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3,354,711

CONTINUOUS THREAD TENSION INDICATING DRIVE ROLLER

Filed Feb. 9, 1967

2 Sheets-Sheet 1

FIG. 1

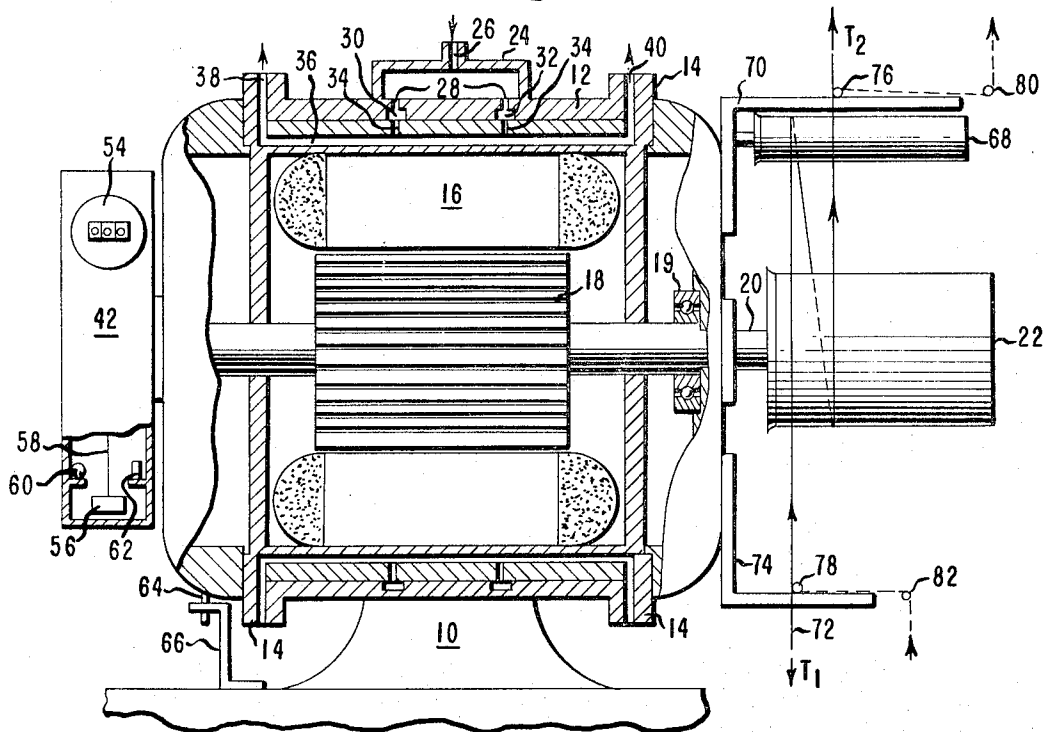


FIG. 3

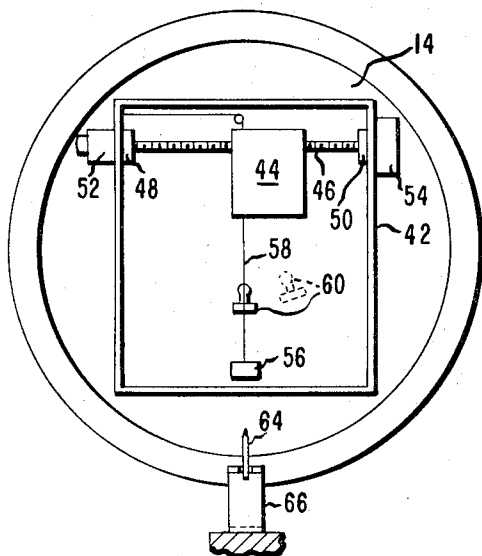
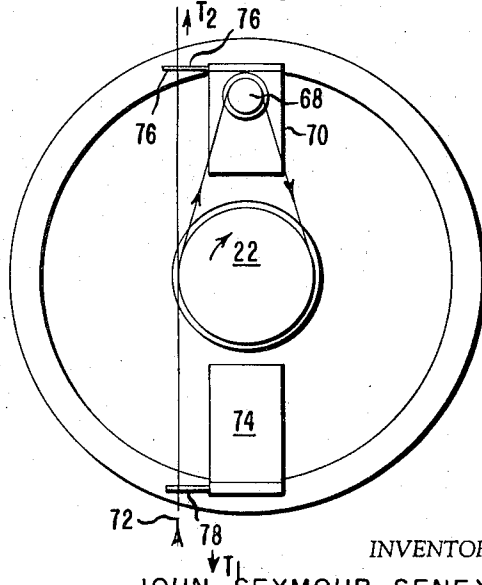


FIG. 2



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FIG. 4

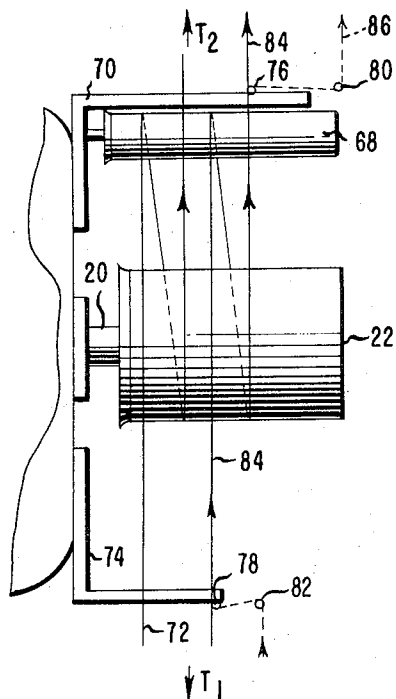


FIG. 5

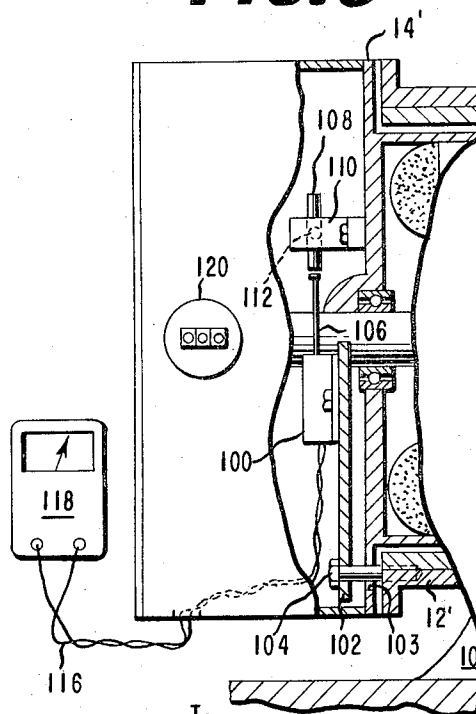
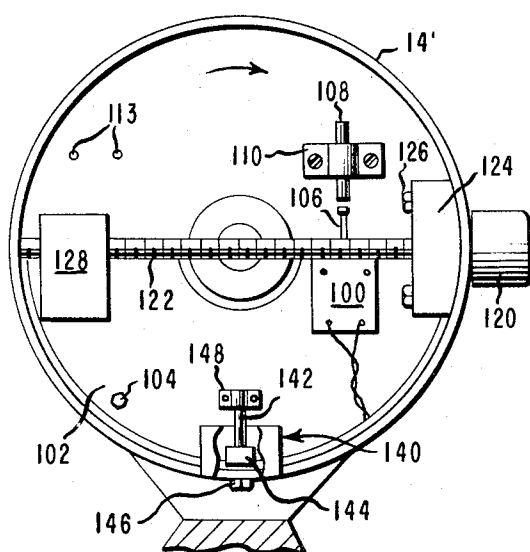
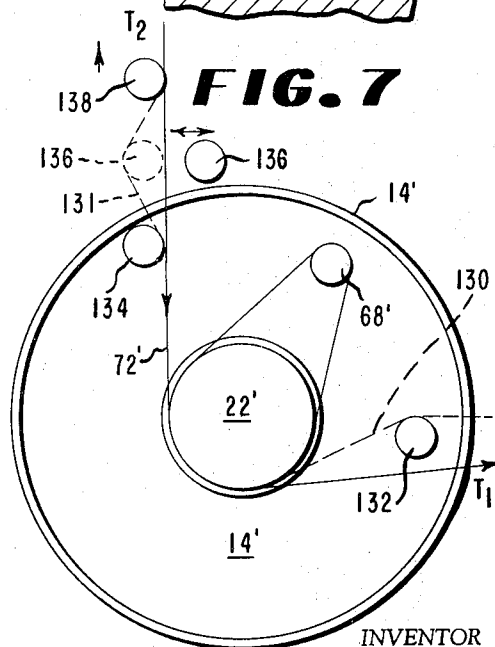


FIG. 6

**FIG. 7**

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CONTINUOUS THREAD TENSION INDICATING DRIVE ROLLER

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11 Claims. (Cl. 73—143)

ABSTRACT OF THE DISCLOSURE

A yarn forwarding apparatus adapted for simultaneously indicating the yarn tension. A yarn advancing roll is coupled to an electric motor the frame of which is supported in an air bearing on a stationary base for free oscillation about an axis coincident with the motor axis. A deviation detector connected to the motor frame indicates tension induced deviations of the frame. The use of tension cancellation devices fixed to the motor frame at right angles to the path of the yarn permit selective measurement of the absolute tension of either an incoming or outgoing threadline.

This application is a continuation-in-part of my co-pending application Ser. No. 307,181 filed Sept. 6, 1963 and now abandoned.

Background of the invention

The invention relates generally to an apparatus for moving a strand material and, more particularly, to the use of the apparatus to simultaneously measure the strand tension while moving the material. When used herein the embodiments will be illustrated as a yarn forwarding apparatus; however, it is to be understood that the invention is also applicable to the forwarding of wire, tape, film, foil, etc. In prior art devices, tension of a moving yarn is measured by a hand-held or permanently fixed device which deflects the moving thread from its normal course of travel and measures its tension by measuring the force in the yarn which attempts to restore the same to its normal course of travel. Pins or rotating wheels are used to deflect the thread and in high speed operations these are trouble spots which wear rapidly. In addition, they degrade the yarn under measurement.

Summary of the invention

It is accordingly an object of this invention to provide a novel apparatus set-up for advancing yarn whereby the tension difference between an incoming and outgoing yarn may be ascertained and indicated without interposing additional contact points along the course of travel of the yarn. Another object of this invention is to provide a novel apparatus for moving the yarn that will simultaneously measure the absolute tension of either an incoming or outgoing threadline.

The improved tension-measuring apparatus of this invention comprises: A yarn advancing roll connected to and driven by an electric motor which is supported for free oscillation on a stationary base; a photocell arrangement, including a beam of light, supported in a fixed position relative to the frame of the motor and a thread like weighted element supported to maintain an essentially constant vertical position, for effectively interrupting the beam of light when the photocell arrangement is in the null position or for passing the light beam through when the photocell arrangement, together with the motor, have deviated from a null position. In addition tension cancellation devices are included for cancelling the tension of the yarn on either the incoming or outgoing end with respect to the roll whereby the apparatus will measure the absolute tension of an incoming or outgoing

end. The cancellation devices include a post or guide extending at right angles to the path of the yarn and situated to serve as a direction changer for the yarn, the guide is rigidly connected to the frame for joint oscillation with the motor.

Brief description of the drawings

FIGURE 1 is a side view of the apparatus partially in section shown controlling a single threadline.

FIG. 2 is the right end view of FIG. 1.

FIG. 3 is a left end view with the cover removed from the control box.

FIG. 4 is a partial right side view of the apparatus controlling two threadlines.

FIG. 5 is a partial left side view of the preferred embodiment.

FIG. 6 is the end view of FIG. 5 with the cover removed.

FIG. 7 is the right end view of the preferred embodiment of the invention.

Description of the illustrated embodiments

The yarn moving apparatus shown in FIG. 1 comprises a fixed support 10, to which is attached an outer bearing shell assembly 12. Supported by a frictionless bearing inside said shell is the motor frame 14, which is the support for a standard synchronous motor. Also shown are the stator windings 16 and a rotor 18 which is supported in the stator by bearings 19 and is connected to shaft 20, which supports drive roll 22.

An air bearing is used as the frictionless support whereby shell assembly 12 supports the motor frame 14. The shell assembly 12 has mounted on it an air manifold 24 where air is supplied by entrance hole 26, and through holes 28 to two annular cavities 30 and 32. Each annular cavity supplies air to four restriction ports 34, located 90° apart. Air from the restriction ports flows into an annular space 36 between shell 12 and frame 14. Air escapes from the annular space 36 to the atmosphere through the gaps 38 and 40 which are formed by flanges on shell 12 and frame 14. The air in the gaps 38 and 40 provides axial support for any thrust load that might be applied to the motor or the drive roll 22. Thus, the air-bearing supports the motor both radially and axially. With this frictionless bearing it can readily be seen that any torque, induced by outside means on the drive roll 22, will cause the motor frame 14 to rotate.

Referring to FIG. 3, affixed to the back of the motor frame 14 is a control box 42, in which is mounted a movable weight 44, supported on a screw thread 46, which in turn is supported by bearings 48 and 50. The screw thread 46 may be made to rotate by the weight motor 52, which is mounted on one side of the control box 42. The position of the movable weight 44 is shown visually by an indicator 54, which measures the rotation of the screw thread 46. Also mounted in control box 42 is a weight 56, hung as a pendulum on wire 58. Mounted in close proximity to weight 56 is a light 60 and a photocell 62 (FIG. 1), which act jointly to monitor the position of wire 58. In order to prevent the motor frame 14 from rotating too much, it is constrained by pin 64, attached to the motor frame, and notched bracket 66, affixed to the stationary base 10. On the front end of the motor, in association with the drive roll 22, is a separator roll 68 which is mounted on bracket 70, the latter in turn being affixed to the motor frame.

In operation, air is supplied to entrance hole 26, and the motor frame 14 is supported by the resulting cushion of air. Thus, any force or moment on the assembly will cause the frame 14 to rotate. The movable weight 44 is used to counter-balance this force. If the frame 14 rotates, light 60 and photocell 62 rotate with respect to weight

56 and wire 58. The photocell pickup 62, which can be any of several well-known position pickup devices, receives a signal indicating that wire 58 is not in the null position. This signal is then amplified through appropriate circuitry (not shown) and causes the weight-motor 52 to rotate screw thread 46 and position the movable weight 44 so that the frame 14 is brought to a null position. In this particular embodiment, the null or "zero" position is when wire 58 assumes a position of alignment between light 60 and photocell 62.

The indicator 54 measures the rotation of the screw thread 46 and indicates the location of the movable weight 44. By setting indicator 54 to zero when the assembly is operating and drive roll 22 is running without a thread, the indicator 54 can be calibrated in terms of tension-induced torque to indicate tension in grams. The sensitivity of this system has been measured to be one part in 10,000.

A moving thread 72 is strung up around drive roll 22 and separator roll 68, as shown in FIGS. 1 and 2. While only one wrap is shown, several wraps may be taken around the two rolls if necessary. The tension in the incoming portion of thread 72 is indicated as T_1 . The tension in the outgoing portion of thread 72 is indicated as T_2 . If, due to external factors, tension T_2 is greater than tension T_1 , there will be a tendency for the difference between these two tensions to cause frame 14 to rotate counter-clockwise, looking at the back end of the motor (FIG. 3). This tension-induced torque will cause light 60 and photocell 62 to move out of null position with respect to wire 58 and consequently a correction signal will be applied to weight motor 52, which will cause movable weight 44 to move to the right to counter-balance the applied torque. The indicator 54, which measures the location of movable weight 44 indicates, in grams, the differential tension applied to the drive roll 22. Any well-known remote signal indicator can be used to transmit this indication of thread tension to a location removed from control box 42.

If a moving thread first contacts an appurtenance of the floating frame while moving in a direction parallel to the axis of the motor, the tension in the thread will cause an axial reaction on the frame; however, there will not be any component which will tend to rotate the floating frame. By taking advantage of this phenomenon it is possible to measure the absolute tension either on an incoming thread or on an outgoing thread. This is done with either of the cancellation guide pins 76 and 78 which are mounted on brackets 70 and 74, respectively. In combination with the cancellation guide 76 on bracket 70, there is a direction restoring guide 80 mounted on a solid support, not associated with the floating frame 14. In association with cancellation guide 78 on bracket 74, there is a direction changing guide pin 82 mounted on a solid support.

If it is desired to measure tension T_2 , then thread 72 can be strung up around guide pins 82 and 78, around drive roll 22 and associated separator 68 and on the next piece of equipment. T_2 will then be the only force causing rotation. Movable weight 44 will take a position to balance this force, and indicator 54 will indicate the tension T_2 . If it is desired to measure T_1 , pins 76 and 80 are used, but not 78 and 82.

Frequently more than one thread may be driven by drive roll 22 but it is desired to measure the tension in one thread only. For example, in FIG. 4 two threads are being driven, the thread whose tension is to be measured may be strung up as indicated by thread 72. In order to cancel the tension from the second thread 84, the incoming portion thereof is strung-up around pins 82 and 78, while the outgoing portion follows the course around pins 76 and 80 as indicated by dotted lines. The measuring apparatus, then measures only the difference in tension applied to thread 72.

In the preferred embodiment, shown in FIGS. 5, 6 and

7, the motor frame 14' is suspended on an externally pressurized air bearing as previously described and a simplified read out system consisting of a force sensitive transducer actuated by tension induced torque is substituted for the photocell indicator means described in connection with FIGS. 1 and 4.

Referring to FIGS. 5 and 6, a semicircular plate 102 is attached to outer bearing shell assembly 12' by bolt 104 which passes through clearance hole 103 in the motor frame 14'. Angular movement of the measuring system is limited by the clearance between bolt 104 and hole 103. Fastened to plate 102 is a force transducer 100, which is connected to meter 118 through leads 116. The force transducer is of the type manufactured by Statham Transducers Inc. as model number G-1-4-250. An actuator rod 108 is held in bracket 110 by set screw 112 and is located in close proximity and axially aligned with transducer linkage pin 106. A counter balance weight 124 is fastened to motor frame 14' by bolts 126. Movable calibrating weight 128 is supported on screw thread 122 which in turn is rotatably supported at its ends in motor frame 14' and is attached at one end to microdial 120. Screw thread 122 is made to rotate to position weight 188 by turning microdial 120 which is also mounted to motor frame 14'. The tendency for the system to oscillate is restrained by a dash pot 140 attached to motor frame 14' by bolt 146 and includes a conventional piston 144 attached to plate 102 through arm 142 and bracket 148. The use of Dow 200 silicone oil within the dash pot has been found to allow adequate response without affecting the accuracy of the system. As shown in FIG. 6, the system is set up to measure torque induced on the motor when the roll 22 is rotating counter-clockwise; however, by removing transducer 100, turning plate 102 over, remounting the transducer on the plate and mounting actuator rod bracket 110 in holes 113, the system is readily adapted to sense torque when the roll 22 is rotating clockwise.

In operation, any force or moment on the assembly will cause frame 14' to rotate. The calibrating weight 128 in conjunction with weight 124 is used to counter balance this force. If the frame 14' rotates the actuator rod 108 transmits force to transducer 100 through linkage pin 106. This force is translated to an electrical output which is read out on meter 118 calibrated in grams. The tension cancellation feature of the preferred embodiment (FIG. 7) involves taking the threadline off or on the floating frame assembly in a line which passes through the center of rotation of the floating assembly. This is accomplished by mounting roller guides 132, 134 on frame 14'. In combination with roller guide 134, there is a movable guide 136 and a direction restoring guide 138 mounted on a solid support not associated with frame 14'.

If it is desired to measure tension T_2 , then thread 72' can be strung up in peripheral contact with guides 138, 134 around drive roll 22' and associated separator roll 68' over guide 132 along threadline path 130 and on to the next piece of equipment. T_2 will then be the only force causing rotation. If it is desired to measure T_1 , guide 136 is moved to the dotted position, the threadline is diverted to path 131 and guide 132 is not used. Guide 136 may be either manually or mechanically actuated or driven by an indexing motor. It is readily understood from the previous discussion that more than one thread may be driven by roll 22' and sometime it is desirable to measure the tension on one thread only. The thread whose tension is desired to be measured is strung up as indicated at 72'. To cancel the tension from the other threadlines, they are strung up as indicated by the dotted lines around guides 132 and 136.

In a single thread operation, it is readily understood that if the thread should break there would be no tension on the measuring system and it would assume its zero position. By appropriate circuitry, this effect can be used to indicate that there occurred a breakdown in the process-

ing system. Similarly, if a number of threads are being driven by drive rolls 22, a break in one thread would reduce the measured tension and this also can be used to indicate a break in one of the threads.

In all the previous discussions the synchronous motor has been set at a selected speed to drive the thread and measure tension-induced torque, thus measuring the tension in the threadline. But if desired, this apparatus also can be used to measure the speed of the thread. Thus, the speed may be varied until the differential tension between T_1 and T_2 is zero, and then a measurement of the speed of the roll is an indication of the linear velocity of the thread.

Frequently it is desirable to know what the dynamic coefficient of friction is between a moving thread and a stationary object or one that is moving at a different speed than the thread. This apparatus can be used to measure the dynamic coefficient of friction in such cases. Thus the thread is pulled across the drive roll 22 by some outside drive means and the drive roll 22 can either be driven in the same direction as the moving thread at a different speed, or it can be moved counter to the direction of the thread. The friction forces will generate torques which will then be counter balanced by movable weight 44; indicator 54 will then indicate the magnitude of these forces and, by appropriate calibration, it can indicate the coefficient of friction.

In certain closely controlled melt spinning processes, yarn denier is a direct function of threadline tension. Therefore, this invention is readily adapted for continuous high speed deniering of yarn by measuring either the incoming or outgoing absolute tension which, in turn, will correlate with denier.

It will be understood that the details of the above disclosure may be varied widely within the skill of those engaged in this art. Thus, while an induction motor has been named in the preferred embodiment described above, it is clear that any other electric motor having a rotor which operates within a stationary frame may be used in this invention, the principle of this invention being that while the rotor rotates within the frame, the latter is itself supported for free oscillation on an essentially frictionless bearing. Likewise, while an air-bearing has been used in the preferred embodiment as a means for producing essentially frictionless support, any form of support which will reduce the supporting friction to a negligible value may be resorted to, for instance an oil film, highly lubricated roller bearings, etc. In any event, the mode of supporting the motor frame can influence only the degree of sensitivity of the device for measuring yarn tension, but does not change the principle of its operation.

The advantages and wide field of utility of this invention will be readily apparent. Thus, the apparatus of this invention provides an improved method of measuring the differential tension in a yarn without additional contact points. It also is capable of measuring the absolute tension in an incoming or outgoing threadline. Further, it is so sensitive that it can be used to detect a missing filament from a single threadline or a missing thread from a multi-threadline position as a result of the reduction in tension when the thread is missing. This apparatus also can be used for measuring the dynamic coefficient of friction between a thread and a roll, as well as for measuring the linear velocity of a thread.

In a specific embodiment, using a one HP induction motor, successful results were obtained by using an air pressure at inlet 26 of 20 to 40 p.s.i.g. and an air consumption of 3 to 5 cu. ft./min. (under standard conditions).

In the foregoing discussion I have used repeatedly expressions like "driving roll," "a roll for propelling the yarn," or "driven by a synchronous motor," by which I followed merely customary usage of language among plant people. Such terminology would be strictly correct when the yarn does not travel beyond roll 22, for instance, in an operation where roll 22 represents a bobbin on which

yarn is wound to make a yarn package. Often, however, the yarn is being pulled from a point beyond roll 22, in which case T_2 is greater than T_1 and roll 22 acts merely as a tension-changing device or as a yarn movement control. This control is aided by motor 14-18, which acts sometimes as a motor and sometimes as a generator to maintain the speed of roll 22 constant, regardless of changes in T_2 or T_1 .

What is claimed is:

1. A yarn moving apparatus adapted for indicating simultaneously the tension in the yarn, said apparatus comprising: a yarn movement control roll; an electric motor operatively connected to said roll, to control the speed of the same, the frame of said motor and said driving roll being jointly suspended through an essentially frictionless contact, on a stationary support for free oscillation about an axis coincident with the axis of the motor; and indicator means rigidly connected to the frame of the motor for joint oscillation therewith whereby to indicate deviations of the motor frame from an assumed zero position as a result of variations in the torque imposed on the roll, said indicator means comprising: (a) a photocell arrangement, including a beam of light, supported in a fixed position relative to the frame of the motor; and (b) a thread-like element weighted to maintain an essentially constant vertical position, said thread-like element being supported for effectively interrupting said beam of light when the photocell arrangement is in the null position and for passing said light beam through when the indicating device, together with the motor, have deviated from said null position.

2. An apparatus as in claim 1, said indicator means comprising further means, actuable by said photocell arrangement, for restoring the assembly of the motor and indicator means to its null position and means for measuring and indicating the amount of rotation required by said assembly for achieving said restoration.

3. The apparatus as in claim 2, said means for restoring, comprising a weight movable on a support in a direction transverse to the axis of the motor and means for moving said weight along said direction whereby to displace the center of gravity of the entire assembly and to swing the motor back to its zero position.

4. An apparatus as in claim 1, said electric motor being a synchronous alternating current motor.

5. An apparatus as in claim 1, said electrical motor being a synchronous alternating current motor and being suspended on said stationary support by means of air bearings, whereby to achieve essentially frictionless contact between said motor and support.

6. An apparatus as in claim 5, said air bearings being fashioned to allow the motor freedom of independent motion, within predetermined restricted ranges.

(a) circularly, around the axis of the motor, and (b) linearly, in a direction parallel to said axis.

7. The apparatus of claim 1 containing means for cancelling the tension of the yarn with respect to said roll, said cancellation means including a guide extending at right angles to the path of the yarn and situated to serve as a frictional-contact direction-changer for said yarn, said guide being rigidly connected to the frame of the motor for joint oscillation therewith.

8. An apparatus as in claim 1, said yarn control roll being associated with a separator roll, for separating the windings of the yarn on said control roll, said separator roll being radially spaced from said control roll and affixed to the frame of the motor, thereby allowing said separator to oscillate about the axis of the control roll.

9. A yarn moving apparatus adapted for indicating simultaneously the tension in the yarn, said apparatus comprising: a yarn advancing roll; an electric motor having a rotor and a frame, said rotor being operatively connected to said roll for rotation thereof; a stationary support; the frame of said motor extending coaxially through and being freely suspended in said stationary sup-

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port for limited oscillation about an axis coincident with the axis of the motor; means for indicating deviations of the motor frame from an assumed zero position as a result of variations in the torque imposed on said roll, said indicating means including a deviation detector rigidly connected to the frame of the motor for joint oscillation therewith; and means for cancelling the tension of the yarn on the incoming end with respect to said roll whereby said indicating means will measure solely the tension on the outgoing end, said cancellation means including a guide extending at right angles to the path of the yarn and situated to serve as a frictional-contact direction-changer for said yarn, said guide being rigidly connected to the frame of said motor whereby to oscillate jointly with the motor.

10. An apparatus as in claim 9 containing further means

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for cancelling the tension of the yarn on the outgoing end with respect to said roll whereby said indicating means will measure solely the tension on the incoming end, said cancellation means including a guide extending at right angles to the path of the yarn and situated to serve as a frictional-contact direction-changer for said yarn, said guide being rigidly connected to the frame of said motor whereby to oscillate jointly with the motor.

11. The apparatus of claim 10 wherein said guides are roller guides.

No references cited.

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