A dual-function in-line tensiometer-yarn tension controller to constantly maintain and measure tension on a running length of continuous filament comprising in combination a housing with an elongated slot, a first, second and third yarn guide, a narrow, very flexible, thin, continuous metal band, and an opposed pair of spring loaded pulleys have been designed. The first and third guides have been mounted at one end of the slot in the housing, and the second guide is slidably mounted in the slot and fixed to the metal band. The band is mounted to pass around the pulleys under tension and the pulleys are rotatably mounted at either end of the slot in the housing with the band width facing the slot. One of the pulleys is spring-loaded to bias against rotational movement and the other is spring loaded to bias against motion toward the other pulley.

19 Claims, 5 Drawing Figures
DUAL FUNCTION IN-LINE TENSIOMETER-YARN TENSION CONTROLLER

BACKGROUND OF THE INVENTION

This invention relates to a filament tension controller or a dual-function in-line tensiometer-yarn tension controller to constantly maintain and measure tension on a running length of continuous filament, such as multifilament, or monofilament yarn, either natural or synthetic. In-line tensioners are known, for example, U.S. Pat. 3,599,300. Tensioning apparatus which can also indicate the amount of tension is also known in U.S. Pat. No. 3,692,251 and tension meters are known for example in U.S. Pat. No. 3,344,664. Also, various devices to compensate for tension changes during bobbin changeover on automatic doff wasteless transfer winders are shown in Netherlands disclosure 721,271 and other methods of maintaining tension during doffing are shown in U.S. Pat. Nos. 2,176,182; 3,350,022; 3,393,880 and 3,550,871. All the above cited patents and publications are hereby incorporated by reference. However, the prior art devices are all too massive or unresponsive for other reasons so that they are not sensitive to rapid small deviations in tension. Prior art in-line devices generally respond to about a minimum 20 gram change in the tension in the running length of filament. Small fluctuations do not cause response.

SUMMARY OF THE INVENTION

The device of this invention is designed so it can be sensitive to as small as a 1 gram change in yarn tension, even in a rapidly fluctuating tension environment. The device of this invention not only has fast response and low inertia, it provides a long storage, if necessary, during transfer of yarn from one bobbin to another. It also has small physical size, controllable tension curves, and linear travel. This device can be used to constantly maintain and measure tension in any filament process operation where a running length of continuous filament, natural or synthetic, exists. For example, it can be used in the continuous processing of yarn, synthetic or natural, monofilament or multifilament yarn to be used for tire and industrial uses, apparel, or carpets. The apparatus of this invention is a yarn tension controller or a dual-function in-line tensiometer-tension controller constantly maintaining and/or measuring tension on a running length of yarn comprising, in combination, a yarn guide, means to restrain the yarn guide to movement in one line or plane, such as a frame, or other rigid member, a highly flexible, highly responsive, continuous tensile member having low mass, such as a narrow thin continuous metal band, an opposed pair of pulleys, an optional means to measure position of the yarn guide, means to provide tension in the continuous tensile member, such as means to bias one of the pulleys against motion toward the other pulley attached to the pulley; this bias means could be a spring; means to bias at least one pulley against rotational movement attached to the pulley, such as a spring attached with a noncontinuous, highly flexible, highly responsive, tensile member having low mass, such as a noncontinuous narrow thin metal band. The means to bias at least one of the pulleys against rotational movement operates to urge rotation of the pulley opposite to the rotation caused by the action of the yarn on the movable guide mounted on the continuous tensile member or band. The guide is restrained in the means to restrain the yarn guide movement in one line or plane and fixably mounted on the continuous tensile member. This movable yarn guide then moves along the line which can be any line congruent with and parallel to a line between and perpendicular to the pulley axes and extending from one pulley axis to the other pulley axis. These opposed pairs of pulleys are mounted with their axes parallel to one another and spaced apart. The continuous tensile member is mounted to pass around the pulleys under tension and the pulleys are rotatably mounted at either end of the means to restrain the yarn guide.

In a preferred embodiment, the yarn tension controller or dual-function in-line tensiometer-yarn tension controller to constantly maintain and/or measure tension on a running length of yarn comprises, in combination, a housing with an elongated slot, a first, second and third yard guide, a narrow, thin, highly flexible, continuous tensile member and an opposed pair of spring loaded pulleys. An optional means to measure the position of the second yarn guide can also be used in combination. In this preferred embodiment, the first and third guides are fixably mounted at one end of the slot in the housing and the second guide is slidable mounted in the slot and fixably mounted on the band. The band is mounted to pass around the pulleys under tension, and the pulleys are rotatably mounted at either end of the slot in the housing with the band width facing the slot. One of the pulleys is spring loaded to bias rotational movement and the other pulley is spring loaded to bias against motion transverse to the pulley axis. The preferred means to attach the means to bias against rotational movement of the pulley is a noncontinuous, highly flexible, highly responsive tensile member having low mass.

Either the continuous or the noncontinuous tensile member can be a narrow, thin, highly flexible metal band, a high strength synthetic polymer ribbon or high strength low mass cable. The means to bias the pulleys can be a helical coil spring or any other type of spring or possibly a hydraulic system with spring-like characteristics. The bias means against the rotational movement could be a torsional spring to cause wind-up. When a metal band is used in the preferred embodiment, it must be a low mass, highly flexible highly responsive metal band having thickness less than 0.01 inch. For example, the continuous bands should have a preferable thickness of from about 0.001 to 0.008 inch and noncontinuous metal band should have a preferable thickness from about 0.0001 to about 0.004 inch. The width of the metal band is relatively unimportant but can run from a fraction of an inch to several inches wide. The preferable method to attach the means to bias the pulley against rotational movement is to attach a narrow, thin, noncontinuous highly flexible metal band to a smaller pulley integral with the pulley upon which the continuous band is mounted. The small diameter pulley provides a mechanical advantage by the ratio of large to small diameter. The ration of diameters of the large pulley to the small pulley should be from about 2 to 1 to about 10 to 1 and the noncontinuous band thickness should correlate with the small pulley diameter. The yarn guide of this invention can be any of the known types of guides such as pin, ceramic slot, metal slot or preferably, a rotating wheel.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of the housing and yarn guides.
FIG. 2 is a side elevation view of the housing with the cover removed.

FIG. 3 is a front elevation cross-sectional view of the housing.

FIG. 4 is a partial front elevation cross-sectional view of the housing with the yarn guide removed showing how the yarn guide is mounted on the metal band in the slot in the housing.

FIG. 5 is a side view with cover on showing the scale to measure tensioning by measuring position of the yarn guide.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings describe the preferred embodiment. Like numbers describe like elements in all the drawings.

FIG. 1, the top view of the housing and yarn guides shows housing 1 and yarn guides 2, 3 and 4. Yarn guide 3 is shown in mounting 25. In FIG. 2, the elevation side view, the housing with the cover removed, yarn guide 4 is shown in slot 5 in housing 1 mounted on continuous metal band 6. Noncontinuous metal band 7 connects pulley 10 with spring 12 mounted on rod 13 fixed in mounted bracket 14. Opposed pulleys 8 and 9 are both spring loaded. Pulley 8 is spring loaded to bias against motion toward the opposite pulley, such as transverse to the axis of the pulley, by spring 11 mounted between ball members 22 and 23 as shown. Pulleys 9 and 10 are an integral piece mounted on axle 24. As can be seen, pulley 10 is much smaller than pulley 9 for mechanical advantage. Pulleys 8, 9 and 10 are mounted on stationary axles 24 and 26 by antifriction bearings, such as ball bearings. Axle 24 is rigidly mounted in the side of housing 1 and into mounting assembly 15. Axle 26 is similarly mounted as shown. Yarn guide 4 is attached to mounting assembly 21 in a fixed position on continuous metal band 6 by passing continuous metal band 6 over pins 19 and 20 and securing. Mounting assembly 21 contains pins 19 and 20 and rollers 16, 17 and 18, shown more clearly in FIG. 4, to maintain mounting 21 in line with slot 5 in housing 1. FIG. 3 shows a front cross-section view of housing with elements as described above shown in a front view relationship. FIG. 4 shows a partial front cross-sectional view of the housing 1 clearly showing how the yarn guide 4 is mounted on the metal band and mounted in a slot of the housing by means of the rollers 16, 17, 18 and pins 19 and 20 and mounting assembly 21 as described above. Yarn guide 4 is removed to show the details.

FIG. 5 shows housing 1 with scale 27 mounted thereon to measure the position of movable yarn guide 4 as it moves along a line or plane in slot 5, not seen in this view.

The apparatus of this invention operates as follows.

In the preferred embodiment the running length of yarn passes over yarn guide 2, travels around movable yarn guide 4 and back over yarn guide 3. Yarn guides 2 and 3 are optional in that the running length of yarn can simply be looped around movable yarn guide 4 as in prior art patents U.S. Pat. Nos. 3,350,022, 2,176,182 and 3,393,880. The movable yarn guide then regulates tension by the unique action of the apparatus of this invention. Also, by use of the scale 27 it can measure tension in a relative manner, which could be calibrated on each apparatus to an absolute number. The movable yarn guide 4 moves in slot 5 on the continuous tensile member or band 6. Movement of guide 4 is subject to the biasing means or spring 12, band 7 and rod 13 on pulley 9 as shown in FIGS. 2 and 3. Thus, the tension of the running length of yarn is regulated by the bending modulus of the continuous tensile member or band 6 as it bends around pulleys 8 and 9 and by the spring 12 and bending modulus of band 7 (noncontinuous tensile member) as it bends around pulley 10. Band 6 is held taut by biasing means or spring 11 biasing pulley 8 by means of ball member 22 and 23.

From this preferred embodiment, it can be easily seen that various changes may be made to the apparatus without departing from the scope of the invention and the preferred embodiments should be interpreted as illustrative and not limiting. The invention is not limited to the precise details described, but it is intended to convey all the variations and modifications formed within the spirit of the invention and within the scope of the claims.

I claim:

1. A dual-function in-line tensiometer-yarn tension controller to constantly maintain and measure tension on a running length of yarn comprising in combination a movable yarn guide, an opposed pair of pulleys, mounted with their axes parallel to one another and spaced apart, means to restrain said movable yarn guide to movement in one line, said line being any line congruent with and parallel to a line between nd perpendicular to said pulley axes and extending from on pulley axis to the other pulley axis, a highly flexible, highly responsive continuous tensile member having low mass, said yarn guide fixably mounted on said continuous tensile member, said continuous tensile member mounted to pass around said pulleys under tension, said pulley rotatably mounted at either end of said means to restrain said yarn guide, means adjacent said movable yarn guide to measure the position along said line of said movable yarn guide, means connected to one of said pulleys to bias said one of said pulleys against motion toward the opposite pulley, and means connected to one of said pulleys for urging said one of said pulleys to rotate in one direction of rotation, said urging means including a resiliently biased, noncontinuous, highly flexible, highly responsive tensile member having low mass, said one direction of rotation being opposite to the direction of rotation caused by movement of said guide and said continuous tensile member due to a tensioned yarn.

2. A dual-function in-line tensiometer-yarn tension controller to constantly maintain and measure tension on a running length of continuous filaments comprising in combination a housing having an elongated slot, a first, second and third yarn guide, a narrow, thin, flexible continuous tensile member, an opposed pair of spring loaded pulleys, mounted with their axes parallel and spaced apart, said first and third guides fixably mounted at one end of said housing.
said second guide slidably mounted in said slot and fixably mounted on said continuous tensile member,
said tensile member mounted to pass around said pulleys under tension,
said pulleys rotatably mounted at either end of said slot in said housing with said continuous tensile member width facing said slot,
means adjacent said second guide to measure the position along a line of movement of said second yarn guide, said line being any line congruent with and parallel to a line between and perpendicular to said pulley axes and extending from one pulley axis to the other pulley axis,
means to connect to one of said pulleys to bias said one of said pulleys against motion toward the opposite pulley,
means connected to one of said pulleys for urging said one of said pulleys to rotate in one direction of rotation, said one direction of rotation being opposite to the direction of rotation caused by movement of said guide and said continuous tensile member due to a tensioned yarn.

3. The tensiometer-yarn tension controller of claim 2 wherein said means for urging said one of said pulleys to rotate in one direction of rotation includes a resiliently biased, noncontinuous, highly flexible, highly responsive tensile member having low mass.

4. The tensiometer-yarn tension controller of claim 3 wherein both said continuous and said noncontinuous tensile members are a narrow, flexible, thin, metal band.

5. The tensiometer-yarn tension controller of claim 4 wherein said continuous metal band and said noncontinuous metal band each have a thickness less than 0.010 inch.

6. The tensiometer-yarn tension controller of claim 5 wherein said continuous metal band has a thickness of between 0.001 and 0.008, and said noncontinuous metal band has a thickness of between 0.0001 and 0.004 inch.

7. A tensiometer-yarn tension controller of claim 3 wherein said noncontinuous tensile member is connected to said pulley by means of another pulley integral with and on the same axis with said pulley and having a smaller diameter.

8. The tensiometer-yarn tension controller of claim 7 wherein the ratio of the diameter of the integral pulleys is from about 2 to 1 to about 10 to 1.

9. An in-line yarn tension controller to maintain tension on a running length of yarn comprising in combination
   a movable yarn guide,
an opposed pair of pulleys, mounted with their axes parallel and spaced apart,
means to restrain said movable yarn guide to movement in one line, said line being any line congruent with and parallel to a line between and perpendicular to said pulley axes and extending from one pulley axis to the other pulley axis,
a highly flexible, highly responsive, continuous tensile member having low mass,
said movable yarn guide mounted rigidly upon said continuous tensile member,
said continuous tensile member mounted to pass around the pulleys under tension,
said pulleys rotatably mounted at either end of said means to restrain said yarn guide,
means connected to one of said pulleys to provide tension in said continuous tensile member, and
means connected to one of said pulleys for urging said one of said pulleys to rotate in one direction of rotation, said one direction of rotation being opposite to the direction of rotation caused by movement of said guide and said continuous tensile member due to a tensioned yarn.

10. The controller of claim 9 wherein said means for urging said one of said pulleys to rotate in one direction of rotation includes a resiliently biased, noncontinuous, highly flexible, highly responsive tensile member having low mass.

11. The controller of claim 9 wherein said means for providing tension is a means to bias either one of said pulleys against motion toward the other pulley.

12. The controller of claim 10 wherein both said continuous and said noncontinuous tensile members are a narrow, flexible, thin, metal band.

13. The controller of claim 12 wherein said continuous metal band and said noncontinuous metal band each have a thickness less than 0.010 inch.

14. The controller of claim 13 wherein said continuous metal band is a thickness of between 0.001 and 0.008, and said noncontinuous metal band has a thickness of between 0.0001 and 0.004 inch.

15. The controller of claim 10 wherein said noncontinuous tensile member is connected to said pulley by means of another pulley integral with and on the same axis with said pulley and having a smaller diameter.

16. The controller of claim 15 wherein the ratio of the diameter of the integral pulleys is from about 2 to 1 to about 10 to 1.

17. The controller of claim 11 wherein both said means to provide tension and said means for urging said one of said pulleys to rotate include springs.

18. An in-line yarn tension controller to constantly maintain tension on a running length of continuous filament comprising in combination
   a housing with an elongated slot,
a first, second and third yarn guide, a narrow, thin highly flexible, continuous metal band, an opposed pair of pulleys, mounted with their axes parallel and spaced apart,
said first and third guides fixedly mounted at one end of said slot and said housing,
said second guide slidably mounted in said slot and fixedly mounted upon said band,
said band mounted to pass around said pulleys under tension said pulleys rotatably mounted at either end of said slot in said housing with the band width facing said slot,
means connected to one of said pulleys to bias said one of said pulleys against motion toward the opposite pulley, and
means connected to one of said pulleys for urging said one of said pulleys to rotate in one direction of rotation, said one direction of rotation being opposite to the direction of rotation caused by movement of said guide and said continuous tensile member due to a tensioned yarn.

19. The controller of claim 18 wherein said means for urging said one of said pulleys to rotate in one direction of rotation includes a resiliently biased, noncontinuous, highly flexible, highly responsive tensile member having low mass.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,873,044
DATED : March 25, 1975
INVENTOR(S) : Thomas A. Flower

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

Column 2, line 58, "ration" should be --ratio--.
Column 2, line 63, after "as" insert --a--.
Column 3, line 20, "in" should be --on--.
Column 4, line 30, "nd" should be --and--.
Column 4, line 39, "pulley" should be --pulleys--.
Column 4, line 62, "an" should be --and--.

Column 5, line 19, "siad" should be --said--.
Column 6, line 58, "onen" should be --one--.

Signed and Sealed this thirtieth Day of March 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks
UNITED STATES PATENT OFFICE
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Attest:

RUTH C. MASON                C. MARSHALL DANN
Attesting Officer              Commissioner of Patents and Trademarks