Sept. 4, 1962 E. D. BEACHLER 3,052,294

WIRE TENSIONING DEVICE

Filed Oct. 23, 1958 3 Sheets-Sheet 1

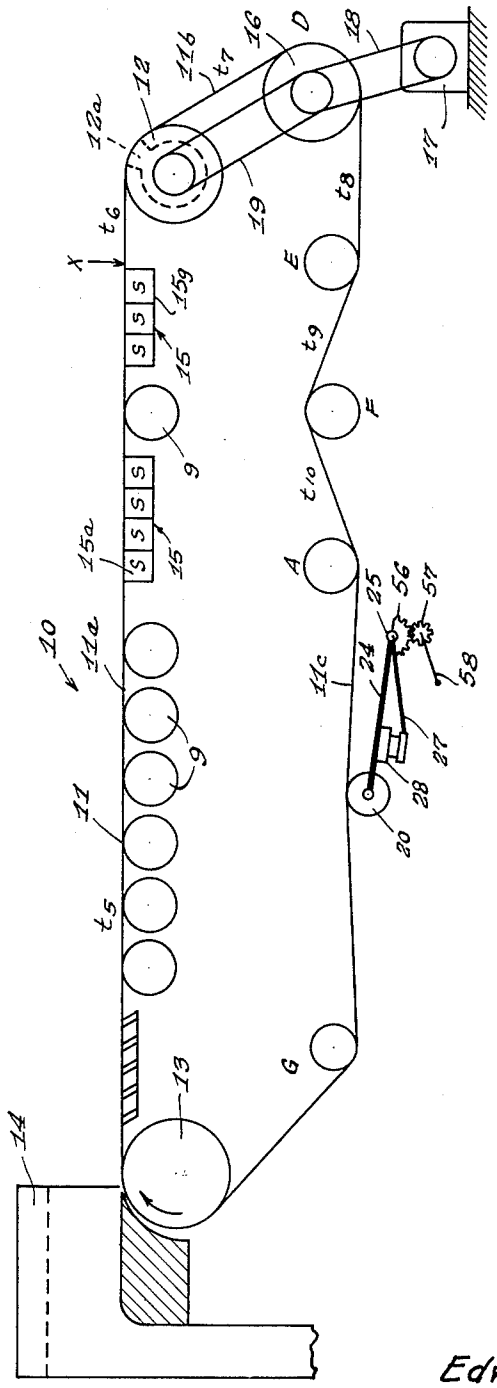


FIG. 1

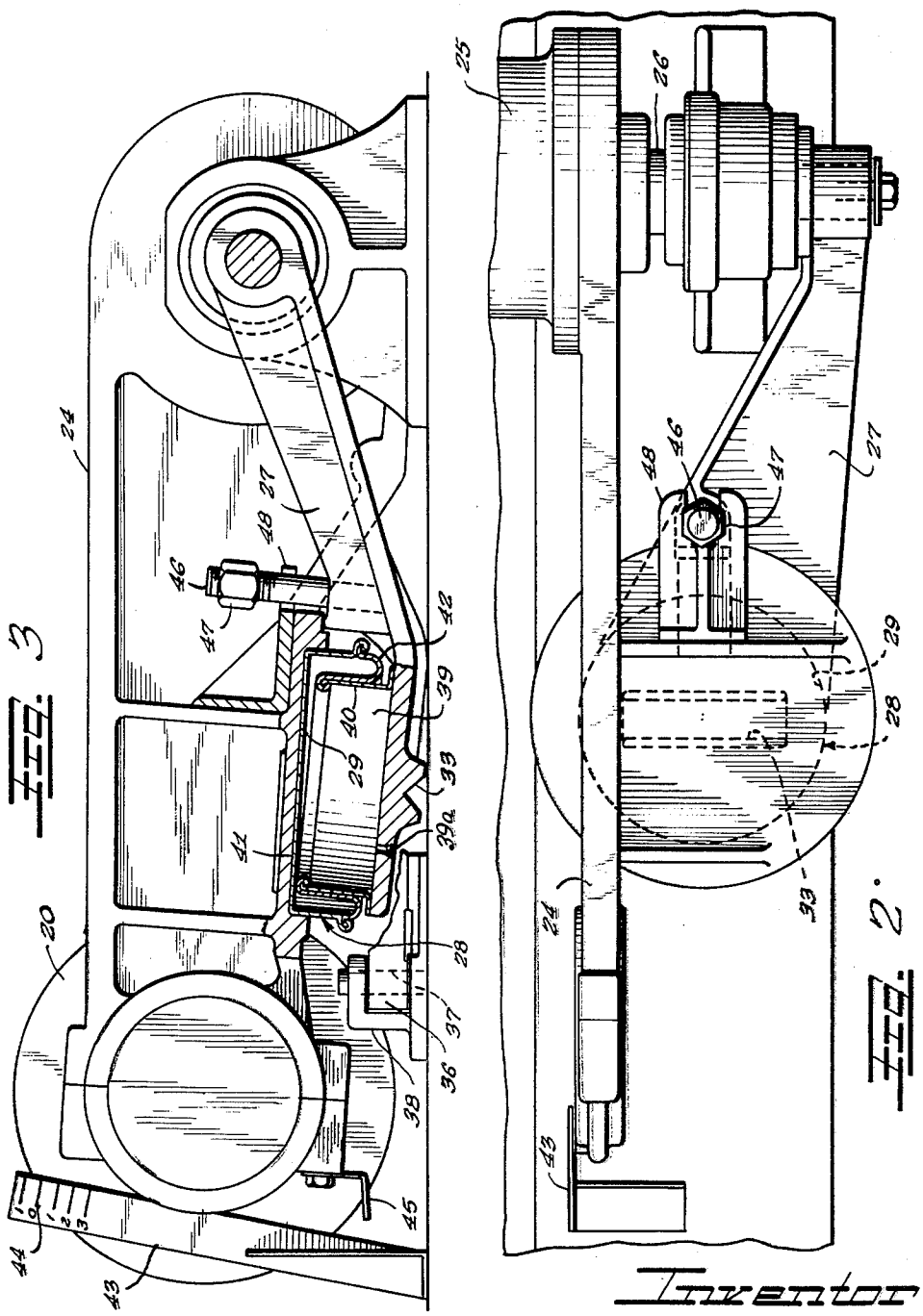
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WIRE TENSIONING DEVICE

Filed Oct. 23, 1958 3 Sheets-Sheet 2



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WIRE TENSIONING DEVICE

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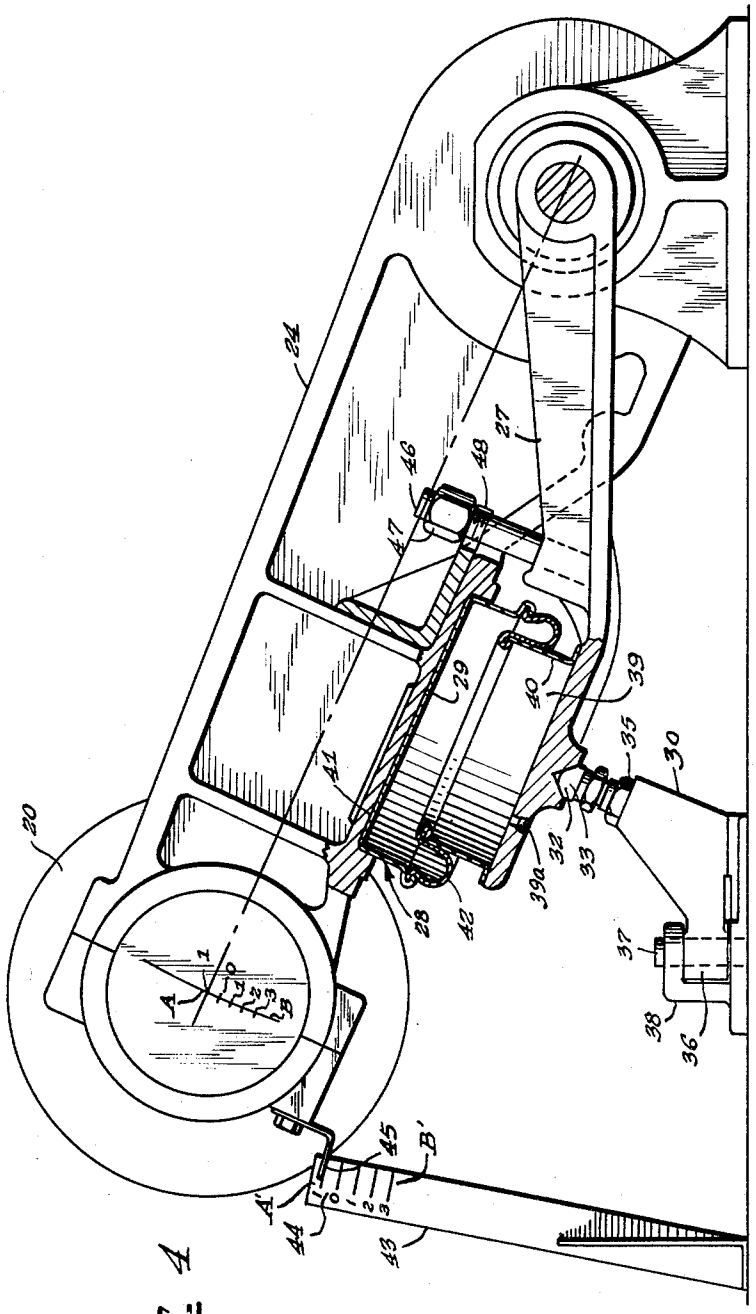


Fig. 4

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WIRE TENSIONING DEVICE

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8 Claims. (Cl. 162—273)

The present invention relates to devices for controllably adjusting the path length of endless looped bands and particularly to mechanisms suitable for use in Fourdrinier type paper making machines. It is particularly adapted for the controllable adjustment of the operating length of the Fourdrinier wire while maintaining a controllable initial tension in such wire loop.

In the Fourdrinier type paper machine, a looped forming wire is trained over a breast roll (at the end receiving stock from a headbox), over a plurality of suction boxes and the like dewatering devices, and then over a couch roll and a turning roll at the end of the web forming zone. In modern paper machines, the length of the wire required and other considerations dictate the addition of carrying rolls and other devices to support the reach of the forming wire from the breast roll to the suction boxes and couch roll. The forming wire is a critical and comparatively delicate element in the paper machine, and it must be handled with care in order that the forming wire may be driven by its frictional engagement with the surfaces of the turning roll and usually the couch roll, and a certain initial tension is required. This initial tension, besides furnishing the frictional engagement to permit driving the wire, also serves to maintain the smooth level condition necessary for the formation of paper. In addition to this initial tension, there is developed much greater tension in the wire reach between the turning roll and/or couch roll, at which point or points the driving force is supplied to the wire, and the suction boxes. It will be understood that during the normal operation of the paper machine with stock forming on the wire, a considerable drag is introduced by the atmospheric pressure, tending to force the forming wire tightly to the surface of the suction boxes. This effect constitutes the major part of the driving load in a Fourdrinier part of a paper machine.

Despite the efforts of papermakers and machine builders to the contrary, there always remain minor irregularities in the suction forces, in the stretch modulus of the Fourdrinier wire, in the frictional factors causing the wire to drag over the suction box covers and in the friction behavior of the driving rolls themselves. These and other factors make necessary the provision of mechanism to provide for the change of the path length of the Fourdrinier wire during operation. In actual operation, the length of the wire is slightly greater than the length determined only by the initial tension, because of the greater tension resulting from the suction box drag and extending to the driving roll, or rolls.

These continuing variations in length during the operation of the paper machine have heretofore been provided for by devices known generally as stretchers. These stretchers have been, conventionally, rolls so mounted so as to swing on arms about a remote axis and have been weighted (or counterweighted). These devices have usually provided for the minor differences in length of Fourdrinier wires as supplied from the manufacturer and frequently have provided sufficient adjustment to permit the placement of new Fourdrinier wires as well.

For convenience in the removal and replacement of the Fourdrinier wire, it is desirable that the wire stretcher roll be located outside the wire loop in order to avoid the complication involved in removing such apparatus from within the loop. It is also desirable where possible

to use small angles of wrap of the wire over tensioning rolls and other rolls, but for this reason small changes in the total length of the wire make relatively large differences in the position of the tensioning roll. Where tensioning rolls are mounted as described, for pivoting about a remote axis, the arm length required and the counterweights used have become unmanageably large and introduced considerable inertia. These factors made it difficult to compensate for minor fluctuations in the wire path length and caused great difficulties, to the point of damage or destruction of the wires in the event of abrupt loss of suction and the consequent changes in power input.

Heretofore it has not been obvious that a successful stretcher mechanism would require a "controllably elastic" behavior to permit both minor fluctuations in length as well as relative by larger changes due to surges of tension.

The stretcher mechanisms heretofore have not provided for the fluctuations in tension and, therefore, in the path length of the Fourdrinier wire particularly during those instances when the drag due to the suction boxes is lost due to the loss of vacuum. This occurs always when shutting down the paper machine and occasionally during operation. The induced tension between the suction box area and the driving means is dissipated and the wire tends to shorten at the same rate as the tension decays. Conventional stretchers have been relatively rigid because of mass and weight and the abrupt redistribution of the tension results in a damaging surge at the stretcher roll. Despite the advantages of the outside stretch roll, this effect has limited their use.

Stretcher rolls which are swing arm mounted to move with the change of length of the wire, permit large changes in the arc of contact with the wire, usually called angle of wrap. The resultant force on the roll mountings changes significantly in amount and direction. Also, the effective moment about the pivot axis of the arms due to the weight of the apparatus changes. The maintenance of constant initial tension in the Fourdrinier wire with these devices was difficult or impossible.

Accordingly, it is an object of the present invention to provide an improved tensioning mechanism with a minimum of inertia.

It is an object of the present invention to provide an improved tensioning mechanism which is capable of absorbing an abrupt change of length which occurs when suction is lost in the Fourdrinier suction boxes, as, for example, occurs while the paper machine is being shut down.

It is also an object of the instant invention to provide a mechanism including a roll mounted outside of the wire loop which has a minimum of inertia whereby an exact desired initial tension may be maintained in Fourdrinier wires at any position of its operating range.

A further object of the present invention is to provide a mechanism in which the effect of a change in the angle of wrap of the Fourdrinier wire about the stretcher roll does not result in a change in tension in the wire.

An additional object of this invention is to provide for the mounting of an outside stretch roll on pivoting arms in a manner which avoids the effect of the change of gravity moment with a change in stretcher roll position.

A further object of the invention is to provide a stretcher mechanism adapted to follow a change in the path length of a Fourdrinier wire which change is induced by variations in stress in the wire.

Another object of this invention is to permit the mounting of the stretcher mechanism outside of the loop of the Fourdrinier wire to permit convenient and easy disengagement of the mechanism from the wire for wire change.

An additional object of the instant invention is to

provide a stretcher mechanism controllable in its degree of elasticity to permit the maintenance of a desired amount of initial tension in a Fourdrinier wire.

Other objects, features and advantages will become more apparent with the teachings of the principles of the invention in connection with the disclosure of the preferred embodiments thereof, in the specification, claims and drawings, in which:

FIGURE 1 is a side elevational view, shown in schematic form, of a Fourdrinier type of mechanism for a paper making machine with a tensioning roll assembly embodying the principles of the present invention;

FIGURE 2 is an enlarged plan view illustrating details of the tensioning roll assembly for the Fourdrinier mechanism;

FIGURE 3 is a side elevational view of the mechanism of FIGURE 2, and illustrating in detail the tensioning roll assembly with the mechanism in position for removing or replacing the forming wire; and

FIGURE 4 is a side elevational view similar to FIGURE 3 but with the mechanism in position to apply a tensioning force to the wire.

As shown on the drawings:

In FIGURE 1, the reference number **10** indicates generally a Fourdrinier wire arrangement for a paper making machine comprising a looped forming wire **11** having the upper run **11***a* thereof stretched between a suction couch roll **12** at the forward end, a breast roll **13** at the rear end whereat a headbox **14** flows stock onto the upper run **11***a* of the wire **11**. Between the breast roll and suction couch roll, are mounted suction boxes **15** which are stationary and which serve to dewater the web passing thereover on wire **11**. Table rolls **9** may also be provided for additional support and for water removal from the upper run **11***a* of the wire. Dewatering of the web is further accomplished at the suction area **12***a* of the suction couch roll **12**. Conventionally, the new formed web is removed from the reach of wire **11***b* following the suction couch roll. As indicated diagrammatically, a motor **17**, suitably connected to the suction couch roll **12** through a belt **18**, drives the turning roll **16** (also indicated as D) which is the main drive for the wire **11**.

Guide rolls E, F and A are mounted to engage the lower or return, run **11***c* of the wire **11**. A tensioning roll **20** is positioned to engage the outside of the wire loop in the return run **11***c*. This tensioning roll applies a force to the outer surface of the wire, and moves to accommodate variations in the path length of the wire. A take-up roll G may be provided which is adjustable for substantial variations in manufactured length, but which is fixed in position during normal operation of the belt.

In the operation of the machine **10**, the main drive including motor **17** and belt **18**, rotates the turning roll D which frictionally engages the wire to move it. The main drive is assisted in this embodiment by the helper drive belt **19** connected to the couch roll **12** and which is interconnected with the main drive. (In certain applications it has been found advantageous to drive the rolls, E, F and A.) It will be understood that the arrangement of the wire carrying rolls and the drive rolls of FIGURE 1 are shown by way of example only, and that the features of the invention may be employed to utilize their natural advantages in other mechanisms and other environments.

In any mechanism such as that shown in FIGURE 1, local variations of tension will occur in the wire due to the effect of the driving forces applied to overcome the resistances present. For example, the drive roll **16** and couch roll **12** tend to move the wire forward and this is resisted normally by the action of the suction boxes **15**, which create a drag on the wire, which drag is the principal component in the power required for driving a Fourdrinier.

It will be observed by FIGURE 1 that the resistance due to the frictional drag over the suction boxes will accumulate as the wire moves from the first suction box **15***a* to the last suction box **15***g*. Under normal operating conditions, it may be observed that the tension in the wire is a maximum at a point indicated by X in FIGURE 1. Upon consideration of FIGURE 1 it will be observed that the tension in the wire will be reduced as it passes over the suction couch roll **12**, inasmuch as power is being applied to the wire at this point. This power input results in a somewhat decreased tension in the wire reach **11***b*. The maximum reduction in tension, will, of course, occur as the wire is carried around the turning roll D, which is the major source of power input.

The presence of paper making stock, an aqueous suspension of fiber in water, tends to seal the wire permitting vacuum to exist in the suction boxes **15**. If, for some reason, the stock flow is interrupted, as may be the case when shutting down the paper machine, the level of vacuum in the suction boxes will be decreased or eliminated. This will in turn permit the tension in the wire at T_6 to decay abruptly reducing the power required to drive the wire. Concurrently, this reach of wire will tend to reduce in length as will the remaining reaches of wire due to the marked decrease in power required. This results in a redistribution of tension and a change in total length in a wave around the path length of the wire. This in turn will change the position of the tensioning roll **20**.

It is desirable whenever possible to use small angles of wrap of the wire over the rolls including the tensioning roll **20**, and for this reason, small changes in total length can make large differences in the position of the tensioning roll. This in turn leads to large changes in tension if the roll is provided with mechanisms for applying a tensioning force to the roll of the type heretofore used. In mechanisms heretofore used, the substantial weight of the mechanism created inertia problems with sudden reduction in the length of the wire, and created increase in tensioning forces as the wire shortened to move the tensioning roll against its tensioning mechanism. This created severe fluctuations in wire tension, and was capable of creating wire damage, such as known to the art as ridging, both directly and by changing the deflection of other carrying rolls of the wire loop which in turn introduced damaging stresses in the wire.

As a representation of the distribution of tension in the Fourdrinier wire, dimensions and values my be assigned as in FIGURE 1, to furnish a numeric example of typical conditions.

T_5=12#/inch.
T_6=35#/inch.
T_7=33#/inch.
T_8=20#/inch.
T_9=16#/inch.
T_{10}=14#/inch.

For the purpose of this example, it is assumed that no resistance is offered to the wire by the breast roll **13** or the table rolls **9**. While this is not strictly true these forces are sufficiently small that they may be neglected. Further, it may be assumed that the length of the wire tension spans involved are as follows:

T_5—79 ft.
T_6—20 ft.
T_7—15 ft.
T_8—12 ft.
T_9—12 ft.
T_{10}—12 ft.

Assuming a representative value for stretch modulus: 8500 pounds per inch, a simple calculation indicates that if the assumed total length of Fourdrinier wire in the unstressed condition will be 150′, the same wire will increase to 150.21′ under the initial tension as represented by T_5 and further that in the operating stressed condition

the same wire will be extended to 150.40'. This represents a difference of .19', or 2.28". It will be understood that these figures will apply only to a particular machine and further that these figures will be an average which will tend to fluctuate.

In the event of loss of suction in the suction boxes, as, for example, during the period of shutdown of the machine, a redistribution of tension will take place which will require the stretch roll to move abruptly to follow a decrease in path length of approximately 2". This, of course, will tend to substantially change the position of any tensioning roll which bears against the substantially straight run of wire. When this change is abrupt, as it must necessarily be at times, the movement of the tensioning roll must be rapid.

It is also desirable that the stretch or tensioning roll of such an apparatus be adapted to compensate for changes in the unstressed length of the wire due to a permanent set which will develop as the wire becomes worn. It is further desirable that such apparatus provide for differences in successive wires due to differences in manufacturing length.

As illustrated in the drawings, the tensioning roll **20** is rotatably supported at its end with one end carried on a supporting arm **24** on one side of the assembly, and the other end carried on a similar supporting arm at the other side of the assembly. Since the supporting arms and their associated mechanism will be identical in construction, only one arm and the mechanism or side of the assembly need be described in detail.

The arm **24** carrying the tensioning roll is secured to a hub **25** extending across the machine and connected to a similar arm, not shown. The shaft and hub are pivoted on a mounting shaft **26**. The mounting shaft **26** also supports a spring carrying arm **27** for independent pivotal movement.

An air spring **28** is located between the spring supporting arm **27** and the roll supporting arm **24**. The air spring **28** is pocketed in a circular, flat, depressed area **29** on the roll carrying arm **24** so that its upward force will support the roll in operating position. The air spring **28** and operating roll **20**, with its supporting arm **24**, are shown in operating position in FIGURE 4, and are shown in their retracted position wherein the wire loop is relaxed, in FIGURE 3.

The spring carrying arm **27** is supported in operative position in FIGURE 4, by a post **30**, having an adjustable rounded head **32**, which is received by a recess **33** in the spring support arm **27**. The head **32** threads into the post **30**, and locks in adjusted position by a lock nut **35**. The post has an extension foot **36** which is pivoted on a pin **37** in a fixed bracket **38**. This permits the post **30** to be swung out of the path of the spring support arm **27** when it is lowered to inoperative position, as shown in FIGURE 3.

The air spring **28** has a hollow chamber **39** which is supplied with air through an air connection **39a** to control the force of the spring. The spring has a lower annular shell **40** and an upper cup shaped shell **41**, with the shells being joined by an annular bellows **42**.

The air spring is constructed and designed to have a varying load deflection characteristic. The spring is constructed to automatically compensate for differences in the torque on the support arms due to the weight of the roll, and to compensate for changes in the effect of the tensioning roll on the wire with changes in angle of wrap, as changes in position of the tensioning roll **20** occur. The spring is thus designed to maintain a constant initial tension in the wire.

The spring **28** is also designed to have a characteristic wherein the tensioning roll **20** will apply a tensioning force to the wire which will not increase with increased deflection of the roll, such as caused by reduction in length in the wire. In the preferred form, the roll will maintain a substantially constant tension force in the wire when

the wire is reduced in length due to decreases in local tension with reduction in drive forces and the roll moves to compensate for wire length change.

The tensioning roll applies an initial tension in the wire, and thus initial tension is maintained substantially constant regardless of changes in length of the wire and consequent changes in position of the tensioning roll.

The tensioning roll **20** has an effective operating range, as extending from the points A to B, shown in FIGURE 3. In this operating range, the air spring **28** will compensate for the weight of the roll and the desirable load deflection characteristic will be obtained.

To adjust the operating roll **20** to tension the wire in the operating range, a position scale **43** is provided bearing position numbers and index marks **44** which extend from A' to B'. A pointer **45** is positioned secured to move with the tensioning roll supporting arm **24** and moves relative to the scale to indicate the position of the arm and the tensioning roll.

As illustrated in FIGURE 1, the position of the tensioning roll for any given inflation of the air spring **28** is controlled by positioning of the spring supporting arm **27**. This arm is shown diagrammatically as having a segment gear **56** driven by a pinion **57**, rotated by a crank **58**. Rotation of the crank **58** will elevate the spring supporting arm **27** to its operating position where it will be supported by the post **30** when the latter is engaged.

In adjustment of the machine for the proper operation of the tensioning roll **20** and placing the machine in condition for operation from the rest position of the parts, which position is shown in FIGURE 3, the crank **58**, FIGURE 1, is first turned to crank up the spring supporting arm to a position above the post **30**. The post is then swung into position on its pivot pin **37**, FIGURE 4, and the spring supporting arm **27** is lowered so that the notch **33** receives the rounded end **32** of the post. The crank-up gear unit can be disengaged while the post **30** is supporting the spring supporting arm.

The rounded end **32** can be adjustably threaded up or down to bring the pointer **45** to position 3 on the index scale **43**, as shown in FIGURE 3. One of the purposes of this adjustment is to bring the supports on each side of the machine into alignment. At this point, the air spring has not been inflated.

The air spring **28** is then inflated to raise the roll with air until the pointer is at its uppermost location opposite #1 above #0. Means are provided to limit the air spring expansion to this amount, including an air spring stop bolt **46** with an adjustable nut **47**. The stop bolt **46** passes through an opening in a bracket **48**, secured to the tension roll arm **24** and the bolt is mounted on the spring supporting arm **27**. Thus, in the inflated position of the spring, the nut **47** is threaded down to engage the top of the bracket **48**, and this will limit the upward movement of the tensioning roll and prevent blowing out of the air spring in the event of breakage of the wire and to prevent the damage to parts which would occur due to the sudden release of tensioning force of the wire on the tensioning roll.

The next step requires tightening of the take-up roll **22** until the pointer **45** reaches the index #0. The machine will then be in condition for operation.

In operation, the wire **11**, will be driven by the rolls **12** and **16**, and variances in forces on the wire will be encountered as previously discussed. The changes will be accommodated by movement of the tensioning roll **20** supported by the air spring **28**. For example, when the driving forces are suddenly reduced, the length of the belt is shortened. The rapid shortening will be accommodated by movement of the tensioning roll **20**. Due to the low inertia of the roll and its supports and the deflection characteristic of the air spring **28**, the tensioning force applied in the wire will not suddenly increase to damage the wire.

Variances in original length of the wire loops are pref-

erably compensated for by the take-up roll 22 in order that the tensioning roll can be operated within its designed operating range of movement.

Thus, it will be seen that I have provided an improved wire control mechanism for a Fourdrinier mechanism which meets the objectives, features and advantages hereinbefore set forth. The mechanism is reliable in operation, and avoids difficulties encountered with mechanisms heretofore used, and especially the conditions presented by tensioning rolls which will not permit sudden changes in length of the wire loop.

I have, in the drawings and specification, presented a detailed disclosure of the preferred embodiments of my invention, and it is to be understood that I do not intend to limit the invention to the specific form disclosed, but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by my invention.

I claim as my invention:

1. In a paper making machine, a looped Fourdrinier forming wire for carrying paper stock, a plurality of rolls supporting the wire, a suction box exposed to the wire, a drive roll driving the wire whereby driving forces in the wire will be caused when the wire is driven, a tension roll engaging the wire accommodating variances in length due to change in forces on the wire, a movable support for said tension roll accommodating said length variances, and an air spring having an air chamber formed by a flexible wall with ends and connected to said support and urging the roll to engagement with the wire to establish an initial tension therein and having a load deflection characteristic over the operating range of deflection of the roll due to said length variances so that the roll will be held against the wire to maintain said initial tension and the roll will move rapidly with sudden shortening of the wire so as not to increase tension.

2. In a paper making machine, a continuous looped Fourdrinier forming wire for supportingly carrying paper stock, a plurality of rolls positioned within the loop for supporting the wire, a suction means for applying suction to the wire whereby a drag force will be created, a drive roll engaging the wire whereby tension in portions of the length of the wire will change with variation in driving force of the drive roll, a tension roll for engaging the wire and accommodating variances in length due to change in forces on the wire with consequent change in the length of the wire, a movable support for said tensioning roll permitting movement of the roll with variance in length of the wire, an air spring having an air chamber formed by a flexible annular wall with ends and urgingly engaging the support to maintain the tensioning roll in engagement with the wire with said air spring having a load deflection characteristic which will not resist the changes in length of the wire as the length decreases with decrease in forces on the wire over a substantial range of wire length variance, and an adjustable mount for supporting the air spring to move the spring into its calibrated opening range.

3. A mechanism for use in a paper making machine including a looped forming wire for carrying paper stock comprising a plurality of rolls including a breast roll for carrying a looped forming wire, a driving member for driving engagement with the looped forming wire, a suction box exposed to the wire, a tensioning roll for engagement with the looped forming wire, an air spring having an air chamber formed by a flexible annular wall with ends and resiliently supporting the tensioning roll and having a substantial range of movement to accommodate variances in length of the looped forming wire with variances in driving force on the wire, said air spring having a characteristic which will not increase the tension in the wire with shortening of the wire when the driving forces change, means for adjustably supporting the air spring for the tensioning roll, and an indicator means for the tensioning roll whereby said air spring support may be adjusted to bring the tensioning roll into the proper operating range for operation of the machine.

4. In a paper making machine comprising a continuous looped Fourdrinier forming wire for carrying paper stock, a plurality of spaced rolls for supporting the looped wire, a drive roll for engagement with the forming wire and driving it over the carrying rolls, a suction box open to apply a suction to the wire, a tensioning roll positioned for movable engagement with the forming wire to adjust the tension thereof, and an air spring having an air chamber formed by a flexible annular wall with ends and positioned to support the tensioning roll to supply an initial tension to the wire and having a load deflection characteristic for applying a tensioning force to the tensioning roll which is the sum of a first force compensating for the weight of the tensioning roll in various positions over an operating range, and a second force compensating for changes in angle of wrap of the wire about the roll and holding the tensioning roll in engagement with the forming wire with a force to maintain said initial tension in said wire with change in roll position due to changes in length of the forming wire and permitting the roll to yield rapidly with sudden shortening of the wire.

5. A paper making machine including in combination a looped Fourdrinier forming wire, rolls located within the loop supporting the forming wire, a drive roll in driving engagement with the forming wire, a suction box for applying a suction to the wire, a tensioning roll in engagement with the wire for obtaining the proper tension, a pivotal support for said tensioning roll permitting free movement about a pivotal support axis, an inflatable closed air chamber having an annular flexible wall with end walls and having a non-linear force deflection characteristic and positioned to support said tensioning roll and support arm, a chamber support arm positioned to carry the chamber, and means for adjustably locating said chamber support arm to locate the tensioning roll in an operative position relative to the loop and said chamber wherein the changes in length of loop due to variances in drive forces are accommodated by movement of the tensioning roll and said chamber, said chamber having a characteristic to obtain a substantially constant tension in said loop whereby the length of the loop can be suddenly reduced with decrease in drive forces on the wire without an increase in tensioning effect of the tensioning roll.

6. A Fourdrinier type paper making machine including in combination a looped forming wire, supporting rolls including a breast roll located within the loop supporting the forming wire, a suction box positioned to apply a suction to the wire, a drive roll in driving engagement with the forming wire, a tensioning roll in engagement with the wire for obtaining the proper tension, a pivotal support arm for said tensioning roll permitting free movement about a pivotal support axis, an inflatable air spring having a chamber with a flexible annular wall and end walls and having a non-linear force deflection characteristic and positioned to support said tensioning roll and support arm, a pivotal spring support mounted for movement about the axis of the support arm, means for adjustably positioning the operating location of the pivotal support arm to bring the tensioning roll into operating position, and means for limiting the relative movement of said spring support arm and roll support arm whereby said air spring will not over-extend with reduction in tension on the loop.

7. In a paper machine having an elongated travelling element with a run supported at its ends on rolls, a rotatably supported tensioning roll in engagement with the run of the travelling element applying a tensioning force normal to the run, means for supporting the tensioning roll in engagement with said run for tensioning the run, and an air spring supportingly connected to said supporting means having an expansible air chamber formed of an annular flexible wall and end walls with the flexible wall

shaped to provide a non-linear force deflection characteristic at constant air pressure, said characteristic varying the force proportional to deflection over a range of normal operating positions of the roll supporting the weight of the roll, and changing to maintain constant linear tension in said element.

8. In a paper machine having an elongated element with a run supported at its ends on rolls, a rotatably supported tensioning roll in engagement with the run of the travelling element applying a tensioning force normal to the run, pivotally mounted arms supporting said tension roll in engagement with said run for tensioning the run, and an air spring supportingly connected to said pivotal arms having an expansible air chamber formed of an annular flexible wall and end walls with the flexible wall shaped to provide a non-linear force deflection characteristic at constant air pressure, said characteristic varying the force proportion to deflection over a range of normal operating positions of the tensioning roll and arms supporting the weight of the roll and arms and

changing to maintain a constant linear tension in said element.

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