WARP TENSION CONTROL MEANS

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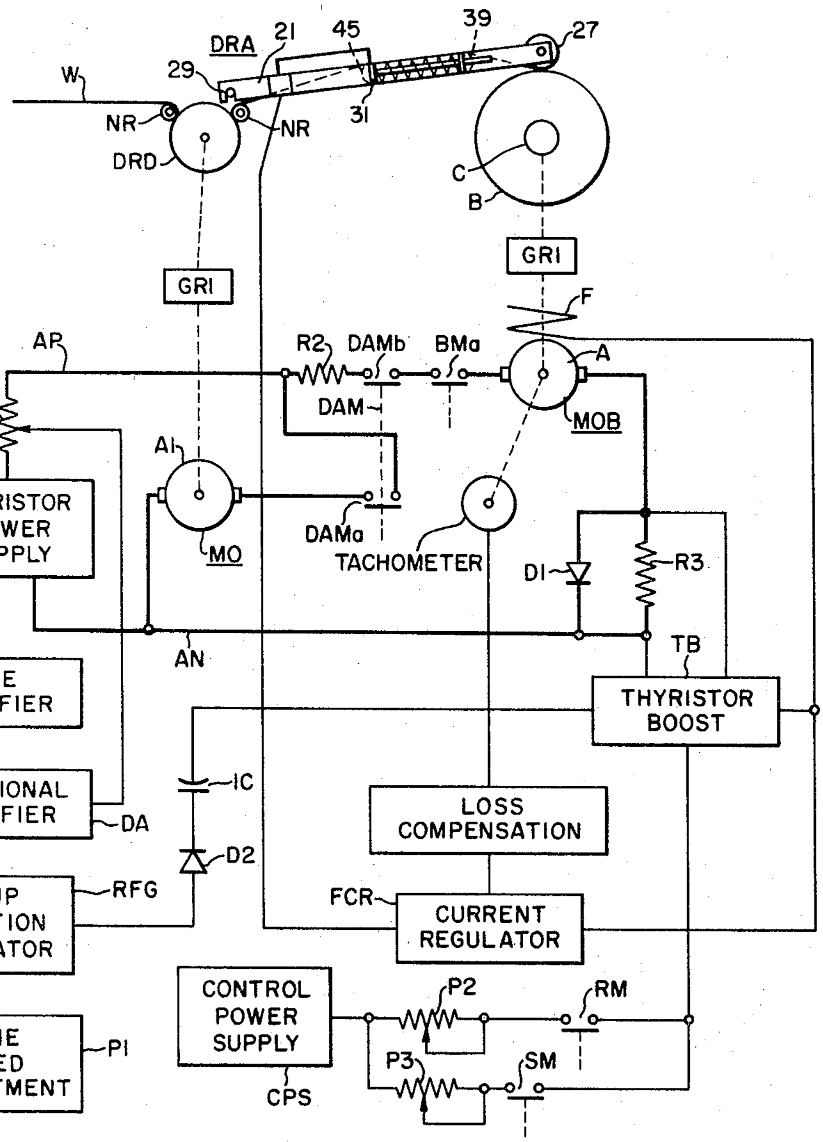

FIG.1.

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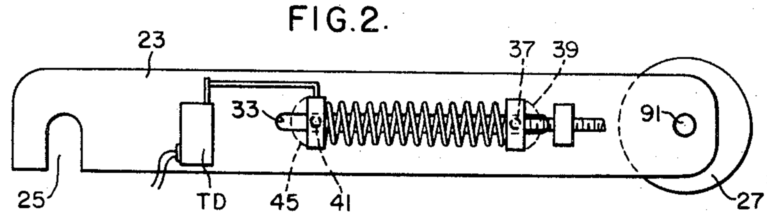
FIG. 2.



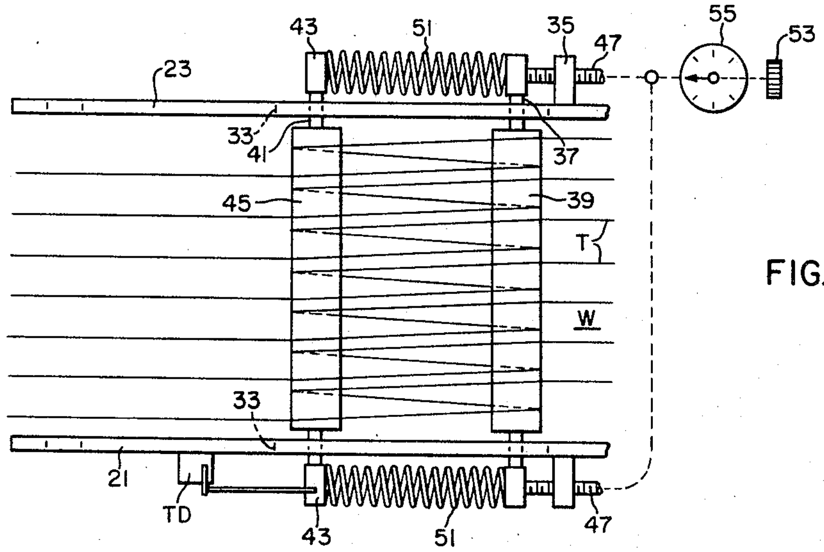


FIG. 3.

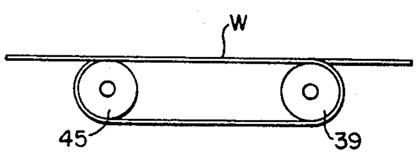


FIG. 4.

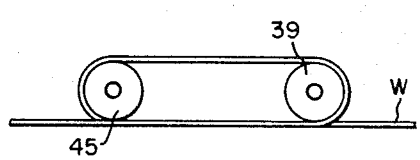


FIG. 5.

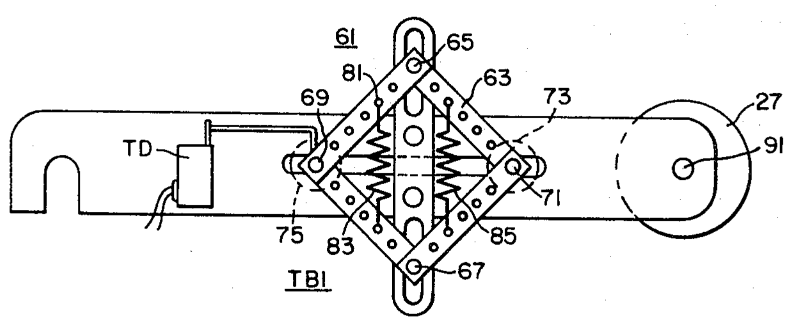


FIG. 6.

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WARP TENSION CONTROL MEANS

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Int. Cl. D02h *13/14*

ABSTRACT OF THE DISCLOSURE

A method of setting the tension of warp W (FIG. 1) wound on a motor-driven beam B in the practice of which the tension is sensed in a linear section of individual threads T of the warp W adjacent the beam B and responsive to the tension sensed the motor MOB is adjusted to maintain the tension at the desired magnitude.

Also reeling apparatus for warp W (FIG. 1) including a motor-driven beam B, a warp delivery roller assembly DRA, a transducer means TB and TD for sensing the tension in the individual threads T of the warp W, and a field current regulator FCR for adjusting the speed of the motor so that the warp has a predetermined tension.

This invention relates to the textile art and has particular relationship to winding apparatus for the thread or yarn which is woven into cloth. The word "thread" will be used herein to designate both yarn and thread. Specifically, this invention concerns itself with a machine which is called in the textile industry a slasher.

A slasher is apparatus for carrying out the process of impregnating the thread which is woven into cloth with a starchy material so that it has body and its weavability is improved. The thread is passed through the starchy material and into a dryer section. From there the thread passes over a delivery roll which is motor driven and which feeds the thread at constant rate of flow of thread to a center-core wind-up beam that is also motor driven. As the thread builds up on the beam the angular velocity of the beam decreases. The motor which drives the beam must then operate at a progressively decreasing speed.

The slasher process is carried out on a varying number of threads. In the textile trade these threads are called ends. As the thread passes through the slasher it is in the form of an extent or sheet of parallel but separate threads which may be described as warp. There may be as many as 5000 threads or ends in a sheet or as few as 150 threads in a sheet. Each thread is composed of strands of the base material of which it is formed which may be a natural textile material such as wool, linen or cotton or an artifical textile material such as a plastic of one type or another. When subjected to tensions different materials withstand tensional stress to different extents. Wool, cotton or linen can withstand substantial tension. The tension which some of the plastic materials can withstand is limited. Fiberglass, for example, has substantially no resistance to tensional stress. The thread must be kept under proper tension at all times to prevent breakage of the yarn and to provide for uniform and compact windup on the beam. Nor can the tension be permitted to increase to too high a magnitude on the thread as it builds up on the beam because the pressure exerted by this thread under higher tension would tend to crush the thread below it on the beam. The tension which is to be maintained is variable over a wide range and depends on the material of which the thread is composed and on the number of ends being processed at any time.

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This invention concerns itself with the maintenance of the appropriate tension in the thread and it is an object of this invention to provide apparatus for tensioning the thread in a slasher precisely and reliably and also to provide a method for operating such apparatus. To the extent that this invention is applicable to operations with thread other than those involved in a slasher it is understood that any such application or use of this invention is within the scope of this application.

In accordance with the teachings of the prior art, the tension regulation is effected responsive to the armature current of the motor which drives the beam. This armature current is sensed and controls the windup speed of the motor and also a booster generator which is connected to supply boosting voltage in the motor-armature circuit. This prior-art practice has in the past on the whole proved satisfactory particularly where the thread is of relatively heavy cross-section, is composed of a material which can withstand substantial tension and/or the number of ends wound is high. But in processes in which the thread is of relatively small cross-section or the number of ends is relatively small or the tension impressed on the warp is relatively low, because the material cannot withstand substantial tension. This prior art apparatus has not operated satisfactorily.

It is an object of this invention to overcome the disadvantages of the prior-art warp-tension regulating apparatus and to provide regulating apparatus which shall operate satisfactorily to maintain the tension over substantially the whole range of tensions demanded of warp wound on the beam for different materials and/or different numbers of ends.

This invention arises from the realization that the current drawn by the armature of the motor which drives the beam is not only dependent on the tension loading on the motor but includes other factors which become important at low-tensions. Among these factors an important one is the loss arising from the rotation of the motor in the air that is the windage losses. Thus losses are proportional to the third power of the speed of the motor parts and varies from a high magnitude at higher motor speeds, when the warp is first being wound onto the beam, to a substantially lower magnitude when the warp on the beam is wound to a substantial diameter. In addition there are the friction losses of the motor, the losses in the gearing, and the losses arising from the velocity of the oil and grease in which the motor shaft and the gears operate. Where the warp is formed of heavy thread and/or a large number of ends and is subjected to high tension, the armature current arising from windage, friction, viscosity and gear losses is small compared to the armature current arising from the load. Under such circumstances the sensing of the armature current is reasonably precisely related to the tension and the tension may be controlled by such sensing. But where the thread is of relatively small diameter and/or the number of ends is small or where the strands are composed of a plastic material having low resistance to tension, the tension applied is low and the relationship between the tension loading current and the losses is reversed. The losses then account for the predominant proportion of the armature current while the loading accounts for a relatively small portion of the armature current. Under such circumstances the losses swamp the portion of the current being measured to sense the tension and the tension control is ineffective.

In accordance with this invention effective tension control as achieved by sensing the tension in the warp directly. The individual threads of the warp between the delivery rolls and the beam pass over a tension responsive device which operates a transducer that in turn controls the beam motor. Specifically, a bar assembly is provided which is hinged near the delivery rolls at one end and carries a roller which rides on the warp at the other. Within the bar assembly there are a pair of rollers one of which is fixed and the other of which is movable along slot S in the bar assembly. A spring is provided between the rollers to urge the rollers apart. The threads of the warp pass over the rollers in such a direction that the tension in the threads counteracts the action of the springs. The position of the movable roller is essentially determined by the tension in the warp and thus position determines the setting of the transducer.

Provisions may be included for setting the tension at a desired magnitude. Departure from the desired tension then causes the movable roller to move and this in turn controls the transducer which effects the necessary regulation.

The tension responsive bar assembly is preferably pivoted about a crossbar extending near the delivery rolls or from a NIP roll and its roll at the other end rides on the outer surface of the thread on the beam. The bar assembly then has a substantially weightless effect on the part of the warp between the delivery rolls and the beam. In addition as the angle of the plane of the warp changes from the position, where it is substantially parallel to the plane of the warp as it emerges from the delivery rolls, to a position where it is at a substantial angle to this plane, the bar assembly and the portions of the warp engaging the tension-responsive rollers on the bar assembly, remain parallel to the instantaneous plane of the warp so that the measurement of the tension is precise.

For a better understanding of this invention, both as to its organization and as to its method of operation together with additional objects and advantages thereof, reference is made to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a partly schematic, partly diagrammatic view in block diagram, showing a preferred embodiment of this invention;

FIG. 2 is a view in side elevation of the tension responsive bar assembly which constitutes an important feature of this invention;

FIG. 3 is a plan view of the tension-responsive mechanism according to this invention;

FIG. 4 is a diagrammatic view showing one way in which the warp passes over the tension-responsive rollers of the bar assembly shown in FIG. 3;

FIG. 5 is a diagrammatic view showing an alternative relationship between the warp and the tension-responsive rollers; and

FIG. 6 is a view in side elevation of a modification of this invention.

In FIGURE 1 the portion of a slasher which involves this invention is shown. This portion includes a drive-roll assembly DRA including a drive roll DRD and a cooperative roll DR. The threads T of the warp W having been treated with a starchy material in other portions of the apparatus is delivered to the drive roll assembly DRA. The warp W is bent around NIP rolls NR at this assembly so that the drive roll DRD is in firm driving relationship with the threads T.

The apparatus also includes a beam B on which the warp W is wound. Typically the beam B may have a core C which has a diameter of about 6 inches and the warp W may be wound on the beam to a diameter of about 30 inches. The number of ends which may be included in the warp may vary from 150 to 5000. The warp threads T may be composed of any type of material. But this invention has its widest applicability to the winding of warp composed of substantially less than the maximum number of ends and of materials to which relatively small tension is or may be applied.

The drive roll DRD is driven by a motor MO. The beam B is driven by a motor MOB. The motor MOB has an armature A and a shunt field F and the motor MO on armature A1 and a field (not shown). As the warp is wound on the beam B the speed of the motor MOB decreases to correspond to the increasing diameter of the warp W. But the speed of the motor MOB must be precisely controlled to set precisely the tension in the warp.

The motors MO and MOB are of the direct current type and are energized from the positive and negative output conductors AP and AN of a regulated power supply PS. Typically, this power supply PS may be of the three-phase thyristor type. The thyristors are energized through a gate-amplifier GA which is controlled by an operational amplifier. The speed of the slasher line is adjusted by variable resistor P1 which is connected through a ramp function generator RFG to the input of the operational amplifier. Feedback from the output of the power supply PS is provided to the input of the operational amplifier OA through a resistor R1 in series with the conductor AP.

The armature A1 of the motor MO of the delivery roll driver DRD is adapted to be connected in energizing relationship with the conductors AP and AN through contacts DAMa of a conductor DAM (coil not shown). This armature drives the roll DRD through a suitable gear reduction mechanism GR1.

The conductors AP and AN are adapted to be connected in energizing relationship with the armature A of motor MOB through a resistor R2, the contactors DAMb and BMa of the contactor DAM and a contactor BM (coil not shown) and a booster R3 across which a protective diode D1 is connected. The contactor DAM permits the operation of the motor MO and the other motors of the slasher while the motor MOB is not in operation. Such operation of motor MO alone may be necessary for threading the warp through the apparatus and for trouble shooting purposes. When the apparatus is in full operation the contactors DAM and BM are both actuated.

A booster potential is impressed across the resistor R3 from a thyristor booster TB. This potential is impressed in series with the potential between AP and AN, the lower terminal of the resistor R3 being connected to the positive output of the booster TB and the upper terminal of the resistor R3 being connected to the negative output terminal of the booster TB. The input to the thyristor TB is supplied selectively from a controlling power supply CPS which typically delivers 24 volts DC selectively through variable resistors P2 and P3. Resistor P2 is connected to the input through a contact RM*a* of a contactor RM (coil not shown) and resistor P3 through a contact SM*a* of a contactor SM (coil not shown). Only one of the contactors is at any time connected. The resistor P2 serves as a reference to set the thyristor booster TB for normal operation of the motor MOB and the resistor P3 serves as a reference to set the thyristor booster TB for stalling the motor. The input of the thyristor booster TB also includes inertia compensation facilities for smoothing the deceleration or acceleration of the motor MOB. For this purpose a signal is impressed from the ramp function generator RFG in the input of a thyristor booster TB through a diode D2 and a capacitor 1C. When the line speed resistor P1 is set for different speeds this network 1C–D2 operates to stabilize the operation of the motor MOB as its speed is changing.

The speed of the motor MOB is varied by the control of the current through its shunt field winding F, that is, by so-called field weakening. The field is supplied typically from the three phase supply which energizes the power supply PS through a field current regulator FCR. The setting of the regulator FCR is controlled from a tension bar assembly TB which may be set for a predetermined tension in the warp W and which is responsive to changes in this tension. The assembly TB operates through a transducer TD the output of which is impressed on the field-current regulator FCR and sets this regulator to set the current through the field winding F. The current through the field winding F also controls the thyristor booster TB to compensate for the operation of the motor MOB at the progressive changing speeds. The compensation is particularly necessary for the change in the air resistance which the armature A encounters as the motor speed changes from a high magnitude to a low magnitude. At a high magnitude the air resistance, being proportional to the third power of the speed, is high and at lower magnitude it is substantially lower. The thyristor booster TB impresses a booster potential across the resistor R3 in the circuit of the armature A to effect this compensation.

The tension responsive bar assembly TB (FIGS. 1, 2 and 3) in accordance with this invention is a framework including a pair of bars **21** and **23** (FIG. 3) having slots **25** for pivoting at one end and having at the other ends suitable bearings (not shown in detail) in which a rider roller **27** is rotatable. The spacing between the bars is somewhat greater than the width of the warp W which is being wound and the roller **25** is of such length that it extends across the warp. The length of the bars is approximately equal to the distance between the delivery roll assembly DRA and the beam B. The bar assembly is pivotally suspended at the slots **25** about an axis near the delivery rolls and the rider roll **27** rests on the outer surface of the warp W being wound on the beam B. For pivotal suspension of the bar assembly a suspending pin **29** may be mounted just above the NIP roll NR on the side of the drive roll DRD towards the beam B, or the bar assembly may be suspended from the pin (not shown in detail) on which this NIP roll is rotatable.

Each bar **21** and **23** of the tension bar assembly has a central longitudinal slot **33**. Near one end of each slot **33** but displaced from the slot a block **35** is secured to the bar. Between these blocks a fixed bearing pin **37** extends on which a roller **39** is rotatable. A movable bearing pin **41** rides in the slots **33** and is secured to a block **43** at each end. A roller **45** is rotatable on the pin **41**. A screw **47** passes through a threaded hole (not shown) in each block **35** and is secured to the corresponding block **43**. A compression spring **51** extends between the blocks exerting a pressure tending to separate the rollers **39** and **45**. The screws **47** may be rotated by a manual mechanism **53** moving the blocks **43** relative to the blocks **35** and setting the force of springs **51**. The setting is indicated on a dial **55**. The pins **41** and the slot **33** should have lubricated bearing surfaces so that engagement of the pins in the slots is substantially friction free.

The thread T of the warp W is wrapped around the rollers **39** and **45**, as shown in FIG. 4 or FIG. 5, so that the tension in the warp counteracts the pressure of springs **51**. As the tension in the thread T changes, the roller **45** moves towards or away from roller **39**. In FIG. 3 the threads T are shown spaced for clarity; adjacent threads are actually very near each other.

A transducer is connected to one of the **43** and is set in accordance with the position of this block. Typically, the transducer may be a SILVERSTAT variable resistor assembly and the movable block **43** may set the magnitude of the resistance of the SILVERSTAT. The transducer is connected in controlling relationship with the field current regulator FCR.

In the practice of this invention the tension-adjustment screws **47** are set for the desired tension. Any departure of the tension in the warp from the setting of the screws results in movement one way or the other of the movable roller **45** and in turn in a change in the transducer output. This in turn resets the field current regulator FCR to compensate for the change and to maintain the tension at the desired magnitude. Since the bar assembly TB rests on the fixed pivot bar **29** or on the pin on which the NIP rolls rotates at one end and on the warp W wound on the beam B at the other end, it has a substantially weightless effect on the warp and does not affect its movement or the tension which is applied to the warp.

In FIG. 6 a tension-bar assembly **TB1** in accordance with a modification of this invention is illustrated. The tension bar assembly **TB1** includes at each end of the warp W a rectangular frame **61** of bars **63** of equal length. These bars are mounted pivotal on pins **65, 67, 69, 71**. The two opposite pins **65** and **67** serve as pivots, the other pins **69** and **71** serve as pivots and also as bearings for rollers **73** and **75** extending along the length of the warp W. The assembly TB1 may be mounted so that the rollers **73** and **75** move freely relative to each other while the pins **65** and **67** move in a slot (vertical with reference to FIG. 6) of a slotted frame member (not shown). Alternatively, one of these roller pins **71**, for example, may be fixed in a suitable bracket (not shown) while the other **69** is movable.

Each bar **63** is provided with a row of equally spaced holes **81** for supporting tension springs **83** and **85**. Depending on the desired tension in the warp W each spring **83** and **85** is connected between selected holes **81** of adjacent bars **63**. The springs **83** and **85** exert a tensional force on the bars **63** tending to pivot them so that the rollers **73** and **75** are urged away from each other. The warp W is wound around the rollers **73** and **75** in the manner shown in FIGS. 4 or 5 and the tension in the warp counteracts the forces exerted by the springs **83** and **85** tending to urge the rollers away from each other. The springs are connected to connecting holes and have constants such that the framework is set for a predetermined tension in the warp. One of the rollers **73** or **75** is connected to a transducer through which the field current regulator FCR is controlled.

The following summary may aid in the understanding of this invention:

This invention relates to the adjustable voltage drive for beam motors MOB of slashers. It is most important to control warp (thread) tension between delivery roll assembly DRA and the beam B during winding. Past practice has been to use beam-motor armature current as an indication of yarn tension.

In a slasher drive, the beam-motor armature current is determined not only by the tension but it also depends on losses due to windage, friction, viscosity of the oil and grease as well as gear losses. Where heavy yarns and many threads are wound, the percentage of armature current from losses is small compared to the current resulting from tension in the warp. Armature current can then be used as a reasonably approximate measurement of warp tension.

The textile industry has now entered a new era where lighter gauge yarns and fewer ends are being wound. This presents a tension problem because the armature current determined by warp tension alone is now a small percentage of the total armature current. The result is that armature current is not a reliable indicator of warp tension.

FIGURE 1 shows the parts of a slasher incorporating the invention. A warp W is wound on a beam B. The delivery rolls DR and DRD set line speed and also acts as a drag on the warp W. Tension must be controlled between the delivery roll and the beam B and this control is effected by a bar assembly TB (FIGS. 1 through 3) or TB1 (FIG. 6).

This assembly includes spaced bars **21** and **23** (or **63**) each with a slot **25** at one end to hook over a crossbar or rod **29** or the nip roll NR itself. At the other end a rider roll **27** is journaled in a pin **91** extending between the bars **21** and **23**. The roll **27** rides on the warp W on the beam B during buildup. This accomplishes the following results:

(1) It renders the bar assembly TB weightless on the warp between the delivery roll assembly DRA and the beam B.

(2) It maintains a constant angular relationship be-

tween the bar assembly TB and the warp W during buildup.

The bar assembly TB includes rolls **39** and **45** over which the warp W is wound (FIGS. 4 and 5). Roll **39** is stationary while roll **45** is free to move according to changes in tension. The setting of tension is accomplished by compression springs **51** by means of calibrating screws **47** set by mechanism **53**. When the set tension (reference tension) is opposed by an equal warp tension, roll **45** is in a fixed position. Any change in warp tension causes roll **45** to move longitudinally in the slot **33**. If tension increases, roll **45** moves against the spring, if it decreases, the spring forces roll **45** away from roll **39**. Use is made of this movement by causing roll **45** to actuate a transducer TD which converts mechanical movement into an electrical change. This electrical change is impressed upon a regulating system which modulates the speed of the motor MOB driving the beam to correct for a change of roll **45**, position and consequently maintain the desired tension on the warp.

This apparatus has facilities for various tension settings and when the warp tension is equal to the reference (set tension) roll **45** is in equilibrium at a position with the transducer TD midway in its travel range. This system permits true tension regulation regardless of the other losses which determine, in part, the armature current in the beam motor.

FIG. 6 shows another mechanism for sensing tension. Tension springs **83** and **85** are used and the magnitude of set tension (reference) is determined by the stretch on the springs and the holes **81** in bars **63** of which the springs are secured. Rolls **69** and **73** both move laterally with this mechanism as tension changes. The mounting of this mechanism is more complicated with respect to that previously described. It requires that a horizontal frame member (not shown) be used to prevent the entire assembly from moving vertically. This horizontal member would be slotted to permit lateral movement of the pivots, **69** and **71**. Alternatively a vertical slotted member could be provided to permit the pivots **69** and **71** to move horizontally. Otherwise, the sensing and corrective methods are similar to those described for FIGS. 1 through 3.

While preferred embodiments of this invention have been disclosed herein many modifications thereof are feasible. This invention, then, is not to be restricted except insofar as is necessitated by the spirit of the prior art.

We claim as our invention:

1. Reeling apparatus for thread particularly for a slasher comprising a beam, warp delivery means from which warp is supplied to be reeled on said beam, the angle of the plane of said warp, as it is reeled on said beam, with reference to the plane of said warp at said delivery means varying from a smaller magnitude to a

larger magnitude, a motor for driving said beam at an adjustable variable speed, transducer means sensing the tension in individual threads of said warp between said delivery means and said beam, and means responsive to said transducer means for adjusting the speed of said motor so that said warp has a predetermined tension.

2. The apparatus of claim **1** wherein the transducer means includes tension responsive means for sampling the tension in a predetermined length of the threads of the warp between the delivery means and the beam and also includes means for maintaining said length substantially parallel to the warp between the delivery means and the beam as the angle of the plane of said last-named warp to the plane of the warp as said delivery means varies.

3. The apparatus of claim **2** wherein the tension-sampling means includes a first roller and a second roller over which the thread of the warp passes and also includes resilient means urging one of said rollers away from the other against the compression exerted by said thread of said warp and also includes means for setting said resilient means so that the rollers exert a predetermined tension on said warp.

4. The apparatus of claim **1** wherein the transducer means includes in addition to a transducer, a bar assembly having a roller at one end, and means to mount said bar assembly for pivoting at the other end, the said bar assembly being mounted to pivot about an axis near the delivery means with the roller riding on the warp, said bar assembly having mounted thereon means for receiving a section of the threads of the warp between the delivery means and the beam in tension-responsive relationship, said receiving means being connected to said transducer to set the transducer in accordance with the tension in the warp.

5. The apparatus of claim **4** wherein the roller rides on the outer layer of the warp wound on the beam and is pivoted in the direction in which the plane of the warp is moved as the warp on the beam builds up.

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U.S. Cl. X.R.

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