United States Patent

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[72] Inventor Carroll H. Parker
1502 Meadowview Road, Greensboro, N.C. 27409

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[54] AUTOMATIC TENSION CONTROLLER
12 Claims, 6 Drawing Figs.

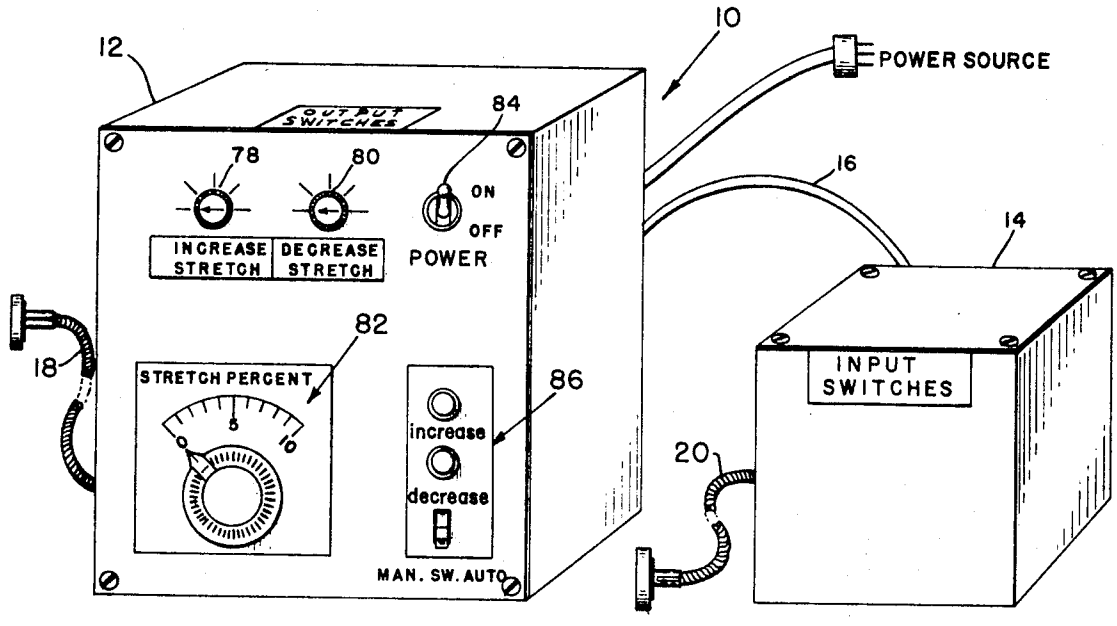
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[51] Int. Cl. B65h 23/22
[50] Field of Search 318/7; 226/30, 40, 41, 42, 45, 100; 26/51

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Primary Examiner—Richard A. Schacher
Attorney—David Rabin

ABSTRACT: An automatic tension controller for a web material machine which has an input shaft and an output shaft on which the web material may be tensioned or overfed selectively during the winding operation, the controller including responsive devices indicating the rotation of the input and output shafts and signalling means providing an electrical pulse when the rotation of one shaft differs from the rotation of the other. The signalling means are operative to prevent the provision of electrical pulses when the rotation of the shafts is within preselected and adjustable tolerances. The shafts are driven by an adjustable differential drive, and a pulse-responsive device controls the differential drive to increase and/or decrease the speeds of the input and output shafts when pulses are provided by the signalling means.



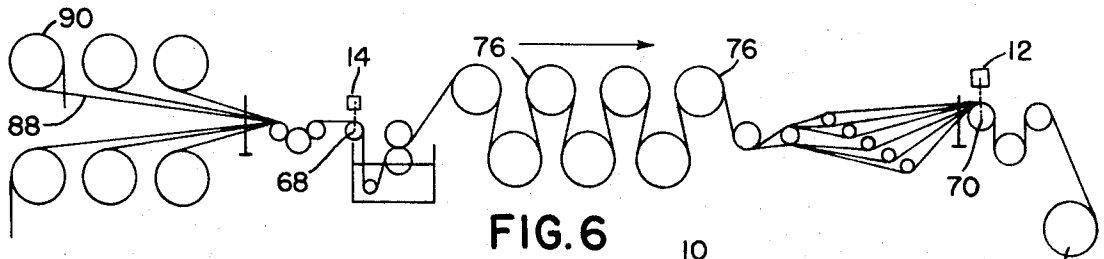


FIG. 6

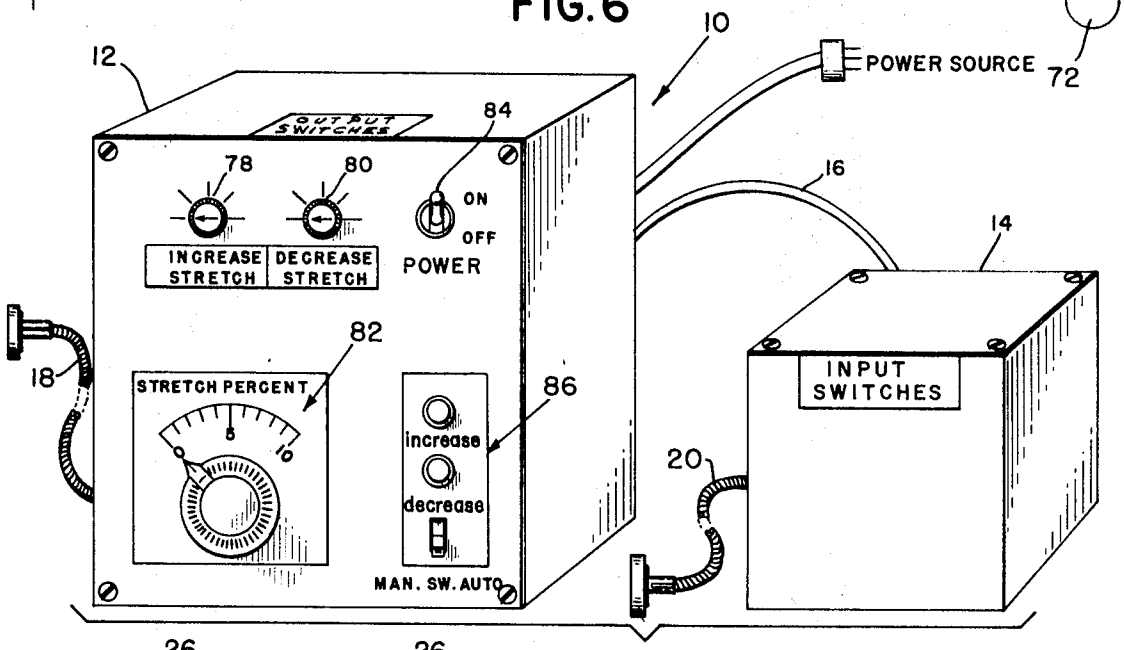


FIG. 1

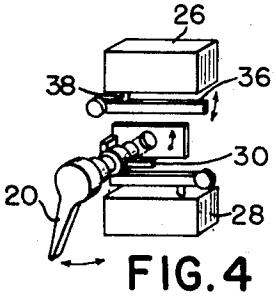


FIG. 4

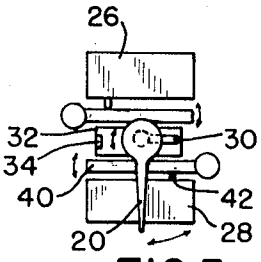


FIG. 5

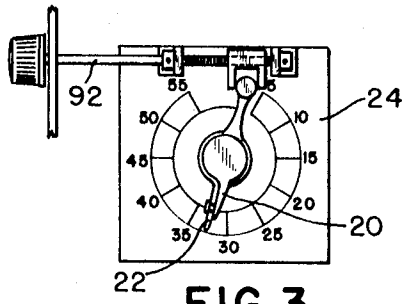


FIG. 3

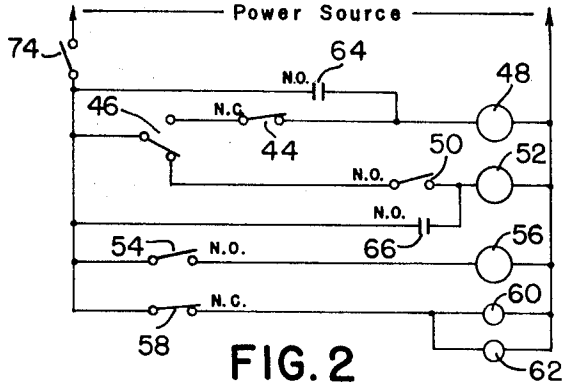


FIG. 2

INVENTOR.
CARROLL H. PARKER

AUTOMATIC TENSION CONTROLLER

BACKGROUND, BRIEF SUMMARY AND OBJECTIVES OF THE INVENTION

The textile industry is replete with numerous operations and machines wherein a continuous web of yarn or fabric is wound onto a bobbin core, or other appropriate holding device. These winding operations are in many cases the result of first unwinding a wound mass of yarn or fabric and then rewinding the material after performing some operation or treatment to the yarn or fabric.

In many cases, the yarn or fabric in wound and finished form is more commercially presentable and functionally useable during the knitting or weaving operation if some degree of tension is included in the final wound package since this will permit the winding of additional material for a similar sized package having no tension and remove any wrinkles or crimping in the material that might be undesirable. In some instances, overfeeding of a final package of yarn or fabric is desired thus requiring the output shaft carrying the pirn or roller to be rotated at a slower speed than the input shaft. This is particularly desirable in the production of bulk yarns and the like where an overfed yarn package is autoclaved to remove undesirable torque in the yarn.

In order to control this tensioning or overfeeding operation, it is necessary to compare the rotational speeds of the input and output shafts by suitable means so that any differential may be immediately detected and appropriate measures taken to correct the speed of the shafts if there is an unwanted differential speed. Additionally, it is desirable to provide automatic means responsive to this comparison operation that will adjust the rotational speed of the two shafts within the prescribed and preselected limits. Pulse generating devices may be used for this operation so that the pulses can be directionally applied in any number of applications to a rheostat, motor windings or any other pulse-responsive device that may be adapted to change the rotational speed of one or both of the shafts involved. An effective controlling technique involves the use of a Reeves drive which comprises two adjustable pulleys wherein the pulley adjustment is made by a device responsive to the generated electric pulses so that the input shaft can be varied in rotational speed with respect to the output shaft by the pulse-generating generating device. The use of a Reeves drive also is advantageous in that a single driving motor can be used to drive both the input and output shafts with the differential rotation of both shafts regulated by the drive in response to the generated pulses.

The present invention is particularly applicable to the slashing operation on a slasher used to prepare warp beams for loom use wherein a section beam is unwound and the yarn strands are continuously passed through a sizing solution which gives each individual warp strand additional strength and allows that strand to slide freely within the heddles of the loom during the weaving operation. As the sizing is applied to the warp, the output shaft of the slasher rotates to rewind the strands on a warp beam for subsequent use in the weaving operation.

Broadly stated, the present invention is an automatic stretch or tension controller for a web material machine which has an input and an output shaft through which the web material may be tensioned or overfed selectively. The stretch or tension controller includes devices which determine and indicate the rotational speed of both the input and the output shafts and signalling devices which provide an electric pulse when the rotation of one of these shafts differs from the rotation of the other. When the shafts rotate at the same speed or within preselected and adjustable tolerances, no pulse is provided. One or more motors drive the input and output shafts, and the controller has electrically responsive means controlling the speeds of the shaft motor or motors to increase and decrease shaft speeds or shaft speed differential when pulses are provided by the pulse-generating devices. The operation of the present invention can be fully integrated with a calibrated device which will enable the attendant to preset and/or read directly the amount of overfeed or tension of the web material during the winding operation.

Accordingly, it is an object of the present invention to provide an automatic tension controller of the type described which will sense the differential rotation in two compared shafts and automatically adjust the shaft driving mechanism to bring the speeds of the shafts within preselected and adjustable tolerances.

Another object of the present invention is to provide an automatic tension controller of the type described which is extremely simple in construction and operation as compared to conventional apparatus used for the same purpose and which will, because of its economy, permit the use of such apparatus in applications heretofore deemed too costly.

Yet another object of the present invention is to provide an automatic tension controller of the type described which is suitable for controlling motor speed and/or mechanical differential drive rotation.

Yet still another object of the present invention is to provide a tension controller of the type described wherein any number of devices including timers, photoelectric cells, relays and the like may be used to compare the two rotational speeds of input and output shafts.

Yet still another further object of the present invention is to provide a tension control device of the type described which is extremely accurate within standard commercially acceptable ranges.

These and other objects of the present invention will become more apparent after a consideration of the following detailed specification taken in conjunction with the accompanying drawings wherein like characters of reference designate like parts throughout the several views.

FIGURE DESCRIPTION

FIG. 1 is a perspective view of the housing and exterior of the present invention showing the main control box and output switch housing and the separate input switch housing along with the input and output shaft connecting rotatable cables attached thereto.

FIG. 2 is a circuit diagram of the present invention.

FIG. 3 is a side elevational, sectional and fragmentary view of a portion of the comparing cycle timer, two of which are used in the present invention.

FIG. 4 is a perspective, fragmentary and exploded view of the limit switch arrangement for one of the two timers which are used in the present invention.

FIG. 5 is a front elevational, sectional and fragmentary view of the timer apparatus of FIG. 4 showing the directional movement of the indicator and operation of the cooperating limit switches.

FIG. 6 is a side elevational and schematic view of a slasher showing the positioning of the present invention to control the tension or overfeed desired in the slashing operation.

DETAILED DESCRIPTION OF THE DISCLOSURE

Referring now to the drawings and particularly to FIG. 1, an automatic stretch controller shown generally as **10** is preferably housed within two packages, a main control panel **12** housing both the basic control components of the invention along with the output shaft speed-responsive timer and the various relays (not shown) suitably wired to pulse a motor control device, and the input shaft speed-responsive timer housing **14** which may be positioned remote from housing **12** and is connected thereto by suitable conductors **16** forming the control wire circuitry. Communication between the shafts and timers to sense shaft rotation is achieved through shrouded rotating cables **18** and **20** so that the comparison operation is actually achieved within the control panels **12** and **14**.

Recycling timers, (not fully shown) portions of which are shown in FIGS. 3, 4 and 5, such as that manufactured by Industrial Timer Corporation, are used in the comparing operation, and the timers are connected directly to the rotating cables 18 and 20 connected with the input and output shafts of the winding machine. The timers are suitably geared down from the actual shaft rotations, and the timer cycle indicator 20 will rotate through a fixed time interval adjusted by a stop 22 thus causing a comparison to be made of the input and output shaft rotation for a set interval after which the timers will be automatically restarted for a subsequent cycle. As will be seen in FIGS. 3, 4 and 5, the timer cycle may be set for a number of seconds such as might be set forth on the indicator face 24, this interval being possibly varied for different material or quality standards.

A first microswitch 26 is positioned at the upper portion of each timer and a second microswitch 28 is located at the lower portion of the timers so that the two switches can be operated at a spaced time interval near the termination of each timer cycle. As will be seen in the appropriate figures, a lug 30 which rotates with the timer indicator 20, contacts a pivot block 32 at a depending stud 34 to rock the pivot block upwardly against the limit switch triggering arm 36 thus actuating the switch at its trigger 38. As the timer indicator continues its rotation, the block 32 continues to pivot downwardly to contact the second pivotally secured limit switch triggering arm 40 to actuate the second limit switch trigger 42. Obviously, the spaced interval for operation of microswitches 26 and 28 can be increased or decreased by any number of changes in the structural configuration of the block and the triggering arms. Both the input and output shaft speed-responsive timers are as described above and utilize the sequential actuation of the limit switches to control the tension of the web material during the winding operation.

Referring now to the circuit diagram of FIG. 2, and considering the operation of the present device through one complete cycle, both the input and output shafts are rotating and their associated timers are proceeding through the set cycle time as the indicators 20 move from the stop 22 through the time interval down to the zero position. Assuming that both shafts are rotating approximately at the same speed and no external control of these shaft driving motors is needed, the first limit switch corresponding to limit switch 26 in FIG. 4 of the output timer will be operated to open normally closed contact 44. Since both the input and output shafts are rotating at approximately the same speed, the normal operational scheme will then permit normally open switch 46 (a double pole single blade switch) to close and consequently no circuit is established to the relay 48 which would eventually provide an electrical pulse when actuated to increase a differential speed between the input and output shaft or increase the speed of the output shaft to compensate for overfeed or too little tension. The next operational sequence will have normally open limit switch 50 of the output timer closing though no energization of relay 52 is achieved because switch 46 opens the circuit to that relay when moved from its normally closed position. Thus no pulse will be generated by relay 52 to slow the output shaft or reduce differential speed as when too much tension is being applied through faster rotation of the output shaft.

The final operation is the closing of normally open contact 54 which actuates the reset mechanism 56 of the timer and thus resets both timers for a subsequent operation cycle. Actuation of the reset portion of the timers 56 opens normally closed contact 58 which deenergizes the timer clutches 60 and 62 thus permitting the spring biased timers to return to their initial full cycle position for the commencement of another operation.

In the event too little tension is being provided in the web material being wound, i.e., the output shaft rotation is not sufficiently greater than the input shaft rotation, the input limit switch 46 will close first thus providing a circuit to relay 48. Energization of relay 48, which will be held in the energized state by holding contacts 64, will cause that relay to generate a pulse which is then transferred to a motor control unit of conventional construction and design which will increase the rotational speed of the output shaft or increase the shaft differential speed to provide proper tensioning of the web material during the winding operation. As can be seen from the circuit diagram, the subsequent operations of the various limit switches will continue until limit switch 54 is closed and the timer cycles are reinitiated.

In the event too much tensioning of the material being wound occurs, i.e., the output shaft is rotating at too great a differential speed over the input shaft, limit switch 44 opens and this operation is followed immediately by the closing of limit switch 50 which then completes a circuit to and energizes relay 52, the motor control slowing relay which will, by pulsing the shaft rotation control device, reduce the speed of the output shaft or shaft differential speed to bring the tensioning to a desired and preset degree. The closing of relay 52 closes its associated contacts 66 which hold the relay in the energized state. Subsequent operations of the limit switches will continue until the last limit switch 54 closes and the timer is reset for the next cycle. In the operation of relays 48 and 52, an interlock associated with both of the relays will preclude the energization of the other relay after the first relay has been actuated.

The present invention is particularly helpful in the slashing operation whereby it is positioned on the slasher components as shown in FIG. 6, the input housing placed in direct connection with the input shaft 68 as shown and the control housing containing the output speed-responsive timer placed at the output shaft 70. The warp, after passing through the sizing solution, is wound onto a beam 72, and the amount of tension of the warp on that beam is controlled between the input shaft 68 and the output shaft 70 by operation of the automatic tensioning controller.

It has been found advantageous to provide a manually operable switch 74 which will allow the automatic tensioning controller to be operable only when the slasher is in the "run" condition thus permitting the slasher to be operated in the "creep" condition without the control of the tensioning apparatus since the tension of the web material being wound is of little concern in this instance. Obviously, the switch 74 may be automatically controlled by wiring directly to the slasher control so that actuation of the "creep" and "stop" conditions will automatically deactivate the tensioner.

Additionally, it is oftentimes desirable to remove the tensioner when starting and stopping the slasher as there is a tendency for the warp yarn tension to change at those particular instances. This may be done by providing wired switches (not shown) directly with the pushbutton "start" and "stop" controls on the slasher so that the automatic control of the tensioner is bypassed during these particular operations to permit the provision of pulses to change the tension in the web material so as to counteract the tension inherent in the starting or stopping of the slasher.

In controlling the speed of the input and output shafts, the conventional drive system of a slasher involves the use of a single electric motor which drives the drying cans 76 and the output shaft as well as the input shaft 68. The differential rotation of the output shaft 70 and the input shaft 68 is achieved by the use of a Reeves drive connected between the drying cans 76 and the input shaft 68 whereby a pulse-responsive device will vary the pulley diameters directly connecting the can drive 76 and the input shaft 68. Thus upon appropriate pulse signal from the stretch controller, the Reeves drive pulleys will change in dimension and the input shaft rotation will be varied accordingly. Any number of conventional devices are available and suitable for electrically controlling the Reeves drive in response to the generated electrical pulses.

While the slashing operation does not usually require any overfeeding since it is normally desirable to wind the warp beam 72 under tension, there are instances where particular fabrics or yarns may require overfeeding so that a very loose

package can be provided by the winding operation. The most appropriate and economical approach to this problem by means of the present invention is the positioning of an electric drive motor contiguous with the surface of the fabric falling along the edge of the input shaft **68** so that this motor may be pulsed through a rheostat to achieve an increase in speed and its associated drive wheel will frictionally drive the fabric at a higher rate of speed over the input shaft. There are other instances where an overfeed is necessary particularly in the production of specific fabrics or in the winding of a bulk yarn for subsequent autoclaving to remove the torque.

It will be obvious that numerous applications of the present invention are available wherever the operation calls for a compared rotational speed of two cooperating drive shafts to insure a proper regulation of that rotation within prescribed limits.

In FIG. **1**, the control panel housing **12** is provided with a number of indicating devices, notably the increase stretch indicator **78**, the decrease stretch indicator **80** and the stretch percentage indicator **82**, these controls being appropriately connected to the system components previously described. for example, when relay **48** is energized thus establishing an electrical pulse to increase the rotation of the output shaft, indicator light **78** is energized to demonstrate visually that an increase in tension is occurring. This also applies to the operation of relay **52** wherein the decrease stretch indicator **80** will indicate that the rotation of the output shaft has been decreased in speed. An off-on switch **84** is provided to deenergize the entire system when necessary, and pushbuttons for manually increasing and decreasing the tension of the machine in conjunction with the "Manual-Auto" switch shown generally as **86** permits the disconnection of the automatic feature of the machine and allows the operator to bring the tension manually to the required degree.

The stretch percentage indicator **82** is provided so that a certain percentage of stretch can be established by a proper coordination of the two timers incorporated in the control portion of the tensioner **10**. The switch is calibrated so that a position at a given percentage will automatically adjust each of the timers for a proper cycle and thus coordinate the circuit to prohibit pulsing so long as the proper percentage of tension remains in the material web being wound. In the event the tension drops below or goes above the preset amount, the timers and associated limit switches will operate as has been previously described to increase or decrease the input shaft speed automatically so that a proper percentage of stretch will again be achieved.

It will be readily apparent that the components of the present invention are extremely simple and inexpensive and thus this invention will permit the use of the device in any number of applications for a nominal cost. It is oftentimes desirable to regulate the tension in the yarn strands **88** extending from the section beams **90** to the input shaft **68**. It would be a relatively simple matter to install a number of input switch housings **14** at the various section beams **90** and place a master control cabinet **12** at the input shaft so that by a selective sampling, tensions in all of the section beams **90** could be monitored within precise tolerances. The use of numerous devices embodying the present invention on such section beams would still not approach the cost of conventional equipment used to control the tension. For example, an output shaft timer may be positioned on each of the section beams **90** so that a control motor can physically adjust the associated brake (not shown) of each section beam **90** and simultaneously control stop **22** of the output shaft timer. Since the diameter of the section beam is constantly diminishing, thus requiring a changing braking action to retain the constant tension of the section beam warp extending between the beam **90** and the input roller **68**, a time ratio of the output shaft timer cycle positioned on the section beam **90** and the input shaft timer cycle is set so that one rotation of the section beam (output shaft) will occur, for example, during the time interval requiring four rotations of the input shaft **68**. The ratio will remain constant so long as the radius of the section beam has not changed significantly, however, as the warp is continuously fed therefrom and the radius of the section beam becomes smaller, pulses will be generated because the timer cycle ratio of, for example, **4:1** has changed. The generated pulses are then fed to the control motor which automatically changes the amount of braking applied to the section beam and repositions the output timer stop **22** for an adjusted new output timer cycle which alters the timer cycle ratio. Thus as the section beam continues to diminish in radius, the pulsing mechanically (through motor control of the cycle adjustors **92**) changes the cycle duration of the output timer which automatically changes the ratio between the output timer cycle and the input timer cycle.

As six or eight section beams are normally associated with the slasher operation, it will be necessary to provide some sequentially operating device such as a ratchet relay or the like to monitor systematically each of the section beams with the input timer. The operation just described is merely the substitution of a control motor in lieu of the Reeves drive previously described for use on the slasher so that the motor is pulse controlled to change mechanically and automatically the braking on the section beam and the timer cycle of the output timer.

It has been found that a commercially acceptable sampling cycle of **50** yards can be achieved within tolerances of plus or minus 9 inches using the present apparatus though obviously any sampling range can be utilized by simply adjusting the operational sequence of the limit switches involved and utilizing even more sensitive devices for effecting the time cycle. Photoelectric cells, relays or other timing apparatus could be used with equal or even greater efficiency than the components shown herein the event more precision is required. It is also obvious that the shaft rotation sensing timers may be positioned directly to the shaft or through the use of cables, stroboscopes or other rotational measuring apparatus without any loss in control efficiency.

While there has been described one embodiment of an automatic tensioning controller, obviously many modifications and variations may be made in the construction of the rotational sensing apparatus, the circuitry, the positioning of the various components and other phases of the present inventive concept in light of the above teachings without departing from the real spirit and purpose of this invention. Such modifications of parts as well as the use of mechanical equivalents to those herein illustrated and described are reasonably included.

I claim:

1. An automatic stretch controller for a web material machine which has an input and output shaft on which the web material may be tensioned or overfed selectively during the winding operation, the controller comprising: adjustable, cyclically operable first responsive means in driven contact with and indicating rotation of the input shaft; adjustable, cyclically operable second responsive means in driven contact with and indicating rotation of the output shaft; first signalling means providing an electrical pulse when said first responsive means indicates the rotation of the input shaft to be greater by a preselected amount than the rotation of the output shaft; and second signalling means providing an electrical pulse when said second responsive means indicates the rotation of the output shaft to be greater by a preselected amount than the rotation of the input shaft.

2. A controller as claimed in claim **1**, said first and second signalling means operative to preclude the provision of electrical pulses when the rotation of the input and output shafts are within preselected and adjustable tolerances.

3. A controller as claimed in claim **1** wherein an adjustable differential drive drives the input and output shafts, the controller further comprising electrical pulse responsive means controlling the adjustable differential drive to increase and decrease the speeds of the input and output shafts when electrical pulses are provided by said first and second signalling means.

4. A controller as claimed in claim 3, further comprising calibrated means for establishing the input and output shaft speed to obtain a preselected percentage of tension or overfeed of the web material during the winding operation.

5. A controller as claimed in claim 3 further comprising means indicating the extent of increase or decrease of input and output shaft speeds.

6. A controller as claimed in claim 3, said first and second signalling means operative to preclude the provision of electrical pulses when the rotation of the input and output shafts are within preselected and adjustable tolerances, the controller further comprising calibrated means for establishing the input and output shaft speed to obtain a preselected percentage of tension or overfeed of the web material during the winding operation, said first and second responsive means each including a selective cycle clutch-resettable timer moving during the cycle in response to rotation of the respective associated shafts, each of said timers having first and second limit switches positioned for automatic operation during the selected cycles so that the operation of the first timer first and second limit switches prior to the operation of the second timer first limit switch will initiate and transmit an electrical pulse to the electrically responsive means to increase the differential speed between the input and output shafts, the operation of the second timer first limit switch will initiate and transmit an electrical pulse to the electrically responsive means to decrease the differential speed between the input and output shafts and the closing of the second limit switch will disengage the first and second timer clutches and reset said timers simultaneously to commence new cycles; and means indicating the extent of the increase or decrease of input and output shaft speeds.

7. A controller as claimed in claim 1, said first and second responsive means each including a selective cycle clutch-resettable timer moving during the cycle in response to rotation of the respective associated shafts having at least one limit switch operable at the termination of a selected timer cycle.

8. A controller as claimed in claim 7, each of said timers having first and second limit switches positioned for automatic operation during the selected cycles so that the operation of the first timer first and second limit switches prior to the second timer first limit switch will initiate an electrical pulse.

9. A controller as claimed in claim 8, wherein the operation of the second timer first limit switch initiates and transmits an electrical pulse to the electrically responsive means to decrease the differential rotational speed between the input and output shafts.

10. A controller as claimed in claim 8 wherein the operation of the first timer first and second limit switches prior to the operation of the second timer first limit switch initiates and transmits an electrical pulse to the electrically responsive means to increase the differential rotational speed between the input and output shafts.

11. A controller as claimed in claim 8 wherein the closing of the second timer second limit switch disengages the first and second timer clutches and resets said timers simultaneously to commence new cycles.

12. A controller as claimed in claim 8 further comprising means indicating the extent of increase or decrease of input and output shaft speeds.