Jan. 2, 1968 G. L. BALL ET AL 3,360,837

TORQUE REACTION CONSTANT TENSION WINDER

Filed Dec. 20, 1965 3 Sheets-Sheet 1

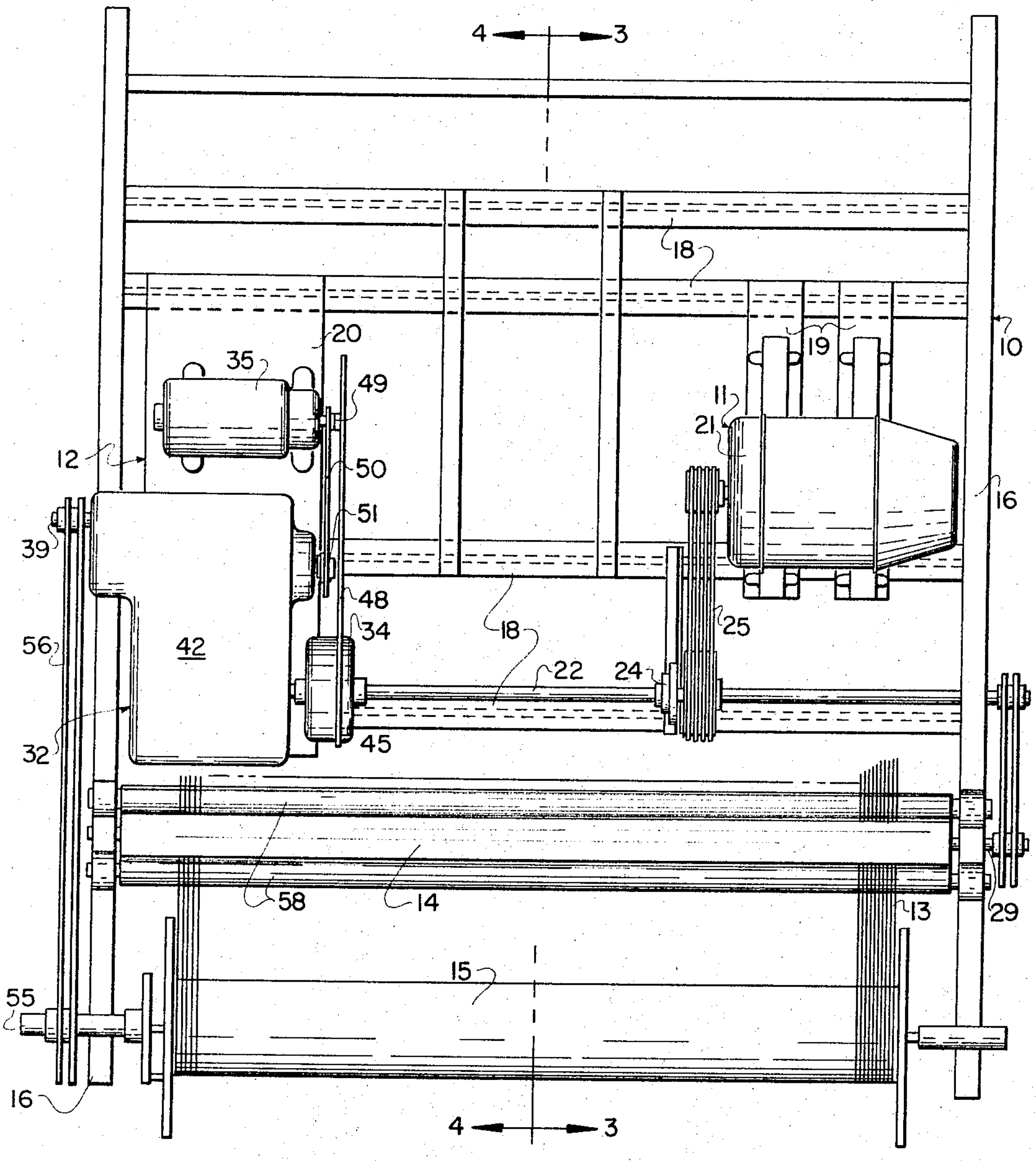

FIG. 1

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TORQUE REACTION CONSTANT TENSION WINDER

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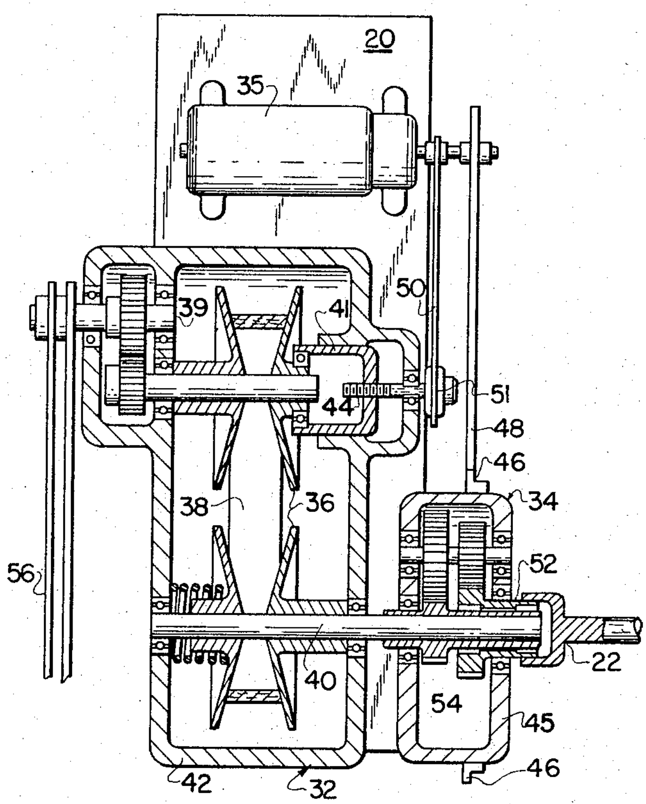

FIG. 2

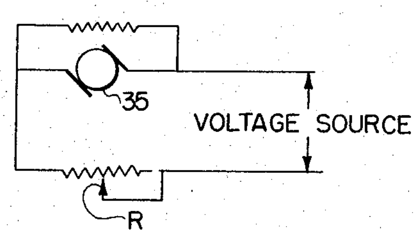

FIG. 5

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TORQUE REACTION CONSTANT TENSION WINDER

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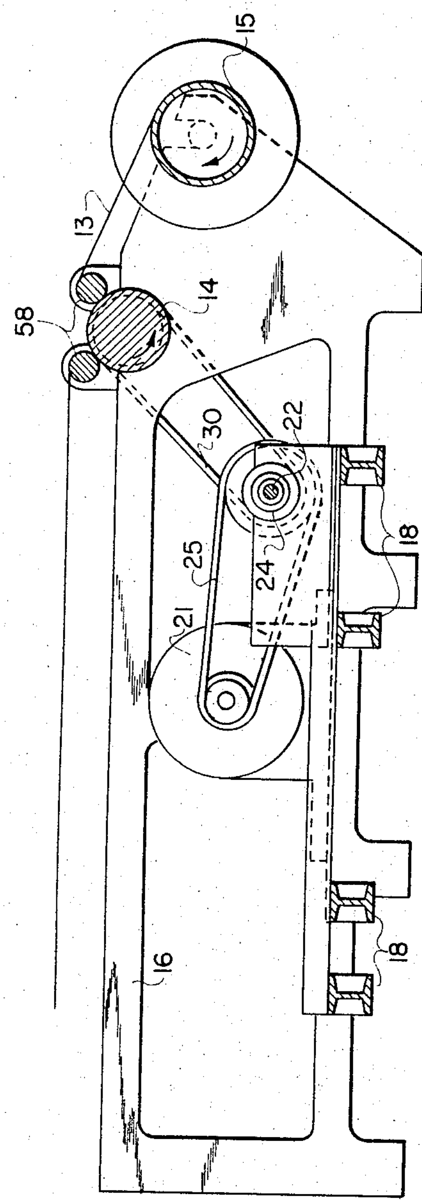

FIG. 3

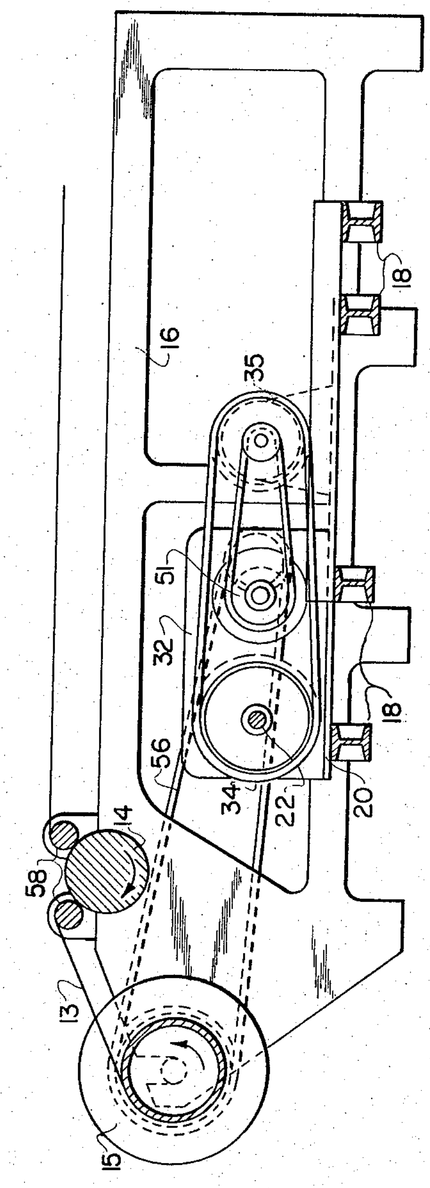

FIG. 4

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TORQUE REACTION CONSTANT TENSION WINDER

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ABSTRACT OF THE DISCLOSURE

A torque responsive speed change control for changing the rotational speed of a driven shaft with respect to a constant speed drive shaft including a variable speed transmission connecting the drive shaft with the driven shaft, and a torque control means for selectively adjusting the variable speed transmission in response to changes in torque applied to the driven shaft.

Disclosure

This invention relates generally to a tension control device for a winding or unwinding machine, and more particularly to a torque reaction tension control device wherein tension is controlled through a torque control means external of the main drive means of the winding or unwinding machine.

In the winding or unwinding of a web of material such as warp threads for use in a loom on a loom beam, it is desirable that constant tension be maintained in the web at all times during the winding or unwinding of the web on the beam. This means that the torque applied to the beam must vary as the diameter of the wound web on the beam increases. More specifically, the torque applied to the drive spindle of the beam must increase in direct proportion to the increase in diameter of the wound web if a constant tension in the web is to be maintained.

Prior art devices have accomplished this result by driving the feed rolls over which the web passes at a constant speed of rotation and interposing between the constant speed drive and the drive spindle for the beam, a means for selectively varying the speed of rotation of the beam. This is usually effectuated by using an infinitely variable adjustable speed transmission, the output speed of which is usually controlled by a clutch and differential control arrangement.

The clutch characteristically has clutch elements which slip with respect to each other as the diameter of the wound web increases which, in turn, manipulates the differential to adjust the output speed of the transmission to maintain constant tension in the web as it is wound. Since most of these control arrangements have had the clutch located in the main drive of the winding or unwinding machine, the control means has to transmit the entire power load to the beam upon which the web is wound. This has created extreme maintenance problems since the clutch elements deteriorate so rapidly that almost constant attention is required.

Since prior control means has been almost totally mechanically and is comprised of unreliable elements, the incidence of mechanical adjustment and failure is high. Since prior art machines must be operating before the output speed of the transmission can be changed by the control means to reset the transmission to start a new beam, this resetting of the output speed of the transmission must be done either at the beginning or end of the winding of a beam. This results in the tension maintained in the web not being constant at all times.

Often it is necessary to stop winding machines in the middle of winding a beam in order to make adjustments. Prior art machines using the clutch and differential control arrangement have not been able to maintain proper stalled tension in the web being wound on the beam while the machine is stopped. This has resulted in a section of the web being relaxed and being wound under a different tension when the machine has been stopped during the winding thereof. This frequently causes problems in a subsequent weaving operation.

The invention disclosed herein overcomes these and other problems associated with prior art devices in that a torque motor and planetary gear transmission arrangement control the output speed of a variable speed transmission so that tension in a web being wound or unwound is maintained constant. The torque motor is located externally of the main drive of the winding or unwinding machine and the main drive power is transmitted through the planetary transmission. The planetary transmission acts as a reaction element which senses the need for a change in the output speed of the variable speed transmission to maintain constant tension in the web being wound and acts through the torque motor to change the output speed of the transmission so that the tension in the web is maintained constant.

Since the torque motor has substantially no wearing parts, maintenance problems are practically eleminated. Moreover, the tension maintained in the web may be easily adjusted simply by adjustments in the torque motor circuit so as to increase or decrease the torque exerted by the torque motor.

As each beam on the beam winder becomes filled, it is necessary that the transmission be reset so that proper tension will be applied to the web at the beginning of the winding of the next beam. This can be done simply by energizing the torque motor to reset the transmission for the proper output speed to maintain constant tension in the web when the next beam is placed on the drive spindle and the winding operation is begun. Therefore, it will be noted that the entire web is wound on the beam at constant tension.

When it is necessary to stop the winding machine with a partially filled beam thereon so that certain operating adjustments may be made, the torque motor drives the variable speed transmission through the planetary transmission so that the proper tension is maintained in the web being wound on the beam even though the main drive is stopped. Therefore, the web material is not relaxed and will continue to be wound at constant tension when the machine is restarted.

These and other features and advantages of the present invention will become more clearly understood upon consideration of the following specification and the accompanying drawings wherein like characters of reference designate corresponding parts throughout and in which:

FIG. 1 is a top plan view of one embodiment of the invention;

FIG. 2 is a cross-sectional view of the torque reaction beam drive used in connection with the invention;

FIG. 3 is a cross-sectional view of the invention taken aolng line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view of the invention taken along line 4—4 of FIG. 1; and,

FIG. 5 is a control circuit for use with a shunt torque motor in the present invention.

These figures and the following detailed description disclose one specific embodiment of the invention; however, it is to be understood that the inventive concept disclosed herein is not limited to this specific embodiment, since the invention may be embodied in other specific forms.

Referring to FIGS. 1, 3 and 4, it will be seen that the apparatus of the invention comprises generally a support base **10** carrying a main drive unit **11** and a torque reaction beam drive **12** thereon. The support base **10** also carries a feed roll **14** and a beam **15** thereon. The main drive unit **11** directly drives the feed roll **14** and indirectly drives the beam **15** through the torque reaction beam drive **12**.

The support base **10** comprises a pair of upstanding sides **16** spaced apart by a plurality of I-beams **18** extending therebetween. The I-beams **18** serve as a mounting base for support plates **19** and **20** which carry the main drive unit **11** and the torque reaction beam drive **12** respectively. The upstanding sides **16** have appropriate apertures and bearing mountings therein to receive shafts and the like, as will be explained later.

The main drive unit **11** comprises a drive motor **21** fixedly carried by the support plate **19** and a transversely extending drive shaft **22**. The drive shaft **22** is spaced from the motor **21** and is rotatably journaled at one end in one of the sides **16**. The drive shaft **22** is journaled intermediate its ends at the bearing **24** and has its other end carried by the torque reaction beam drive **12** as will be explained hereinafter. A main drive **25** connects the output shaft of the motor and drive shaft **22** and a feed roll drive **30** connects the end of the drive shaft **22** journaled in the side **16** to the feed roll **14**. The drive motor **21** is an adjustable speed motor of conventional design and has a substantially constant speed output at each selected setting. Therefore, once an output speed of the motor **21** is selected, it will be seen that the feed roll **14** is driven at a substantially constant speed through the drive train connecting it to the motor **21**.

The torque reaction beam drive **12** comprises a variable speed transmission **32** mounted on the support plate **20** as well as a reaction element **34** and a torque motor **35** also mounted on the support plate **20**. The variable speed transmission **32** is of conventional type and has a housing **42** with a pair of variable pitch pulleys **36** therein which operate in conjunction with a belt or chain **38** to selectively change the speed of rotation of an output shaft **39** with respect to an input shaft **40**. The input shaft **40** is driven by the output of the reaction element **34** and the output shaft **39** drives the beam **15** through a chain or belt drive **56**. A slidable cup **41** which is used to change the pitch of the pulleys **36** is slidably carried in the transmission housing **42** and is positioned by a threaded rod **44** rotatably mounted in the housing **42**. Therefore, by rotating the threaded rod **44**, it can be seen that the output speed of the transmission will be varied with respect to the input speed to the transmission.

The reaction element **34** is a conventional planetary transmission having the usual three rotatable elements arranged so that the torque on all three elements are of a fixed ratio to one another. For the purpose of this description, however, we will be concerned primarily with a rotatable housing **45**, an input shaft **52**, and an output shaft **54** of the element **34**. The element **34** serves to connect the input shaft **40** of the variable speed transmission **32** to the drive shaft **22** driven by the drive motor **21**. It will be seen that if the housing **45** of the reaction element **34** is held stationary, the input shaft **40** will be driven at a substantially constant speed by the drive shaft **22**. It will also be seen that if the housing **45** of the reaction element **34** is released, and assuming that there is a frictional drag on the input shaft **40**, the housing **45** will rotate and the input shaft **40** will remain stationary. Therefore, the amount of power transmitted through the reaction element **34** will be dependent on the amount of torque exerted on the housing **45** in a rotational direction opposite to that in which the housing **45** tends to rotate.

A reaction sprocket **46** is provided around the housing **45** and has associated therewith a torque chain **48** for supplying torque to limit the rotation of the housing **45**. The torque motor **35** is connected to the torque chain **48** through a sprocket **49** so that when the torque motor **35** applies a torque on the housing **45** opposite to that in which it is tending to rotate, as will be explained hereinafter, a constant power output from the reaction element **34** will be attained. An adjusting chain **50** is also connected to the torque motor **35** and is connected to a sprocket **51** associated with one extending end of threaded rod **44**. Therefore, if the housing **45** of the reaction element **34** rotates, the adjusting rod **44** of the variable speed transmission also rotates. Since the power for winding the beam is supplied by the main drive motor **21** and the torque motor **35** controls the torque transmitted through the torque reaction element **34**, it is apparent that a small torque motor can control the power of a relative high power transmission since a large mechanical advantage can be easily attained with this arrangement.

The feed roll **14** is of conventional design and has associated therewith a pair of freely rotatable idler rolls **58** which force the web **13** of the warp threads to conform with the feed roll **14**. The beam **15** is also of conventional design and is mounted in conventional manner on the support base **10**.

The torque motor **35** is a shunt type DC motor and is connected in series with a rheostat R as shown in FIG. 5 so that the torque developed by the motor **35** can be adjusted. The entire circuit is connected to a convenient source of direct current when in use. It is to be understood, however, that an alternating current motor or an air or hydraulic control system may be used for this operation.

Operation

In operation it will be seen that the web **13** is wound upon the beam **15** after passage over the feed roll **14**. The main drive motor **21** rotates the drive shaft **22** and the feed roll **14** through the feed roll drive shaft **29** at a substantially constant speed. The drive shaft **22** also drives the input shaft **40** of the variable speed transmission **32** through the reaction element **34**. The variable speed transmission **32** drives the output shaft **39** and a beam drive spindle **55** through a chain drive **56**.

If the tension in the web **13** extending between the feed roll **14** and the beam **15** is to remain constant, the rotational speed of the beam **15** must be decreased as the diameter of the wound web **13** on the beam **15** increases. This is because the power through the torque reaction beam drive **12** must remain constant.

When the diameter of the wound web **13** on the beam **15** increases, a reaction torque is exerted on the housing **45** of the reaction element **34**. Since this torque cannot be greater than that selectively exerted on the housing **45** by the torque motor **35**, the housing **45** will rotate in a direction opposite to that in which the motor **35** is tending to rotate the housing **45**.

As the housing **45** rotates, the adjustment chain **50** rotates the threaded rod **44**. This serves to change the pitch of the pulleys **36** so that the output shaft **39** speed is reduced and the surface speed of the take-up beam **15** is synchronized with the surface speed of the feed roll **14**. Since the beam **15** is increasing in diameter with every revolution, the housing **45** of the element **34**, torque motor **35** and adjusting rod **44** will rotate very slowly so that the surface speed of the beam **15** is kept equal to the surface speed of the feed roll **14**.

It will also be seen that the beam drive **12** will compensate for a decrease in tension in the web **13** as well as an increase in tension in the web **13** so that the tension will remain constant in all events. It will also be noted that the device may easily be adapted to an unwinding machine.

By readjusting the rheostat R, it will be seen that the tension in the web **13** between the feed roll **14** and beam **15** will be changed in accordance therewith. Therefore, the tension in the web **13** may be easily varied, even while the winder is in operation.

When the beam **15** has been filled with the wound web **13**, the winder is stopped and the control motor **35** turned off. The wound beam **15** is removed to be replaced by empty beam **15**. While this is being done, the torque control motor 35 is turned on. Since there is no resistance at the beam drive shaft 55, the torque motor 35 will drive the transmission and the adjusting screw 44 so as to shift the variable pitch pulleys 36 to their initial or starting position.

If the drive motor 21 must be stopped so that adjustments may be made in the machine, it will be seen that the torque motor 35 is left switched on and will drive the housing 45 of the reaction element 34 so as to drive the input shaft 40 of the variable speed transmission 32 and drive the beam drive spindle 55 until proper tension is achieved in the web 13 being wound on the beam 15. It is also noted that the same mechanism may be used as an unwinder for beams, simply by reversing the rotational direction of the motor 21. Therefore, it will be seen that the reaction beam drive 12 serves to isolate that portion of the web 13 between the feed roll 14 and the beam 15 and maintain a constant tension therein at all times.

It will be obvious to those skilled in the art that many variations may be made in the embodiments chosen for the purpose of illustrating the present invention without departing from the scope thereof as defined by the appended claims.

What is claimed as invention is:

1. A torque responsive speed change for changing the rotational speed of a driven shaft including:

a constant speed shaft; and

torque controlled means connecting said constant speed shaft and said driven shaft, said torque controlled means being effective to transmit a substantially constant power from said constant speed shaft to said driven shaft by varying the speed of said driven shaft in accordance with the torque exerted by said driven shaft on said torque controlled means,

said torque controlled means including a variable speed transmission having an input shaft, an output shaft, a speed changing mechanism, and an adjusting means for manipulating said speed changing mechanism, said adjusting means being torque controlled and responsive to changes in torque applied to said driven shaft.

2. The apparatus of claim 1, wherein said torque controlled means includes a reaction element having a housing, a driven element and a driving element, said driving element positively connected to said constant speed shaft and said driven element positively connected to said input shaft of said variable speed transmission, said housing having a torque controlled torque exerted thereon and operatively connected to said adjusting means effective to manipulate said adjusting means upon movement of said housing.

3. The apparatus of claim 2, including a torque generating torque motor for exerting a torque on the housing of said reaction element.

4. The apparatus of claim 3, wherein said torque exerted by said motor is selectively adjustable.

5. The apparatus of claim 4, wherein said torque motor is a direct current shunt type motor.

6. The apparatus of claim 5, wherein said torque motor has a control circuit including a regulator for controlling the torque exerted on said housing of said reaction element by said motor.

7. In a winding device for winding a web onto a loom beam:

(a) constant speed drive means;

(b) feed roll means driven at a constant speed by said drive means;

(c) a loom beam upon which the web is to be wound;

(d) a variable speed transmission having an input shaft, an output shaft, a speed changing mechanism and adjusting means for manipulating the speed changing mechanism, said output shaft positively connected to said loom beam;

(e) a planetary transmission having a housing, an input shaft and an output shaft, said input shaft connected to the constant speed drive means and said output shaft connected to said input shaft of said variable speed transmission;

(f) electromagnetic torque generating means connected to said housing and said adjusting means, said generating means being effective to selectively supply a torque to said housing and to change said adjusting means in response to movements of said housing.

8. The apparatus of claim 7 wherein said torque generating means is effective to return said adjusting means of said variable speed transmission to a predetermined position when said web is severed and said constant speed drive means is stopped.

9. The apparatus of claim 8, wherein said torque generating means comprises an electromagnetic direct current shunt type motor.

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