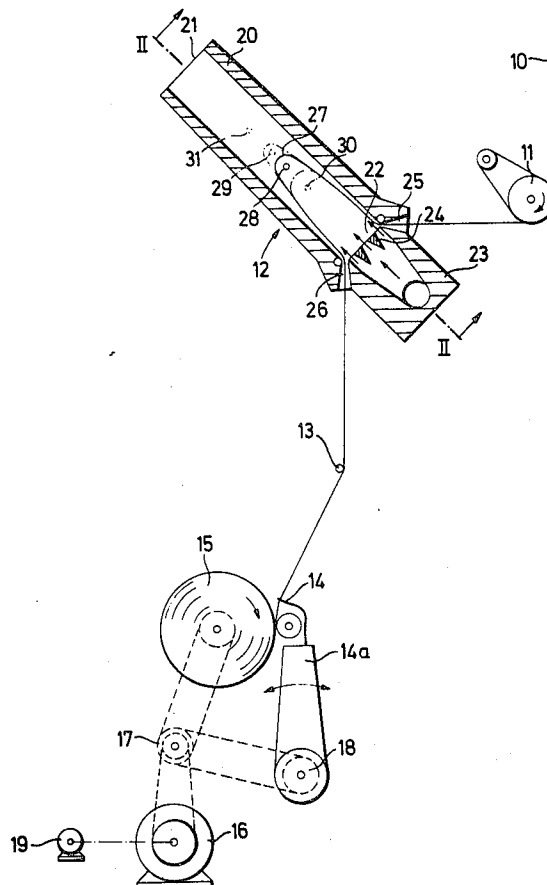
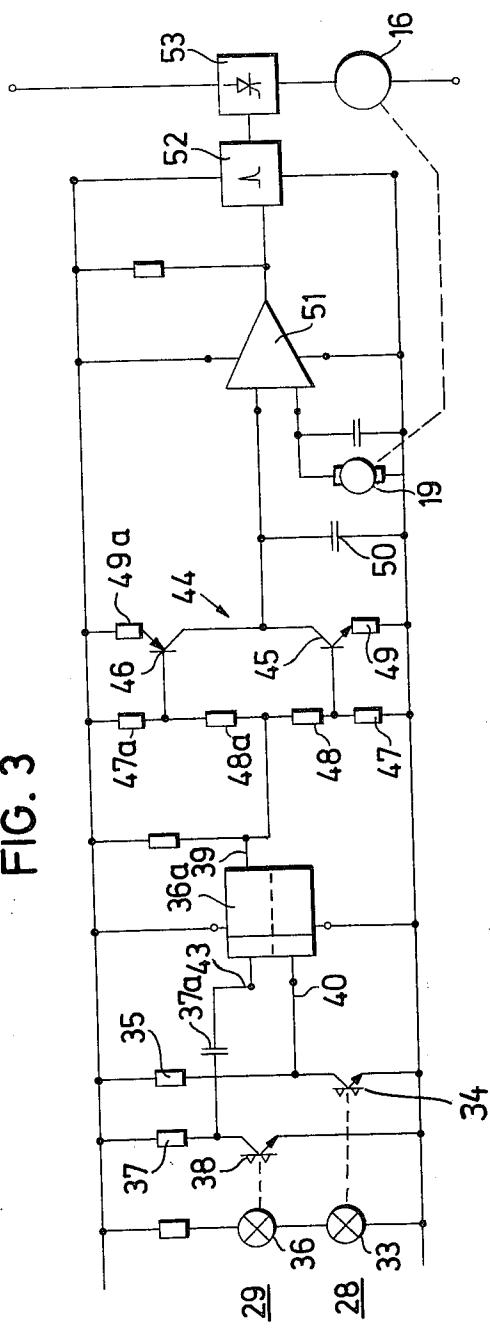
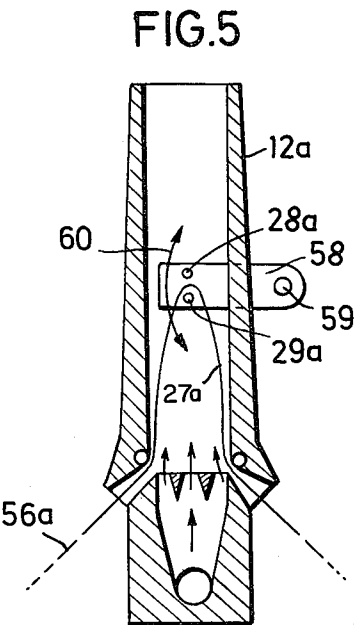
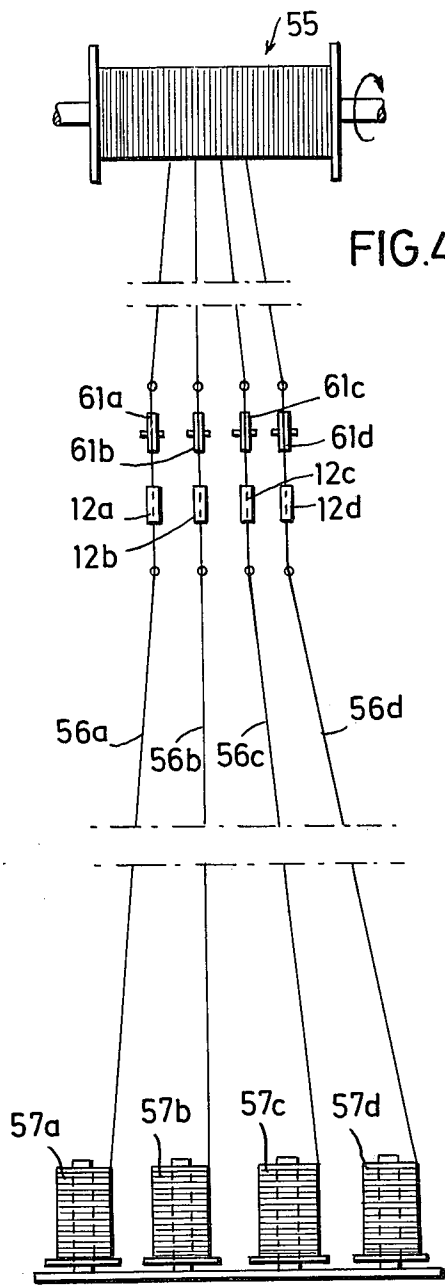


FIG. 3





PROCESS AND APPARATUS FOR MAINTAINING CONSTANT THREAD TENSION

SUMMARY OF THE INVENTION

The invention relates to a process and an apparatus 5 for maintaining constant thread tension while the thread is being fed to a textile processing machine such as a winding machine and the like.

It is extremely important that the thread tension of thread being fed into a textile machine remain constant 10 during the operation of the textile machine. This is particularly true with textile machines where one of several threads are being fed at the same time such as in winding machines for the production of thread windings of different types. Constant thread tension is applicable to transverse spool machines and the like in which fluctuations of the thread tension of the thread being fed occur due to the working process. It is also important to maintain constant thread tension in machines actually working under a constant thread speed 15 in which, however, due to other influences such as friction, differences during the rerouting of the individual threads and the like, the thread may change speed.

To permit a constant thread speed during such an operation, it is known to use the thread tension of a thread 20 guided in a loop as a measured variable for the actuation of the control and adjusting device of a thread feeding assembly. Such a prior art apparatus is known as a dancing lever unit. In the dancing lever unit, the thread is guided at the outer end of the dancing lever about a guide pin or a guide roller with a looping angle of about 180°. A counter force is used to retain the thread loop resulting from a predetermined thread tension. Weights or adjustable tension springs are used as a counter force. However, the restoring moment may be effected electromagnetically or the like. The actual 25 value of the thread tension is covered by the dancing lever. Fluctuations resulting from the dancing lever are corrective values for the control system so that the ratio of the thread speed at the supply point of the processing machine to the thread feeding speed may be kept constant subject to the thread tension adjusted at the dancing lever.

The dancing arm is a guide element with mass and its dynamic inertia is so great that it cannot cover short-time thread tension fluctuations. The guide roller provided at the end of the dancing lever is a body rotating with a high speed and due to its moment of inertia, it cannot react on short-time changes of the thread speed. Moreover, friction at the guide rollers or at the guide 30 pin of the dancing lever do not permit small thread tensions with high thread speeds. Above all, with transverse spool machines, short-time thread speed variations occur at the turning points of the winding assembly so that considerable thread tension peaks may be caused while the inert dancing lever does not react.

In other winding machines, the thread is guided to and fro in an oscillating motion from a stationary supply point to the spool. With these machines it is necessary to compensate for a large distance existing 35 between the stationary supply point and the spool. In other words, there must be established a considerable length for the so-called thread triangle in order to reduce thread tension peak at the turning points. As a result thereof, the building height of the machine is considerable. It is extremely important to keep the thread tension constant during the feeding of the filament to

the processing machine because changes of the thread tension will adversely influence the final product being produced.

PURPOSE OF THE INVENTION

The primary object of the invention is to provide a method and an apparatus for maintaining a constant thread tension during the feeding of a thread to a processing machine with a high sensitivity for the control 5 of the adjustment.

Another object of this invention is to provide a method and apparatus which easily and safely covers short time fluctuations of the thread speed having an effect on the thread tension.

A further object of this invention is to use a thread 10 guided in a loop wherein the change of the loop length is a major variable for operation of a control or adjusting device of the thread supply assembly.

A further object of this invention is to provide a mechanism for maintaining constant thread tension 15 through the use of a substantially massless operation.

SUMMARY OF THE INVENTION

These objects and other advantages are accomplished through the use of the process and apparatus as disclosed herein. The thread loop is formed by blowing the thread being fed with a constant air stream. Contactless scanning elements providing light barriers are used to monitor the displacement of the loop apex 20 resulting from thread tension fluctuations. The displacement of the loop apex is used as corrective value for the adjustment of the thread supply assembly.

An apparatus made in accordance with this invention includes an open-ended channel housing forming a channel having a long extension. An inlet aperture and an outlet aperture are provided at the end of the channel housing opposite the open end. The thread passes 25 into the inlet aperture through the open-ended channel and out of the outlet aperture. Means is provided for establishing an air stream between the inlet and outlet apertures and against the thread so that a loop is formed in the thread. The apex of the loop is located within the channel. At least two consecutive light barriers or the like are provided within the area of the loop apex of the thread. The light barriers are connected 30 with a control device for a supply assembly which supplies the thread to the processing machines. The channel housing or walls may consist of transparent material thus permitting observation at any time of the loop and the position of the reversing arc or apex of the loop.

A thread delivery unit to be controlled may be provided before the blowing device so that it feeds a thread 35 at a constant speed. It is also possible to have the control assembly act on a thread delivery unit located behind the blowing device.

Another feature of the invention is directed to the manner in which the desired supply control is effected. Each time the reversing arc of the loop apex passes through the light barriers, an electrical signal is applied to separate inputs of a trigger step circuit which always stores the last signal up to the receipt of the next signal. The outlet end of the trigger step circuit may be 40 connected with a circuit at the output of which a voltage or voltage change subject to the impulse scanning ratio of the impulse signal sequence generated at the trigger step circuit is caused.

It is necessary for such a control that the reversing arc of the thread loop constantly moves to and fro between the two light barriers. The adjustment is made in such a way that the thread tension differences caused due to the movement of the setting device, will allow the signal points to pass about a reversing arc of the loop so that during one working cycle of the setting device, both signal points are normally surpassed. As a consequence thereof, there is created a constant impulse sequence, the scanning ratio of which, i.e. the ratio impulse: impulse interval, may be used to control a thread delivery unit. The evaluation of the scanning ratio is carried out with the integration step generating a direct voltage in accordance with the effective value of the impulse sequence.

In cases where the thread tension in the processing machine is constant from the beginning, the blowing device for the control and adjustment of the constant thread tension may be used in such a way that the light barriers commonly oscillate to and fro. The change of length of the thread loop otherwise achieved is replaced by the oscillation or swing of the light barriers within a predetermined area to permit operation with the control device. It is also possible to generate artificial thread fluctuations which are constant, e.g.

The control circuit may be designed as an integration step with a condenser chargeable via a first electronic switch and a resistance dischargeable via a second electronic switch and a resistance. Both of the electronic switches are controlled from the output end of the trigger step circuit. In other words, the condenser is charged during the time when the pulses are generated by the trigger step while it is discharged for the remaining time or vice versa. The charging time constant and the discharging time constant are large relative to a period of movement of the setting device and, consequently, large with respect to the pulse frequency expected normally. This is necessary to ensure that no complete discharge of the condenser takes place between two pulses.

The output signal of the integration step and a signal corresponding to the speed of the delivery unit or to the spool respectively are connected to the inputs of a differential amplifier which, optionally via a power amplifier, controls the drive motor of the spool or the like. The output voltage of the integration step, the change of which is a measure for the mechanical thread tension, is compared to the output voltage of the tachogenerator. The differential signal controls the drive motor.

BRIEF DESCRIPTION OF DRAWINGS

Other objects of this invention will appear in the following description and appended claims, reference being made to the accompanying drawings forming a part of the specification wherein like reference characters designate corresponding parts in the several views.

FIG. 1 is a schematic sectional view of the thread travel through a blowing device to a winding device in accordance with this invention,

FIG. 2 is a sectional view along line II—II of the blow device of FIG. 1,

FIG. 3 is a schematic circuit diagram of the controller used with a device made in accordance with this invention,

FIG. 4 is a plan view of a further application of the invention, and

FIG. 5 is a schematic cross-sectional view of another embodiment of a blowing device made in accordance with this invention.

DESCRIPTION OF SPECIFIC EMBODIMENTS

More specifically, referring to the drawings, a constant tension blowing apparatus, generally designated 12, is used to determine and adjust the tension of the thread 10 being supplied at a constant speed from a motor driven pulley 11. The thread 10 passes through the constant tension device 12 over the guide pin 13 and thread guide 14 and is wound up on spool 15. Spool 15 is driven by the motor 16 by way of the gear 17 which also drives the thread roller 18 causing the control of the thread guide 14 which has an oscillating to and fro movement. The direction of the oscillating movement of thread guide 14 is transverse to the direction in which the axis of the spool 15 extends. The speed of movement for the thread guide 14 is subject to the speed of the spool 15 due to the coupling via the gear 17.

In this specific embodiment, the assembly 12 includes a housing 20 forming a channel with a rectangular cross-section and having an opening 21 at the front side thereof. At the other end of the channel housing 20 is an aperture 22 into which is blown an air stream from an air supply 23 by a nozzle-shaped outlet aperture 24. Openings 25 and 26 are disposed at the narrow sides of the channel housing 20 to feed and remove thread 10 as shown in FIG. 1.

The thread 10 enters directly into the channel 20 near the outlet apertures 24. A loop is formed in the thread 10 by making a reverse arc 27 of 180°. Thread 10 runs out of the channel housing 20 through the opening 26 at the other narrow side thereof near the outlet apertures 24. The thread 10 then goes to a subsequent processing machine, e.g. a winding machine, by way of guide pin 13. If desired, a brake mechanism can be intercalated.

Two light barriers 28 and 29 are disposed on the middle axis of the broad sides of the channel housing 20 approximately in the center of the length of the channel 20. The light barriers 28 and 29 scan the inside of the channel 27 and are interrupted by the reversing arc 27 of the thread 10 when the thread loop moves across the path of either of the light barriers 28 and 29 if the thread 10 has the corresponding length. Additional light barriers 30 and 31 are disposed on opposing opposite sides of the light barriers 28 and 29 and are in alignment therewith as shown in FIGS. 1 and 2 for effecting a quick and momentary change of the speed of the motor 16 when there are large changes of length in the thread loop.

Air is blown through the outlet apertures 24 into the inside space of the channel housing 20 which has a slot shaped cross-section. Due to the air current, the thread loop is tensioned so that the reversible arc 27 takes its greatest distance possible from the lower channel end 22. Means may be provided for adjustably varying the force of the blown air stream.

The reversing arc 27 in the thread loop moves along the length of the channel housing 20 during the operation of the processing machine which is disposed downstream of the assembly 12. For example, the processing machine may require a periodic change in the thread speed during its operation. It is during this operation of this processing machine that the reversing arc

27 is movably displaced by the air stream blown into the channel housing 20. A channel housing 20 may be disposed vertically or obliquely as desired.

The location of the light barriers 28 and 29 along the channel housing 20 and their spacing therebetween is dimensioned so that the reversing arc 27 may exceed the light barriers 28 and 29 in a predetermined area. The sensitivity of the light barriers 28, 29, 30 and 31 may be adjusted such as to cover the finest titers up to 15 den., and, if desired, below that value. The effective area of the light barriers 28, 29, 30 and 31 is very small against the total area covered by the reversing arc 27 so that the light barrier signals are short pulses.

The wiring diagram of FIG. 3 is for the controller which performs the evaluation of the signals from the assembly 12. The light barrier 28 consists of a light 33 and phototransistor 35 provided in series with a resistance 35 at the supply direct voltage. The light barrier 29 is composed of light 36 and phototransistor 38 provided in series with a resistance 37 at the supply direct voltage. The collector of phototransistor 34 is connected at input 40 of a bistable trigger step 36a. The input 43 of trigger step 36a is connected to the collector of phototransistor 38 via a coupling condenser 37a. The trigger step 36a has a storage function and it keeps its switch position with a pulse trigger as long as the trigger pulse appears at the other input concerned.

The output 39 of trigger step 26a is connected to a current constant step or counter-contact step, generally designated 44. The current constant step consists of two series connected complementary transistors 45 and 46 and the resistances 47, 48, 49, 47a, 48a, and 49a are necessary for the adjustment of the operational points. The connectors of the transistors 45 and 46 are placed at different supply potentials via resistances 49 and 49a, respectively, and are interconnected and connected with the condenser 50. The other connection of the condenser 50 is placed at the minus potential.

The voltage of condenser 50 is compared to the output voltage of a tacho-generator 19 in the differential amplifier 51. The differential amplifier 51 is connected via a control unit 52 with a thyristor power amplifier 53 connected in series with drive motor 16 and the output of which is determinative for the speed of drive motor 16.

The operation of the controller is as follows:

First, it is assumed that the supply speed of the thread 10 is equal to the minimum winding speed on the spool 15. As explained hereinabove, the reversing arc 27 then moves between a minimum and maximum point which are both outside the area of the light barriers 28 and 29. Therefore, there are generated pulses at the light barriers which trigger the trigger step 36a each time that the thread passes through the light barriers 28 and 29.

If the reversing arc 27 of the thread 10 passes through the upper light barrier 29, the output 39 of the trigger step 36a is turned on. When the arc 27 passes through the lower light barrier 28, the output 39 is turned off. Due to the quick change between the upper and lower reversible point of the reversing arc 27, there is caused a square voltage of the output of the trigger step 36a. The pulse scanning ratio of the trigger step 36a is subject to the medium position of the reversing arc 27 within the channel housing 20.

The square signals are transmitted to the current constant step 44 and there the signals alternatively cause

the opening of transistors 45 and 46 constituting electronic switches. If the transistor 46 is conductive, condenser 50 is charged via transistor 46 and its emitter resistance 46a. If, however, transistor 46 is blocked, transistor 45 is conductive and the condenser 50 is discharged by the transistor 45 and its emitter resistance 49. The time constant of the condenser charging is dimensioned so as to be great against the time of an impulse ensuring the formation of a direct voltage at condenser 50 which is only constant in case of a pulse ratio of 1:1 while it either constantly increases or decreases otherwise. This direct voltage is at the input of the differential amplifier 51 at the other end of which the voltage of the tacho-generator 19 is located. The differential voltage is at the input of the control device 52.

When the thread supply is equal to the medium speed at the processing machine, e.g. winding up speed, the pulse scanning ratio at the trigger step output 39 is first 1. In other words, there is a constant voltage at condenser 50 corresponding to the voltage of the tacho-generator 19. Thus, the drive motor 16 keeps its speed. If the diameter of the spool 15 is greater, the winding speed increases. As a result thereof, the central position of the reversing arc 27 is shifted in direction toward the nozzle 24. The influence on the two light barriers 28 and 29 is no longer symmetric and thus causes an asymmetric square voltage at the trigger step output 39. Therefore, the average value of the voltage at the condenser 50 constantly decreases so that the voltage at the output of the differential amplifier 51 also decreases. The speed of the motor 16 and the winding speed of the spool 15 are lowered accordingly.

In other words, the control always becomes effective with the aim of establishing a pulse scanning ratio of 1:1. If this ratio is established, the voltage at the condenser 50 is constant. The absolute height of said voltage does not play a primary part. It decreases with increasing spool size because the equilibrium between the condenser voltage and the voltage of the tacho-generator 19 changes to smaller voltage values with an increasing spool 15.

The device of this invention permits the quick and exact control of the winding speed. In order to keep the amount of air necessary for the operation of switch system 12 as small as possible, it should be possibly avoided to deviate threads 10 between the supply pulley 11 and the thread entrance into the air channel. This is especially important if small tractions of up to 0.5g with high speeds shall be obtained for processing fine deniers.

The different yarn types require different thread winding forces. The traction upon discharge from the air channel may be influenced by changing the amount of air injected per unit of time. Preferably, one will operate with air amounts as small as possible in order to obtain a low discharge traction. This small discharge traction may be realized by a brake (not shown) on the desired winding traction. The brake may be connected with the winding unit so that the thread winding traction decreases with increasing diameter.

It has been found that the distance between the assembly 12 and the thread guide 14 should be kept very small because the speed change, in case of small thread triangles, does not cause difficulties in the edge build-up of the spool 15 to be formed.

In the embodiment of FIGS. 4 and 5, the filament or filaments 56a, 56b, 56c and 56d are moved under a

constant speed while no regular or irregular fluctuations, due to the processing machine, impair the thread tension of the thread being delivered. In such a case, the apparatus for the control of the retention of the thread tension may be used within predetermined limits. Threads 56a, 56b, 56c and 56d are removed from stationary spools 57a, 57b, 57c and 57d, respectively, and are wound up on spool body 55 while maintaining the same thread speed. Blowing devices 12a, 12b, and 12c and 12d are provided to control the thread tension so that it is always the same or so that it remains within a predetermined, limited range during the winding process. Each of the blowing devices 12a, 12b, 12c and 12d include two light barriers 28a and 29a between which the apex of the thread loop 27a is kept. FIG. 5 is a cross-sectional view of the blowing device 12a which is representative of all the other blowing devices of this embodiment.

Two light barriers 28a and 29a are in an extension arm 58 which is pivotal about the pivot point 59. The arm 58 swings constantly with predetermined movements according to arrow 60 in cross-direction relative to the apex of the loop 27a. Supply units 61a, 61b, 61c and 61d are provided for each thread 56a, 56b, 56c and 56d, respectively. As long as the apex of the thread loop 27a remains within the provided swing area with predetermined sizes, the fluctuations of the thread tension are as small as to be within the admissible tolerance area. This is controlled by the light barrier pair 28a and 29a which are kept swinging.

The apex of the thread loop 27a causes pulses on the swinging light barriers 28a and 29a. These pulses control the trigger step 36a and they generate a pulse sequence with a pulse scanning ratio corresponding to the position of the apex in the air channel. It is possible to perform the control electronically such as described with the circuitry of FIG. 3. By means of the control unit, the supply unit of the spool body 55 may be controlled. It is also possible to use a pneumatic flip-flop control.

With a device in which the thread speed of the moving thread essentially unchanged, the thread tension may be controlled by the blowing device 12a to have an adjusted medium value.

ADVANTAGES OF THE INVENTION

With the process and apparatus of this invention, only the mass of the thread is subjected to a movement concerning a longer or shorter loop following the change of the thread speed. The thread itself has only an extremely small mass on the loop length. The movement of the prior art jumping arm itself additionally caused relatively high tension fluctuations on the thread. This type of fluctuation is completely eliminated with the apparatus of this invention.

According to the invention, the thread is not affected by any means. Changes in the length of the thread loop, i.e. increasing or decreasing of the loop, do not bring about shocks in the thread. Thread loop modifications are due to variations of the thread speed resulting from the processing machine. Consequently, a high sensitivity and accuracy is possible for the control of maintaining a constant thread tension.

The change of the thread loop length occurs smoothly against the counter force, i.e. against the air stream without the occurrence of additional losses by friction or the like. Therefore, a frictionless thread

buffer is provided particularly in the case of a sudden speed change of the processing machine. Only this massless reverse with the retention of the constant thread speed is used for the control. It is possible to re-establish the thread reserve with the thread loop within a short period of time in accordance with a predetermined thread tension by using the contactless scanning elements according to the invention. Due to these phenomena, the retention of the constant thread tension may be realized much more accurately and with lesser tolerances than heretofore.

Above all, the reaction times may be essentially reduced so that a highly sensitive response is ensured for short-time thread tension fluctuations. It is possible to adjust finest titer down to 5 den. to a constant thread tension. Moreover, only partially stretched threads may be processed without the risk of causing titer fluctuations within the thread due to the control. It is guaranteed that the processing machine is always fed with threads having a constant thread tension.

The intensity of the air stream may be adapted to the thickness of the thread being processed. When processing thin threads, it is possible to operate with a correspondingly low air stream, thus considerably increasing the sensitivity of control.

The assembly made in accordance with this invention contains elements which are stationary. It is extremely handy. It does not offer any difficulty to use it for the control of maintaining a constant thread tension for filaments fed to the processing machine. Finally, the apparatus is adaptable to many different process parameters. That is, the strength of the blown air stream may be variably adjusted. As a result thereof, the same blowing device may be used for different thread thicknesses and titers and for the adjustment of different predetermined thread tensions.

While the process and apparatus for maintaining constant thread tension has been shown and described in detail, it is obvious that this invention is not to be considered as being limited to the exact form disclosed, and that changes in detail and construction may be made therein within the scope of the invention, without departing from the spirit thereof.

Having thus set forth and disclosed the nature of this invention, what is claimed is:

1. An apparatus for maintaining a constant thread tension while feeding a thread to a processing textile machine comprising:

- a. housing means forming an open ended, elongated air channel,
- b. means for moving a thread along a path transversely across the air channel at one end thereof,
- c. means adjacent the channel for blowing a fluid stream against the thread to form a thread loop having an apex which moves within the air channel,
- d. at least two light barrier means disposed at laterally spaced locations with respect to each other and extending in a direction across the path of movement for the apex of the thread loop within the air channel,
- e. each light barrier means defining a signal point within the air channel where an electrical signal is generated by the thread loop as it passes by a signal point,
- f. the electrical pulse signals generated by the thread loop at both signal points being transmitted to separate inputs of a bistable element that stores in

- each case the last pulse signal up to the receipt of the next signal,
- g. the output of the bistable element being connected with a circuit and at the output of said circuit there is generated a voltage change dictated by the pulse sequence at the bistable element due to the pulse scanning ratio, and
- h. means responsive to the electrical signals generated at the light barriers for regulating the supply of thread along its path of movement.
2. An apparatus as defined in claim 1 wherein means is provided for oscillating the light barrier means.
3. An apparatus as defined in claim 1 wherein the circuit comprises an integration step with a condenser chargeable via a first transistor and a resistance and dischargeable by a second transistor and a resistance, both said transistors being controlled by the output of the bistable element.
4. An apparatus as defined in claim 1 wherein the processing textile machine has a take-up means driven by an electrical drive motor for taking up the thread moving along said path and means providing a signal corresponding to the speed of the take-up means, the output signal of the integration step and the signal corresponding to the speed of the take-up means are provided at the entries of a differential amplifier which, if necessary through a power amplifier, controls the drive motor of the take-up means.
5. An apparatus as defined in claim 1 wherein the charging time constant and the discharging time constant of the integration step is great relative to a cycle of movement of a setting device.
6. An apparatus as defined in claim 5 wherein the charging time constant and the discharging time constant of the integration step are equal.
7. An apparatus as defined in claim 1 wherein means are provided to effect oscillating movement of the light barrier means, and the charging time constant and the discharging time constant of the integration step is great relative to a cycle of movement of the oscillating movement of the light barriers.
8. An apparatus as defined in claim 7 wherein the charging time constant and the discharging time constant of the integration step are equal.
9. An apparatus as defined in claim 1 wherein said two light barrier means constitute primary light barriers and there are supplemental light barriers disposed outside the region of the primary light barriers, the supplemental light barriers are electrically connected in the control circuit to generate supplemental electrical signals when the length of the thread loop passes by a signal point established by the supplemental light barriers, and second means responsive to said supplemental electrical signals are provided for regulating the supply

of thread along its path of movement.

10. An apparatus for maintaining a constant thread tension while feeding a thread to a processing textile machine comprising:

- a. housing means forming an open ended, elongated air channel,
- b. means for moving a thread along a path transversely across the air channel at one end thereof,
- c. means adjacent the air channel for blowing a fluid stream against the thread to form a thread loop having an apex which moves within the air channel,
- d. at least two light barrier means disposed at laterally spaced locations with respect to each other along the air channel and extending in a direction across the path of movement for the apex of the thread loop within the air channels,
- e. means for oscillating the light barrier means, and
- f. means responsive to the electrical signals generated at the light barrier means for regulating the supply of thread along its path of movement.

11. An apparatus for maintaining a constant thread tension while feeding a thread to a processing textile machine comprising:

- a. housing means forming an open ended, elongated air channel,
- b. means for moving a thread along a path transversely across the air channel at one end thereof,
- c. means adjacent the air channel for blowing a fluid stream against the thread to form a thread loop having an apex which moves within the air channel,
- d. at least two light barrier means disposed at laterally spaced locations with respect to each other along the air channel and extending in a direction across the path of movement for the apex of the thread loop within the air channel,
- e. each light barrier means defining a signal point within the air channel where an electrical signal is generated by the thread loop as it passes by a signal point,
- f. the electrical pulse signals generated by the thread loop at both signal points are being transmitted to separate inputs of a trigger step means storing in each case the last pulse signal up to the receipt of the next signal,
- g. the output of the trigger step being connected with a circuit and the output of the said circuit there is generated a voltage change dictated by the pulse sequence at the trigger step due to the pulse scanning ratio, and
- h. means responsive to the electrical signals generated at the light barrier means for regulating the supply of thread along its path of movement.

12. An apparatus as defined in claim 11 wherein the circuit comprises an integration step with a condenser chargeable via a first electronic switch and a resistance and is dischargeable via a second electronic switch and a resistance,

both said electronic switches being controlled by the output of the trigger step means.

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