Jan. 30, 1968 J. PICANOL 3,366,147

ADJUSTABLE TENSIONING DEVICE FOR THE BACK ROLLER IN LOOMS

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Fig. 1

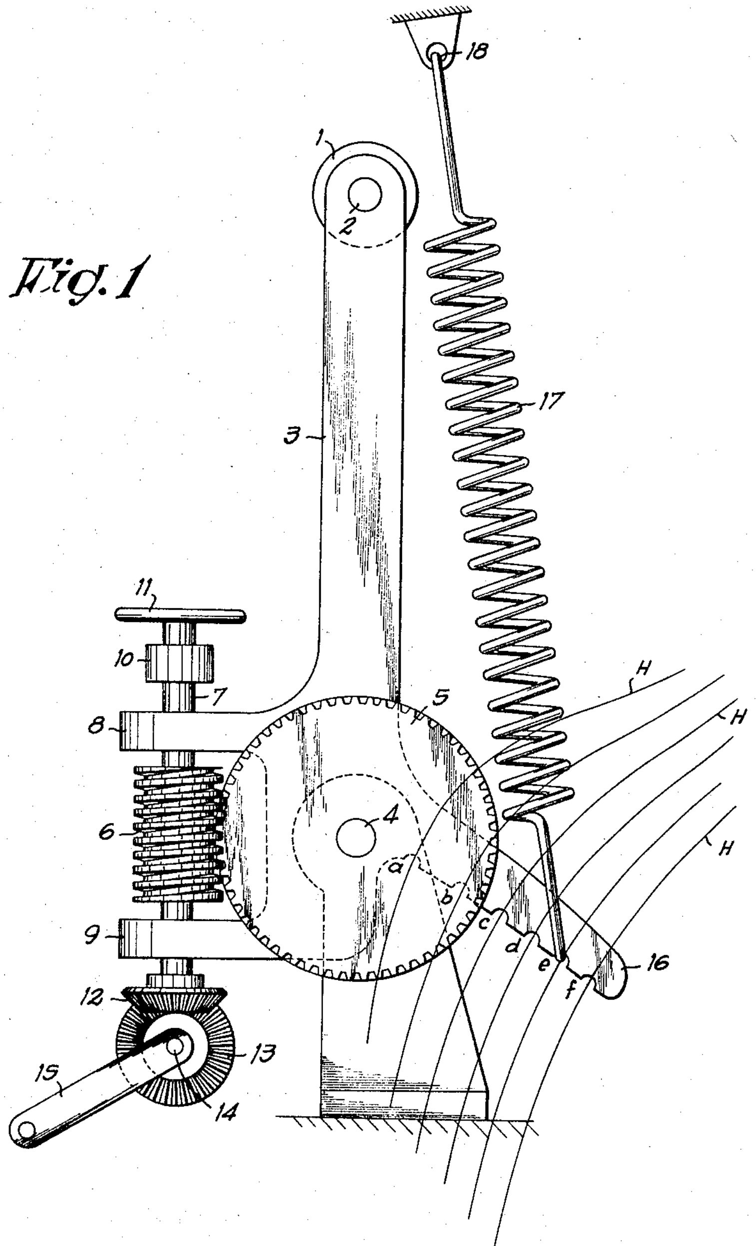

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Fig. 2

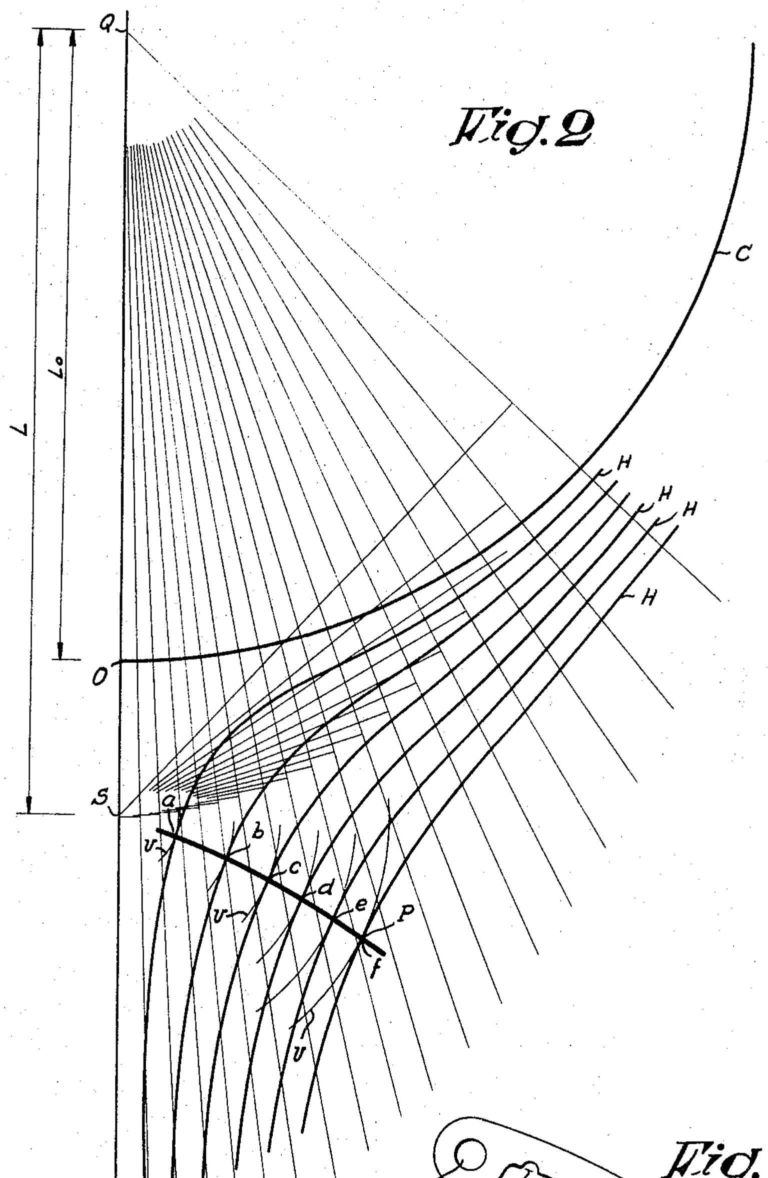

Fig. 3

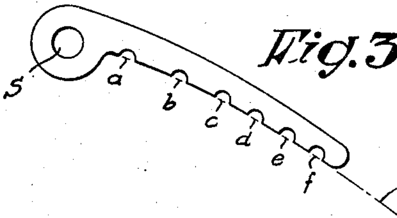

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Fig.4

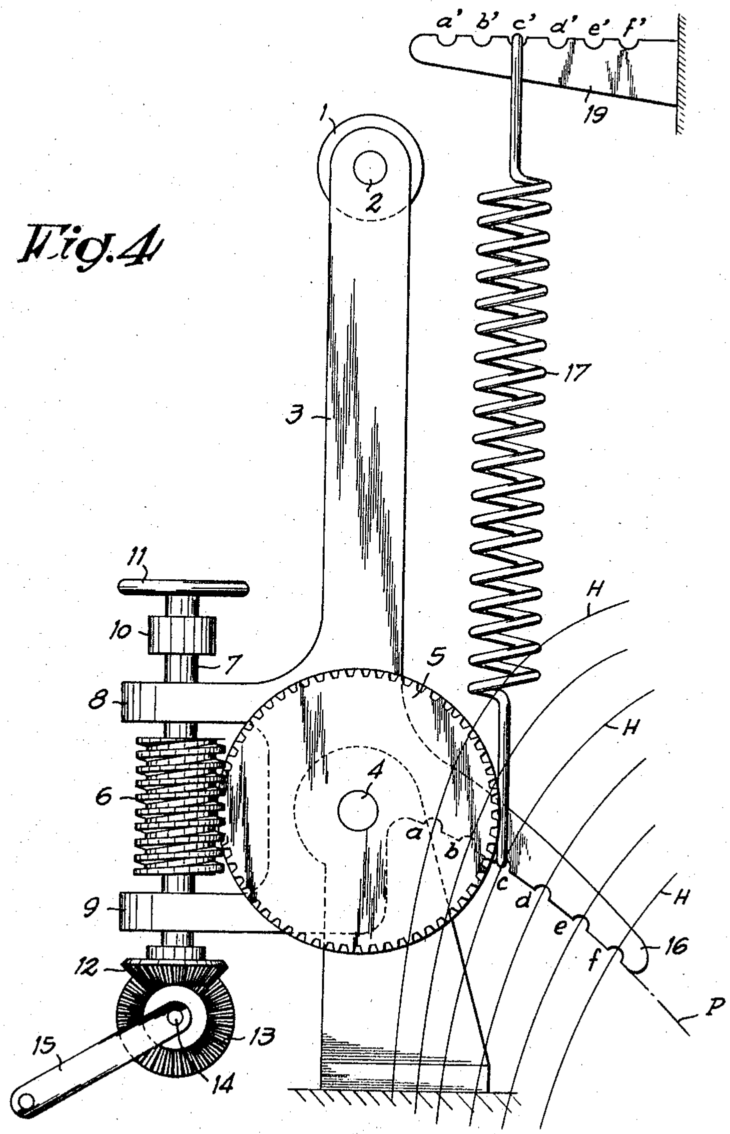

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Fig. 5

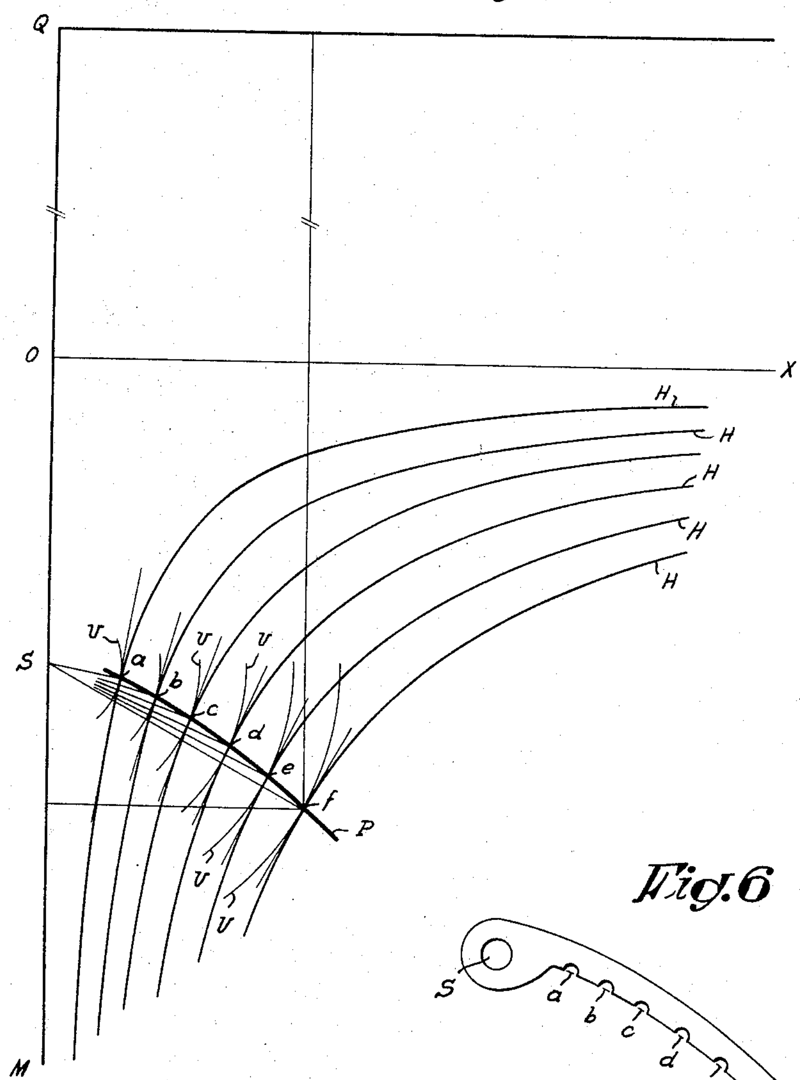
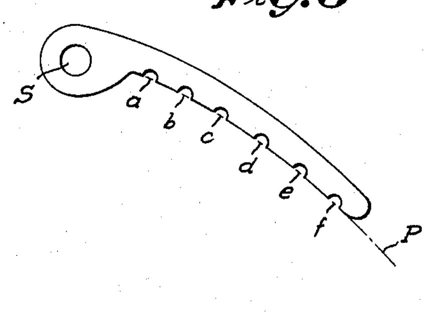


Fig. 6



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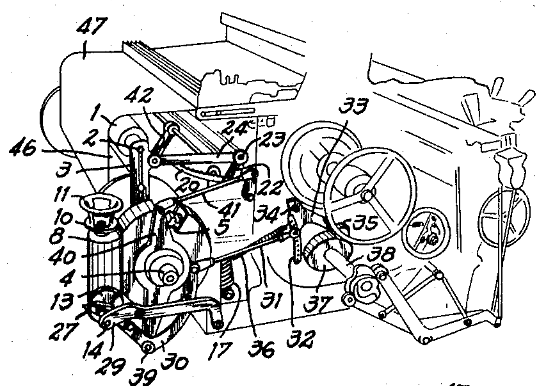

Fig. 9

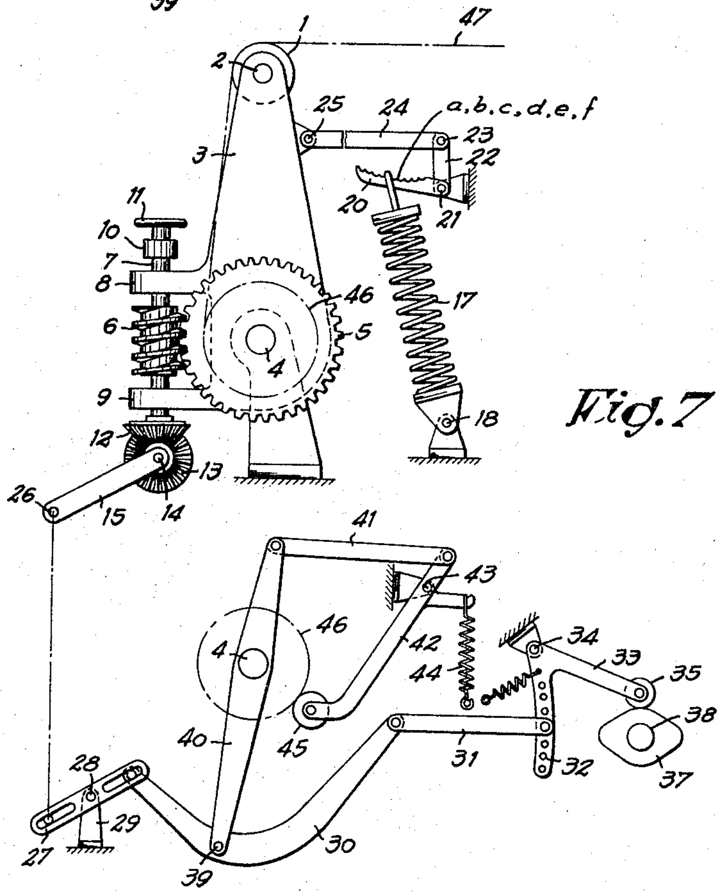

Fig. 7

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ADJUSTABLE TENSIONING DEVICE FOR THE BACK ROLLER IN LOOMS

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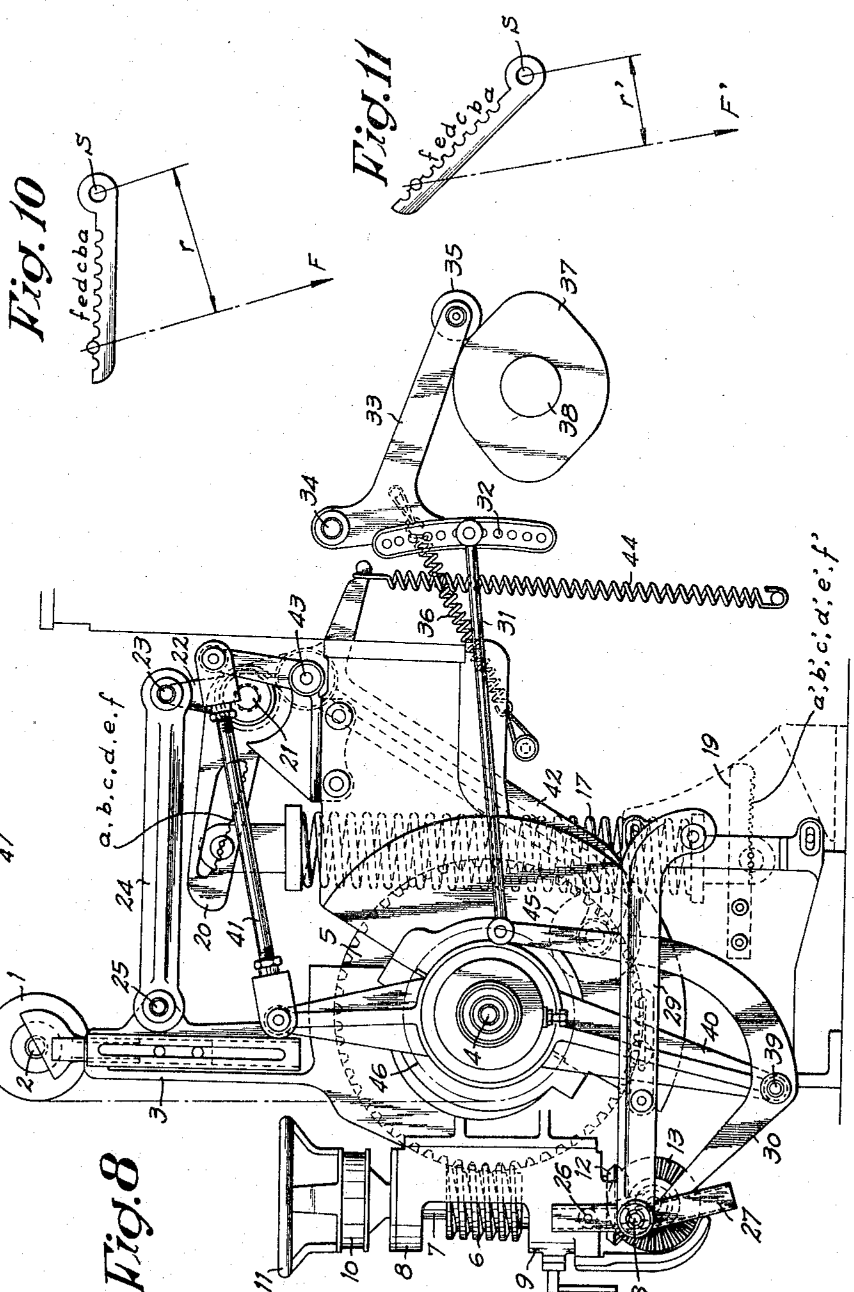

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United States Patent Office

3,366,147

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3,366,147

ADJUSTABLE TENSIONING DEVICE FOR THE BACK ROLLER IN LOOMS

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Claims priority, application Belgium, Apr. 23, 1965, 662,927
7 Claims. (Cl. 139—100)

One of the most essential problems related to weaving looms, especially to automatic weaving looms, ensues from the necessity of maintaining throughout the weaving operation a practically constant tension in all warp threads, as any variation in tension may result in weaving faults or irregularities, particularly in plain and/or fine tissues.

This problem of the constancy of wrap tension is aggravated, on the one hand, by the ever increasing speeds of the picking motion and on the other hand, on account of the large variety of yarns to be treated and the wide range of requirements to be met as regards the performances of the loom.

Generally, constancy of wrap tension is aimed at by a judicious arrangement of the warp unrolling or dispensing motion in conjunction with adequate tensioning of the back roller, both these arrangements being integrated with a view to ensuring the best possible synchronism between warp dispensing and the pull of the cloth wind-up motion.

The present invention relates more particularly to back roller tensioning devices, especially to such tensioning devices using resilient means, the back roller being supported by a pair of bars mounted for swinging movement around the warp beam axis.

Swinging back rollers of this kind have already been provided with tensioning arrangements using counterweights or springs.

Generally the arrangements based on the use of counterweights are to be rejected on account of the inertia effects they produce, particularly in the case of rapid changes in the equilibrium conditions of the mechanisms used for maintaining constant tension in the warp threads. Moreover such counterweight arrangements are relatively cumbersome and bulky.

Such back roller arrangements mounted for swinging motion around the warp beam axis and using resilient tensioning means, as hitherto proposed, have the major drawback of the swinging back roller support bars being associated with the tensioning device in such a manner, that it is impossible to change the initial position of the back roller without changing at the same time the characteristics of the resilient tensioning device itself.

Moreover such resilient tensioning devices do not provide a sufficient accurate setting procedure which is practical, i.e. which can be carried out by means of a rapid and systematic action of the weaver.

On the contrary the present invention aims at providing an adjustable tensioning device for back rollers mounted for swinging movement around the warp beam axis, said device being essentially characterized by the provision of means for shifting the point of application of the resilient tensioning member along a curve which is the locus of the intersections of perpendiculars dropped from the rotation centre of the tensioning device on a family of near-hyperbolic curves.

The term "near-hyperbolic curves" should be understool to comprise true hyperbolae as well as slightly distorted hyperbolae.

The tensioning device should be adaptable to wrap dispensing motions of all kinds and particularly to such

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warp dispensing motions which are driven by the picking motion and controlled by the warp beam sensing device.

The same adjustable tensioning device may be arranged to act directly upon the back roller support bars mounted for swinging movement about the wrap axis. Alternately and preferably however, said adjustable tensioning device according to the invention acts upon said support bars through the intermediary of a force converting transmission system of any suitable kind.

Finally the tensioning device according to the invention is also characterized in that the curve, on which the point of application of the tensioning spring may be shifted, can be determined either for the case in which the opposite end of the spring is attached to a fixed point of the loom, or for the case in which this other end of the spring is shifted concurrently so as to keep said spring parallel to itself in any of its predetermined positions in the tensioning device in question.

Accordingly it is a first object of the invention to provide an adjustable resilient tensioning device, which can be adjusted by judiciously positioning the point of application of the resilient member, said device being arranged for easy and reliable adaptation to the nature of the yarns and/or the desired properties of the fabric by means of a simple and systematic action.

It is a further object of the invention to provide such an adjustable resilient tensioning device which permits the initial position of the backroller to be changed according to the nature of the yarn to be treated and/or the fabric to be produced, without undue modification of the position and the intrinsic properties of said tensioning device.

It is a further object of the invention to provide such an adjustable resilient tensioning device which can be adapted at will either for direct action of said resilient spring members upon said back roller support bars, or for such action being achieved through the intermediary of torque converting transmission systems.

It is another object of the invention to provide such adjustable resilient tensioning devices having the same efficiency and reliability either with the second end of the tensioning spring member being kept at a fixed location, or with said second end of said spring member being shifted simultaneously with the first end so as to keep said spring member parallel to itself in any of its predetermined positions.

The invention comprises all possible embodiments of such adjustable tensioning devices comprising means for shifting the point of application of the tensioning spring along a characteristic curve as will be further defined in this specification.

By way of an illustrating example some embodiments will be described hereinafter in detail with reference to the accompanying drawings, in which:

FIGURE 1 represents the essential parts of an adjustable resilient tensioning device according to the invention;

FIGURE 2 illustrates in a polar diagram the procedure for plotting the characteristic curve on which must be chosen the points of application of the tensioning spring in the arrangement according to FIGURE 1;

FIGURE 3 represents a lever to be used in the tensioning device and which is shaped according to the curve as plotted in the polar diagram of FIGURE 2;

FIGURE 4 is a view similar to FIGURE 1, representing a modified embodiment of the invention;

FIGURE 5 illustrates in an orthogonal coordinate system the procedure for plotting the characteristic curve on which must be chosen the points of application of the tensioning spring in the arrangement according to FIGURE 4;

FIGURE 6 represents a lever to be used in the tensioning device and which is shaped according to the curve as plotted in the orthogonal coordinate system in FIGURE 5;

FIGURE 7 schematically represents a modified embodiment of the tensioning device according to FIGURES 1 to 3;

FIGURE 8 schematically represents a modified embodiment of the tensioning device according to FIGURES 4 to 6;

FIGURE 9 is a sketch showing in broad outlines a weaving loom equipped with a resilient adjustable tensioning device according to the invention;

FIGURES 10 and 11 are graphs useful for indicating the basic condition governing the design of the adjustable resilient tensioning device according to the invention.

Referring first to FIGURE 1, there is shown the tensioning roller or back-roller **1**, the shaft **2** of which rests in two bars **3** disposed on either side of the loom, and bars being mounted for swinging motion about the axis of the warp beam **4**.

One of these bars **3** carries the warp beam dispensing motion. As represented in the drawing this comprises a spiral gear **5** fixed on the axis of the warp beam; and endless screw **6** meshing with said spiral gear **5** and secured on the shaft **7**; two laterally projecting arms **8–9** integral with said support bar **3** and mounting said shaft **7** of said endless screw for rotating movement therein; a brake disc **10** of known construction and a hand wheel **11** for manual motion mounted on one end of said shaft **7**; a bevel gear **12** secured to the other end of said shaft **7** and meshing with a second bevel wheel **13**, the shaft **14** of said second bevel wheel being driven by the warp beam dispensing motion proper connected to the crank **15**, said motion being realized in any suitable form. As represented in the drawing, said support bars **3** are each provided with a laterally downward projecting arm **16** having a certain number of hook-on notches *a–b–c–d–e–f* for one end of the tensioning spring **17**, thus other end of which is secured to a fixed point **18** of the loom.

It is indispensible that the adjustable spring mechanism according to the invention fulfils at any time the following two conditions:

(1) For a determined position of the tensioning spring **17**, the tensioning torque exerted by the back-roller **1** should remain constant within the limits of the usual oscillating movements of the latter;

(2) For any of the positions *a–b–c–d–e–f* of the lower end of said spring **17**, said tensioning torque should be constant for the back-roller movements considered, the constant value of said torque being predetermined by the position of each of said hook-on notches. Therefore, the accurate establishment of the relative position of said hook-on notches is essential. This can readily be achieved with the precision required, either by computation or by means of a graphical construction. By computation it can be found that the curve on which the different hook-on points are to be located corresponds to the formulae:

$$\begin{cases} \cos\alpha = \dfrac{-R(R-L_o)\pm\sqrt{R^2(R-L_o)^2+4L^2L_oR}}{2L\cdot L_o} \\[2ex] R = \dfrac{L+L_o\cos\alpha\pm\sqrt{(L+L_o\cos\alpha)^2-4L\cdot L_o\cos^3\alpha}}{2\cos\alpha} \end{cases}$$

where

$L_0=\overline{QO}$,

$L=\overline{QS}$,

R= the radius vector taken from the point Q as origin to the hook-on point considered (*a–b–c–d–e–* or *f*), and

α is the angle between said radius vector and the axis QM.

Graphically, as shown in FIGURE 2, a polar diagram can be constructed.

For this purpose a family of curves is selected, equal in number to the number of hook-on points *a–b–c–d–e–f*, each of them similar in shape to a hyperbola asymptotically approaching the axis $\overline{QM}$ and the circular arc C around the centre Q, the radius L_o of which is equal to te length of the spring **17** at zero stress.

The hyperbolae are selected according to the desired torque which the spring **17** must impart to lever **16** around shaft **4** for each of the settings. As shown in FIGURE 5, for example, each hyperbola has an equation of the type $xy\equiv T$, where constant T is the torque desired for one setting of spring **17**.

The hook-on points for the spring of the tensioning device are determined, one on each curve H, by drawing a normal on said curve from the point S, which is the rotation centre of the resilient tensioning device according to the invention.

In the embodiment shown in FIGURE 1 this point S coincides with the axis **4** of the warp beam. Point S (FIGS. 2 and 5) coincides with a position of the axis of the shaft **4**. Point Q coincides with a point where the other extremity of spring **17** is hooked, the line QS being an axis joining points Q and S. After said hook-on points have been found in the way described, the curve P can easily be drawn, which makes it possible to give the lever **16** (FIGURE 1) its required shape, or to determine the shape of any suitable lever (FIGURE 3) which can be incorporated in a force multiplying leverage coupled between the back-roller **1** and its tensioning spring. The curves U are circle arcs centered on point S and tangent to the hyperbola H. The lines H are hyperbolae or hyperbolic curves established in the above-described manner.

By this arrangement it is obtained, that as the back-roller and thereby also the adjustable resilient tensioning device carryout their swinging movement, said hook-on points *a–b–c–d–e–f* each describe a circular curve U, and since said movements are always limited to relatively small angular values, within these limits there is a constant ratio between the increments of the spring tension and the leverage respectively, through which said spring acts on said back-roller, in such a way that the torque exerted by the latter is practically constant. As best shown in FIGURE 1, spring **17** applies a torque on shaft **4**, through the lever **16**, the torque having a predetermined value, as indicated. This torque is normally counterbalanced by the resistance of the warp thread passing over the back-roller **1**. During the shedding, for instance, the length of the warp thread slightly varies and this is compensated for by the rotation of bars **3** around shaft **4**. The amplitude of these movements is relatively small, so that the lower extremity of spring **17** which is hooked at *e* in FIGURE 1, may be considered to practically move along the corresponding hyperbola H, so that a torque imparted by spring **17** remains constant, For example, in FIGURE 5, where QO is the initial length of spring **17** under 0 tension when the spring is stretched, the distance of its lower extremity to the axis QM diminishes and vice versa, so that the torque remains constant.

As has been stated already, the line connecting the axis of the warp beam **4** with the hooking end **18** of the spring **17** is represented by the line SQ in the diagram of FIG. 2. This line cannot shift during the operation of the loom. The hook-on points *a*, *b*, *c*, *d*, *e*, and *f* of the lever **16** are determined by normals drawn on the hyperbolic curves from the point S. The permissible limits for the swinging of the back roller **1** in the course of which the hook-on points will carry out their circular movements depend in each case upon the sizes and connections of the various parts and must be established experimentally. It should be pointed out in this connection that under normal operational conditions the swinging movements of the back roller **1** will be well within these permissible limits.

In another embodiment the spring **17**, when shifted from one to another of said hook-on points *a–b–c–d–e–f*, is always kept parallel to itself. In order to achieve this, the other end of said spring **17** is also displaced each time to the corresponding one of a series of hook-on points *a'–b'–c'–d'–e'–f'* provided on a supporting member **19** secured on a fixed part of the loom.

In the embodiment according to FIGURE 4 the same members and parts **1** to **17** are found as in the embodiment of FIGURE 1. However in this second case, the different hook-on points *a–b–c–d–e–f* are on a curve which is the locus of the intersection points between a family of true hyperbolae and the normals dropped on said hyperbolae from the above-mentioned point S, which is the rotation centre of the adjustable tensioning device according to the invention.

In the orothogonal coordinate system this curve P corresponds to the equation

$$y=\frac{h}{2}+\sqrt[2]{\left(\frac{h}{2}\right)^2+x^2}$$

As indicated in FIGURES 5 and 6, the same as in the first example, this curve P can also be obtained by means of a graphical construction. In this case it suffices to trace a family of hyperbolae H, which have the axes $\overline{Q.M}$ and $\overline{O.X}$ as their asymtotes. The distance $\overline{Q.O}$ is equal to the length of the spring **17** at zero stress. The curve P, on which the hook-on points *a–b–c–d–e–f* are to be located, may be obtained by determining the intersection points between said curves H and the normals dropped on said curves from the point S, said point S being the rotation centre of the resilient tensioning device according to the invention.

As said curves H are hyperbolae according to the equation $x \cdot y=C$ and said hook-on points *a–b–c–d–e–f* always swing about said point S, these hook-on points will describe circular arcs U in such a way that, within the limits of the small oscillation amplitudes of the resilient tensioning device, a virtually constant ratio is maintained between the opposite increments of spring tension in spring **17** and of the lever-arm through which the latter acts on the back-roller, respectively. Consequently a constant torque is applied to said back-roller, and this is true for any of the positions *a–b–c–d–e–f* and *a′–b′–c′–d′–e′–f′* respectively of said tensioning spring.

The curve P thus obtained (FIGURE 5) makes it possible to determine the wanted shape of the lever **16** in the device according to FIGURE 4, or of any suitable lever (FIGURE 6) that may be incorporated in any appropriate leverage for the constant torque action to be exerted on the back-roller.

Generally, direct action of the spring **17** on the support bars **3** of the back-roller **1** will be applied, in the particular conditions as described above, provided that in view of the nature of the yarns and the tissues to be produced, the movements of the back-roller are limited to relatively small amplitudes and above all, provided the tension to be provided by said back-roller is not excessive.

In a general way too, in view of the ever increasing range of performances required from weaving looms, especially from automatic weaving looms, it is preferred to insert a force-multiplying leverage between said spring **17** and the back-roller support bars **3**. According to a special feature of the invention said force-multiplying leverage can be readily designed in such a way that, apart from its force-multiplying function, it also permits substantial modification of the initial position of the back-roller, if such be required in special cases, particularly when special yarns are to be woven.

A first application of a device according to FIGURES 1, 2 and 3, but combined with a force-multiplying leverage, is shown schematically in FIGURE 7. It comprises substantially the same members and parts as shown in FIGURE 1, with the exception of the arm **16**.

The spring **17** is fastened on the one hand to a fixed point **18** and on the other hand to one of the points *a–b–c–d–e–f* provided on one of the arms **20** of a toggle joint lever rocking about a fixed pivot **21** the second arm **22** of which is connected by means of a pivot joint to the end of a connecting rod **24**, the latter being hinged at its other end, by means of a pivot joint **25**, to the bars **3** that support the shaft **2** of the back-roller **1**, said bars being mounted for swinging movement about the axis **4** of the warp beam.

The hook-on points *a–b–c–d–e–f* are established in the way as described before.

The connecting rod **24** may be of constant or variable length. In the latter case it can be made in two parts, arranged to be secured one to the other in such a way as to obtain any wanted distance between the pivots **23–25**.

The pin **26** of said crank **15** is connected to a latch **27** capable of oscillating movement about a pivot **28** fixed on a support bracket **29**. Said latch **27** is also articulated to one of the ends of an angle lever **30**, the other end of which is articulated to one end of a connecting rod **31**, the other end of which may be fixed in any one of a number of prepared positions **32** spaced along one of the arms of a V-shaped lever **33** having its top angle rotatably mounted on a fixed pivot **34**. The second arm of said V-shaped lever **33** carries a roller **35** acting as cam follower riding on the peripheral edge of the cam **37** secured on the picking motion drive shaft **38**, said roller **35** being permanently urged against said peripheral edge of said cam by the action of spring **36**. On the other hand said angle lever **30**, in a point near its bend, is rotatably mounted on a pivot **39** mounted on one end of the arms of a rocking lever **40**, which is mounted for free rotational movement about the axis **4** of the warp beam drive gear. The second arm of said rocking lever **40** is connected by means of a pivot joint to one end of connecting rod **41**, the other end of which is pivotally connected to one end of the warp beam sensing device, the later consisting of a lever **42** rotatably mounted at an intermediate point of its length and having at its other end an appropriate roller or roller pair **45** in permanent contact with the warp beam **46**, said rollers being thrust against the circumference of said warp beam by the action of a tensioning spring **44**. Preferably the pivot **43** may be replaced by a rod on which the sensing device would be mounted, said rod being supported by short links which would be articulated to said connecting rods **41**.

FIGURE 8 shows a similar embodiment as shown in FIGURE 7, but using the arrangement of an adjustable resilient back-roller tensioning device according to the FIGURES 4, 5 and 6.

In FIGURE 8, parts and members having equivalent functions as parts shown in FIGURE 7 are indicated with the same reference numbers. It will be seen however in this embodiment, that the spring **17** can be fastened at one end, to one of the hook-on points *a–b–c–d–e–f* provided on lever **20** and at the other end, to the corresponding one of the hook-on points *a′–b′–c′–d′–e′–f′* provided on the bracket **19** which is firmly secured on the weaving loom's framework.

In both cases according to FIGURE 7 or 8, the operation of a warp dispensing motion combined with a resilient back-roller tensioning arrangement according to the invention may be explained in the following way: in both cases, before starting the operation, the lever **31** is connected to the V-shaped lever **32–33** in an appropriate relative position as determined by the weft of the tissue to be produced. The sensing roller **45** is placed in contact with the warp beam **46** and the spring **17** of the constant tension device is correctly hitched on to the branch **20** of the above-said toggle joint lever in the arrangement according to FIGURE 7, or simultaneously with one end to said branch **20** and with the other end to the bracket **19**, in the arrangement according to FIGURE 8. In any case the hook-on points to be employed for the spring **17** will be determined in accordance with the qualities of the warp threads and the properties of the tissues to be produced. All of these preliminary adjustments, as is well known by those skilled in the art, are to be established in accordance with the desirable weaving conditions.

When the loom is put into operation, the picking shaft **38** drives cam **37** which produces oscillating or rocking movement of the leverage consisting of V-shaped lever **32–33**, connecting rod **31**, angle lever **30**, latch **27**, crank **15**. The latter drives the bevel gears **13–12** so as to rotate shaft **7**, endless screw **6** and finally, via the spiral gear **5**, shaft **4** of warp beam **46**. In this way the rotation of the wrap beam is derived from that of the picking motion drive shaft of the loom.

As the diameter of the warp beam **46** decreases, the sensing roller **45**, via the levers **42–41** and the rocking lever **40**, shifts the position of the point of application of the angle lever **30** to the latch **27**. In this way the liner dispensing speed of the warp beam is maintained practically at a constant value in spite of the steady reduction of the warp beam diameter. At each stroke of the weft tightening reed, as well as through the traction of the cloth winding mechanism, the bundle of warp threads **47** tugs at the back-roller **1** so as to produce oscillating movement of the latter about the warp beam axis **4**.

This repeated tugging, in conjunction with possible variations in the length of warp dispensed by the warp beam, which could result from various circumstances, could produce unwanted fluctuations of warp tension which would result in inadmissible irregularities in the tissue.

With a view to ensuring constant tension in said warp threads, said back-roller is acted upon by the resilient constant tension device as described above in such a way that, whichever oscillating movements the support bars **3** and the back-roller are subject to, said tensioning torque remains constant and consequently the tension in said warp threads is also constant.

It is apparent that the above detailed description has been given only by way of a non-restrictive example, the scope of the invention embracing all constant tension devices, whichever means they employ for ensuring said constant tension in a system using a tensioning spring, provided they fulfill the essential condition, as symbolically shown in FIGURES 10 and 11, the resilient tensioning device always exerts a constant torque $F \cdot r$, $F' \cdot r'$, ...

FIGURE 9 shows the relative position of the adjustable tensioning device with respect to the warp dispensing mechanism in an automatic weaving loom.

The invention extends to such warp dispensing motion in itself or combined with any other suitable auxiliary mechanism, as well as to any loom having such adjustable tensioning device incorporated therein.

What I claim is:

1. In a loom having a warp beam, a back-roller tensioning device, means supporting said tensioning device for oscillating movement about the warp beam axis, a displaceable resilient member adapted to adjust said tensioning device, means causing the displacement of one extremity of said resilient member along a curve corresponding to the tension imparted by said tensioning device, and means attaching said resilent member to a fixed point, the other end of said member being displaceable along a curve according to the equation:

$$\begin{cases} \cos\alpha = \dfrac{-R(R-L_o) \pm \sqrt{R^2(R-L_o)^2+4\ {}^2L_oR}}{2L \cdot L_o} \\ R = \dfrac{L+L_o\cos\alpha \pm \sqrt{(L+L_o\cos\alpha)^2-4L \cdot L_o\cos^3\alpha}}{2\cos} \end{cases}$$

2. Adjustable tensioning device as claimed in claim **1**, wherein said resilient member is always displaced so as to remain parallel to itself, one end of said member being displaced along a curve having the equation:

$$y = \frac{h}{2} + \sqrt[2]{\left(\frac{h}{2}\right)^2 + x^2}$$

3. In a loom having a warp beam and a back-roller, an adjustable tensioning device comprising bars mounted for oscillating motion about the warp beam axis and supporting said back roller, a spring having one end attached to a fixed part of said loom, a force-multiplying leverage connected to said bars, the other end of said spring being attached to said force-multiplying leverage, said force-multiplying leverage comprising a lever having a curved edge, said other end of said spring being hitched on to said curved edge of said lever, said curved edge being delineated by the locus of all points of minimum distance on a family of hyperbolae with respect to the rotation center of said tensioning device.

4. Adjustable tensioning device as claimed in claim **3**, characterized in that said lever having said curved edge for movable attachment of one end of said spring constitutes one arm of a toggle joint lever, the other arm of which is connected to said oscillating back-roller support bars by means of a connecting rod.

5. Adjustable tensioning device as claimed in claim **3**, characterized in that said arm having said curved edge for movable attachment of one end of said spring constitutes one arm of a toggle joint lever, the other arm of which is connected to said oscillating back-roller support bars by means of a connecting rod.

6. Adjustable tensioning device as claimed in claim **5**, wherein the one end of said spring is hitched on to a bracket secured on a fixed part of said loom, in such a way that when said spring is displaced along said curved edge, it is always kept parallel to itself.

7. Adjustable tensioning device as claimed in claim **4**, characterized in that said connecting rod joining said oscillating back-roller support bars with said toggle member having one end of said spring attached thereto, is of adjustable length so as to permit shifting the initial position of said back-roller without changing the characteristics of said tensioning device.

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